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The experiences of community dwelling older people using Nymbl - a digital health intervention to prevent falls

A thesis presented in partial fulfilment of the requirements for the degree of Master of Public Health

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Abstract

Falls present a major public health challenge globally, causing significant injury, disability, and increasing economic strain as populations age. Although traditional strength and balance programs are highly effective, they are limited by low long-term adherence and accessibility barriers. Digital health interventions (mHealth), such as the Nymbl balance training app, represent an innovative, scalable approach, but engagement metrics show user participation often diminishes following initial uptake. This qualitative study aimed to deepen the understanding of how community-dwelling older people in New Zealand experience, adopt, and sustain use of the Nymbl app. In-depth, semi-structured interviews were conducted with older Nymbl users, and data were analysed via Template Analysis framed by the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2). The findings reveal that participants engaged successfully when the app satisfied two main conditions: being clearly useful (Performance Expectancy) and easy to use (Effort Expectancy). Users reported measurable gains in balance confidence and daily functioning and appreciated the app's short, simple sessions. Initial adoption was heavily influenced by social factors. However, sustaining engagement was a major challenge, limited by waning motivation, perceived monotony, and occasional technical or content-related frustrations. These findings suggest that the future success of mHealth for fall prevention depends on incorporating user-centred design, ensuring cultural relevance, and integrating digital tools into a comprehensive, supportive community and healthcare ecosystem to promote long-term adherence and equitable access.

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Chapter One – Introduction

1.1 Background

Population ageing is a defining demographic trend of the 21st century, with profound implications for health systems, social structures, and economies worldwide. The phenomenon, often referred to as the "Third Demographic Transition" is characterised by declining fertility rates, increased longevity, and a rapid rise in the proportion of older people within populations (Ogura & Jakovljevic, 2018; UnitedNationsPopulationDivision, 2022). Globally, the number of people aged 65 and over is growing faster than any other age group, driven by improvements in living standards, advances in medical care, and public health interventions (Hong et al., 2023). In high-income countries, this transition has unfolded over several decades, allowing for gradual adaptation of social and healthcare systems (Navaneetham & Arunachalam, 2025). However, many low- and middle-income countries are experiencing population ageing at an unprecedented pace, compressing the demographic shift into just a few decades (Ogura & Jakovljevic, 2018). This acceleration presents unique challenges, as these nations must simultaneously address the dual burden of infectious diseases and the rising prevalence of chronic, age-related conditions (Khan et al., 2024).

The implications of population ageing are multifaceted. As the proportion of older people increases, societies face escalating demands for healthcare, long-term care, and social support services (Hambleton et al., 2023). Financial pressures on pension systems and healthcare budgets intensify, particularly as longevity increases the duration of retirement and the prevalence of disability and frailty (Dieleman et al., 2017; Ogura & Jakovljevic, 2018). These demographic changes underscore the urgency of developing sustainable, person-centred approaches to healthy ageing, including preventive health strategies, age-friendly environments, and innovative models of care. In New Zealand, as in many other high-income countries, the ageing population is expected to drive a continued rise in age-related health issues such as falls, placing additional strain on health and social services unless effective preventive measures are implemented (ACC, 2025a).

In absolute terms, as the world's population ages, the number of falls is rising. The Global Burden of Disability (GBD) 2017 study reported about 695,000 fall deaths in 2017 (James et al., 2020), and a 2021 analysis (GBD 2021) indicated that the total annual number of falls in people aged 65+ worldwide has roughly doubled since 1990 (Murray, 2024).The increase is driven largely by more people living into older age. The overall rate remains high and unequally distributed, high-income countries report the highest fall incidence in older people, whereas low-income countries, despite lower incidence, often have worse outcomes due to limited trauma care (James et al., 2020; WHO, 2021a).

Falls are a major health concern for older people worldwide. Falls often have serious consequences for older people. The WHO estimates that worldwide 37.3 million falls requiring medical attention occur each year and falls cause about 684,000 deaths annually – making them the second leading cause of unintentional injury death after road accidents (WHO, 2021a). Adults over 60 years of age suffer the greatest number of fatal falls (WHO, 2021a). Many non-fatal falls also result in significant injury; between 20–30% of older people who fall suffer moderate to severe injuries such as bruises, hip fractures, or head trauma (Salari et al., 2022; WHO, 2021a). In fact, falls are the leading cause of injury-related hospitalisations in most high-income countries for those 65 years and older (Montero-Odasso et al., 2022). For example, in the United States, about 36% of all older person falls result in an injury that requires medical treatment or restricts activity (Bergen et al., 2016). Falls contribute to disability; globally, they account for an estimated 38 million DALYs (disability-adjusted life years) lost each year (WHO, 2021a), which is more years lived with disability than any other injury mechanism (more than road injuries, drowning, burns, and poisoning combined) (WHO, 2021a). Notably, while older women fall more often than men, older men have higher fall-related mortality rates (possibly due to higher risk falls or comorbidities) (James et al., 2020; WHO, 2021a).

Falls in older age often initiate a cascade of adverse health outcomes that are more severe than those associated with falls earlier in life. Unlike younger individuals, older people typically experience diminished physiological reserves, reduced bone density, and comorbid conditions that amplify the consequences of even minor injuries (Ambrose et al., 2013; WHO, 2021a). A single fall can lead to fractures, particularly hip fractures, which are strongly linked to long-term disability, loss of independence, and increased mortality risk (Haagsma et al., 2020). Beyond physical harm, falls frequently precipitate psychological consequences such as fear of falling, which can result in activity restriction, social isolation, and accelerated functional decline (Sherrington et al., 2019). These outcomes often necessitate prolonged rehabilitation or institutional care, creating a cycle of dependency and escalating healthcare costs (Haagsma et al., 2020). Consequently, falls in later life represent not merely isolated incidents but pivotal events that can significantly alter the trajectory of ageing, underscoring the importance of preventive strategies and early interventions.

Falls from a Global Perspective

Globally, around one in three adults aged 65 and over experiences at least one fall each year (Salari et al., 2022). A recent systematic review of 104 studies (total sample ≈36.7 million) found a pooled annual fall prevalence of 26.5% among community-dwelling older people (Salari et al., 2022). Regional rates vary, the highest reported prevalence is in Oceania (~34%) and North America (~28–30%) (Salari et al., 2022). In most high-income countries, about 30% of older people fall each year, rising to nearly 50% among those aged 80+ (WHO, 2021a). By contrast, in low- and middle-income countries (LMICs) reported rates are often lower, though this may reflect under-reporting; still, older adults in LMICs bear a greater share of severe and fatal falls (WHO, 2021a).

Understanding these fall prevalence rates is critical because they reflect underlying social, environmental, and health system determinants that shape risk profiles across regions. Higher rates in certain areas may be linked to differences in housing design, urban infrastructure, access to preventive health services, and cultural attitudes toward physical activity (Almas et al., 2025; WHO, 2021a). Conversely, lower reported rates in LMICs may mask substantial burdens of severe and fatal falls, often exacerbated by limited emergency care and rehabilitation services (Salari et al., 2022). These disparities suggest that falls are not inevitable consequences of ageing but are influenced by modifiable determinants, offering opportunities for targeted interventions such as home hazard reduction, community exercise programmes, and policy initiatives to create age-friendly environments (Sherrington et al., 2017). Addressing these factors can reduce fall incidence and mitigate the cascade of health and social consequences that often follow falls in later life (Gillespie et al., 2009).

Falls in New Zealand

The epidemiology of falls in New Zealand mirrors global patterns observed in high-income countries. Comparatively, New Zealand’s older-person fall rate of approximately 30% annually (ACC, 2025a) is similar to that in Australia, the UK, and North America (30–35%), and higher than some European countries (which generally report 25–30%) (Salari et al., 2022). Falls are extremely common among older people in New Zealand and represent a leading cause of injury and hospitalization. According to the Accident Compensation Corporation (ACC), about one in three New Zealanders over 65 injure themselves in a fall each year, this rises to roughly one in two by age 80+ (LiveStrongerForLonger, 2025b). In

2024 alone, 260,218 older people in New Zealand (60+) made ACC claims for fall-related injuries, corresponding to ~22% of the 60+ population and ~31% of all fall claims (ACC, 2025a). This reflects the increased proportion of older people in the population. Falls are the number one cause of injury requiring medical attention among older people in New Zealand. Among those aged ≥85, falls account for about two-thirds of all injury claims (ACC, 2019). Common serious injuries following a fall include hip fractures, other fractures, and head injuries. For example, in 2023 about 3,668 New Zealanders over 50 were hospitalized with hip fractures – and the majority were due to falls (ANZHFR, 2024). Many fall injuries in New Zealand result in long hospital stays and rehabilitation; in 2022 the number of hospital bed days due to injurious falls without fractures was 116,081 (ONZ, 2025).

Falls in older people impose a substantial economic cost on healthcare systems worldwide (WHO, 2021a). The cost comes from emergency responses, hospitalizations, surgeries (e.g. for fractures), rehabilitation and long-term care. In the United States, falls among older people were estimated to cost about $50 billion (USD) in direct medical expenses in 2015 (CDC, 2020). Similarly, in Australia, fall injuries in 2021–22 cost the health system an estimated $4.7 billion (AUD); in 2022–23 this rose to about $5.0 billion (AIHW, 2025).

Although age is an important predictor of falls, there are other important characteristics that predict falls and the extent of injury experienced after a fall. Polypharmacy, particularly the use of psychotropic medications, is strongly associated with impaired balance and increased fall risk (Gagnon et al., 2024). Cognitive impairment and dementia further exacerbate vulnerability by reducing hazard awareness and gait stability (Huang et al., 2024; Muir et al., 2012). Sensory deficits, such as poor vision and hearing loss, also play a critical role, as they limit environmental perception and reaction time (Lord et al., 2010; Rubenstein, 2006). Moreover, chronic conditions like diabetes and cardiovascular disease can lead to neuropathy, orthostatic hypotension, and muscle weakness, compounding fall risk and recovery challenges (Colón-Emeric et al., 2024). These factors often interact synergistically, creating complex risk profiles that demand multifactorial prevention strategies, including medication review, cognitive screening, and tailored exercise interventions.

<u>Falls Monitoring and Prevention through the Accident Compensation Corporation (ACC)</u>

Overall, the picture in New Zealand is of a sizeable and growing public health challenge, as the population ages, the number of falls and associated injuries is expected to rise further unless preventive measures can curb the trend (NewZealandGovernment, 2016). What distinguishes New Zealand is the comprehensive capture of fall injuries through ACC, which highlights the impact of falls on the healthcare and insurance system. The ACC system provides a unique advantage in monitoring and addressing falls in New Zealand by ensuring comprehensive, nationwide capture of injury data. Unlike many countries where fall-related injuries are recorded across fragmented health and insurance systems, ACC's universal coverage enables consistent reporting and analysis of falls across all age groups and settings (ACC, 2025a). This integrated approach facilitates epidemiological surveillance, allowing policymakers and health agencies to identify trends, high-risk populations, and emerging patterns. Furthermore, ACC data underpins targeted prevention programmes, such as home safety assessments and strength and balance initiatives, by linking injury claims to evidence-based interventions (ACC, 2019; NewZealandGovernment, 2016). The ability to track outcomes longitudinally also supports evaluation of preventive strategies, making ACC not only a compensation mechanism but a cornerstone of fall prevention policy in New Zealand.

ACC has a unique role in providing support for New Zealanders following accident or injury. Falls represent one of the most significant injury categories, and ACC's commitment to helping people manage their recovery is reflected in the scale of its support (ACC, 2025b). In 2018, fall-related injuries cost ACC approximately NZ$1.1 billion (ACC, 2025a). Since then, costs have escalated dramatically. By the 2023–24 financial year, ACC's annual expenditure on new and active fall injury claims reached ~NZ$2.5 billion (ACC, 2025a). Over the six-year period 2018 to 2023, ACC paid out around NZ$9 billion for fall injury claims in total (ACC, 2025a). This comprehensive approach not only addresses immediate health needs but also promotes long-term wellbeing, enabling older adults to remain active and engaged in their communities. By investing in rehabilitation and prevention, ACC fulfils its core purpose, providing timely assistance to those affected by falls and reducing the broader impact on individuals, families, and society. New Zealand's per-capita fall injury costs are among the highest in the world. In a country of ~5 million people, spending $2.5B NZD on falls is extremely high, roughly comparable on a population basis, to the United States (where ~$50B USD for ~330 million people was reported). The ACC system means that virtually all costs of acute treatment and rehab for falls are captured as claims, revealing the full support offered. By contrast, in other countries costs are carried across various insurers and individuals, but the overall economic impact is similarly large. Preventing even a fraction of falls can thus save millions in healthcare expenses. Beyond medical costs, falls have ancillary economic impacts, for example, long-term care admission rates increase after hip fractures, and families may need to fund home modifications or caregiving.

Recognising that older people account for a substantial proportion of fall-related injuries and associated claims, ACC has prioritised interventions that address the unique needs of this population. The strategy combines evidence-based programmes such as strength and balance classes with community partnerships and targeted campaigns aimed at improving home safety and reducing environmental hazards (ACC, 2023; New Zealand Government, 2016). In recent years, ACC has expanded its focus to include innovative solutions such as digital health tools, reflecting a commitment to accessible, scalable interventions that can reach older people in diverse settings. By integrating prevention into its broader injury management framework, ACC not only supports recovery after falls but actively works to reduce their incidence, aligning with national goals for healthy ageing and independence.

Fall prevention programmes

Evidence-based interventions for fall prevention have evolved over the past two decades (Close & Lord, 2022). Structured exercise programs, particularly those focusing on strength and balance training, have demonstrated strong efficacy in reducing falls among older people (Gillespie et al., 2009; Sherrington et al., 2019). Exercise in general is also widely recommended for older people to maintain functional ability, promote wellbeing and improve quality of life (Izquierdo et al., 2021; Sherrington et al., 2017). Multifactorial approaches which combine exercise with medication review, vision correction, home modifications, and chronic disease management, are also widely recommended. However, despite the proven effectiveness of these interventions, uptake and sustained adherence remain low. Barriers include limited access to programs, transportation challenges, financial constraints, low self-efficacy, and fear of falling (Nyman & Victor, 2012; Yardley et al., 2008).

In response to these challenges, digital health technologies, particularly mobile health (mHealth) interventions have emerged as promising tools for fall prevention. mHealth platforms offer flexible, home-based exercise options, personalised feedback, and remote monitoring with the potential to overcome many barriers associated with traditional programmes. In New Zealand, the integration of digital solutions such as the Nymbl app into the national fall prevention strategies reflects a broader shift toward leveraging technology to support healthy ageing. However, the effectiveness of these types of interventions in real-world settings depends on older peoples' willingness and ability to engage with technology, as well as the design and delivery of the digital interventions themselves. The rapid growth of the older population in New Zealand, along with increasing fall-related injuries and costs, underscores the urgent need for innovative, accessible and user-centred fall prevention strategies. Understanding the lived experiences of older people with digital health interventions is critical to optimising their design, improving uptake and adherence and ultimately reducing the impact of falls in the older population.

1.2 Current Fall Interventions

To address this issue, the New Zealand government has implemented a coordinated, multi-sector approach focusing on fall prevention among older adults. The cornerstone is the Live Stronger for Longer (LSFL) programme, launched in 2016 under the Healthy Ageing Strategy. LSFL is led by the Accident Compensation Corporation (ACC) in partnership with the Ministry of Health and the Health Quality & Safety Commission (HQSC), and it encompasses a range of interventions aimed at reducing falls and fragility fractures. A major component is nationwide community-based strength and balance training. ACC facilitates and approves local providers to run exercise programmes designed to improve older peoples' strength, balance, and mobility. This includes group exercise classes (for example, Age Concern's "Steady As You Go" peer-led classes which focus on improving balance and strength in community-based settings). Such interventions are evidence-based; controlled trials have shown that structured strength and balance programmes can reduce fall rates by around 30% among participants (Gillespie et al., 2009). In parallel, LSFL supported the establishment of Fracture Liaison Services (FLS) in all health regions as a secondary prevention measure. An FLS is a coordinated service that identifies older patients (typically aged 50 and over) who suffer a fragility fracture and ensures they receive appropriate osteoporosis treatment and fall risk management to prevent future fractures. This approach addresses the well-recognised phenomenon that a first fracture greatly increases the risk of subsequent fractures if underlying bone health and risk factors are not managed. Recognising that falls have multifactorial causes, the LSFL programme also promotes other preventative measures, for example, encouraging vision checks, home safety assessments, medication reviews, and vitamin D supplementation in at-risk groups, to create a holistic falls and fracture prevention system. In essence, LSFL integrates efforts across community exercise, clinical care, and public education under one national strategy.

In addition to LSFL's community focus, New Zealand had targeted fall prevention in healthcare settings through an HQSC-led initiative. The "Reducing Harm from Falls" programme (2013–2018) was a national quality improvement campaign concentrating on hospitals and residential aged-care facilities. It introduced standardised fall risk assessment for older inpatients, improved ward environments (e.g. minimizing hazards, using alarm bells and low beds), and promoted best practices like routine vitamin D supplementation in rest homes (HQSC, 2020). Community organisations and the private sector contribute to New Zealand's fall prevention system, working in collaboration with the government programmes. Age Concern New Zealand, for example, is a non-governmental organisation that has been instrumental in delivering community exercise interventions. Age Concern's local branches coordinate the Steady As You Go (SAYGo) strength and balance classes nationwide, providing a low-cost, accessible option for older people in neighbourhood centres. This peer-led programme, which originated in Otago, has been proven to improve balance and leg strength and to help reduce participants' likelihood of falling (Robertson et al., 2014). The SAYGo classes have expanded to dozens of locations across the country and are now an integral part of the LSFL approved network.

1.3 The Nymbl App for Fall Prevention

In 2023 ACC launched the Nymbl mobile application as a free tool for older people to practice balance exercises at home, combining simple physical activities with cognitive tasks (ACC, 2023). The Nymbl app is a digital health intervention developed to improve balance and reduce fall risk in older people. It operates as a self-guided programme that combines physical exercises with cognitive challenges in a dual-task format. This approach is based on the understanding that balance is not only a musculoskeletal function but a complex process requiring sensorimotor integrations and executive control (Papi et al., 2020). The app delivers short daily sessions of approximately ten-minute duration. It is designed to work on any smartphone or tablet and requires no additional equipment. The exercises target balance but not strength. Exercises can be done at varying levels of difficulty and intensity based on input from individual users, via an initial assessment; the app tracks performance over time to monitor improvement and adjust exercises accordingly (Nymbl, 2025) (LiveStrongerForLonger, 2025a).

There is some evidence supporting the feasibility and acceptability of Nymbl. Papi et al. (2020) found that older people using Nymbl demonstrated significant improvements in sway measures during tandem tasks, with most participants reporting the programme as easy to integrate into their daily routines. More recently, Wain et al. (2025) conducted a retrospective cohort analysis using data from Kaiser Permanente, a major U.S. integrated health system that provides both medical care and insurance coverage within a coordinated, non-profit network. Their study observed a 4.24 percentage point reduction in acute fall-related injuries among members registered for Nymbl, with a clear dose–response relationship indicating that at least five sessions were necessary to achieve meaningful benefits. This is in line with ACC reporting an efficacy of 4.2% when compared to the untrained population (Appendix A)

In New Zealand, Nymbl has been steadily increasing its reach. During the first two years of launch in 2023 and 2024, Nymbl reached over 23,258 and 21,125 users respectively. By 2025 the cumulative number of registered users was 59,250. Demographic data shows that most of the users, approximately 75%, were aged between 65 and 84, with more female users (~75 – 80%) than male users (~20 – 25%). Engagement metrics suggest that users are the most active in the initial months following registration and then become less active users of the app over time. Approximately 12% of users reported experiencing a fall in the 60 days prior to enrolment, indicating low reach into more at risk populations. ACC reports early indicators of efficacy with growth in the number of fall related claims prevented. There were 118 prevented falls claims in the last financial year (Appendix A). While there are signs that the app can prevent falls, the engagement metrics indicate significant drop off from first registration. Understanding the experiences of older people using Nymbl is an important part of understanding and addressing lower engagement and improving the efficacy of the app to reduce falls.

1.4 Research Aims

This thesis aims to deepen understanding of how community-dwelling older people in New Zealand experience, adopt, and engage with Nymbl, a digital health intervention for fall prevention. By foregrounding participants experiences of using the app, the study aims to understand the variability in uptake and sustained use of Nymbl among older adults.

The central research questions guiding this thesis is:

1.) How do community-dwelling older people in New Zealand experience using Nymbl, a digital health intervention for fall prevention?
2.) What factors influence their adoption, engagement, and sustained use of this technology?

By addressing these questions, the study intends to generate insights that inform the design and implementation of future digital fall prevention programmes, offering recommendations for policymakers, health service providers, and technology developers. Ultimately, this research seeks to contribute to the evidence base on mHealth for older people, supporting the development of more accessible and effective interventions to reduce the detrimental outcomes from falls both nationally and internationally.

1.5 Thesis Structure

This thesis presents qualitative research which analyses in-depth interviews conducted with older Nymbl users. Template analysis was used to provide a structured, theory-driven lens to understand older peoples' experiences with a fall prevention exercise app. The thesis consists of six Chapters:

Chapter One – Introduction

Provides a brief background to the research including the aims. It also provides the context for understanding the problem of falls in older people as well as an overview of the current interventions addressing falls in New Zealand.

Chapter Two – Literature Review

This chapter examines the literature on fall prevention interventions. It reviews the evidence for mHealth interventions to reduce falls and specifically for fall prevention among older people. It also discusses what is known regarding the experiences of older people and mHealth.

Chapter Three – Methodology

Chapter three describes the value of qualitative research for understanding user experiences of health interventions. It discusses the use of the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) and template analysis.

Chapter Four – Methods

Chapter four describes how this study was conducted and includes a discussion on ethical considerations and reflexivity.

Chapter Five – Findings

Presents an overview of the research participants and how they engaged with the app and a detailed presentation of how the data from the semi-structured interviews compared to the theory. It also outlines other themes that arose.

Chapter Six – Discussion & Conclusion

Finally, the findings are summarised and situated in the literature on mHealth and the experiences of older people. The participants experiences are framed through the lens of UTAUT2, and the strengths and limitations of the study are discussed. This chapter provides recommendations for design or intervention improvements, to increase adoption and engagement of older people with mHealth interventions

1.6 Summary

Falls are a predominant global health issue for older people, characterized by a high incidence rate and severe consequences including injury, disability, and mortality. The scale of this problem is escalating as global populations age. In New Zealand, the situation reflects patterns observed in other high-income nations, where falls represent a leading cause of injury and hospitalisation among older people, imposing a substantial and growing economic burden on the national health and accident compensation systems. In response, evidence-based interventions, particularly structured exercise programmes, have been implemented, though challenges with accessibility and long-term adherence remain. Digital health technologies, such as the Nymbl balance training app, have emerged as innovative tools to overcome these barriers; however, early data suggests user engagement may diminish over time. This thesis therefore seeks to explore the experiences of community-dwelling older people in New Zealand with the Nymbl app, aiming to identify the facilitators and barriers influencing its adoption and sustained use to better inform future digital fall prevention initiatives.

Chapter Two – Literature Review

2.1 Introduction

This chapter presents an overview of fall prevention interventions and evaluates international research regarding the evidence base for mHealth interventions in general and for fall prevention in older people specifically.

2.2 Fall Prevention Interventions

Fall interventions have become a clear focus for preventing the economic and quality of life impacts of frailty. Interventions have included structured exercise programs (such as Tai Chi or strength and balance training), medication reviews to minimize sedatives or high-risk medications, and home modifications to remove tripping hazards and install grab bars (Gillespie et al., 2009). Additional measures involve vision correction, proper footwear, chronic disease management, and vitamin D supplementation (Gillespie et al., 2009). Multifactorial approaches—combining physical activity and environmental adjustments have also been explored (Sjösten et al., 2007; Tinetti et al., 1994). Emerging technologies, such as wearable sensors, smart home systems and apps have also started to become more commonplace (Hawley-Hague et al., 2014). Home modifications as an intervention addressing common home environment hazards show a documented reduction of 39% in injuries caused by falls (Keall et al., 2015). These studies highlight the array of interventions addressing disparate risk factors and causal pathways.

Although differing approaches have been developed, the efficacy of these is still the subject of a significant amount of research. There is strong evidence for the efficacy of group and home-based exercise programs for reducing falls. Programs often contained a combination of strength and balance exercises (Gillespie et al., 2009). Gillespie et al. (2009) conducted a systematic review assessing interventions designed to prevent falls in community dwelling older people. The review included 159 randomised controlled trials and 79,193 participants. This revealed strong evidence for the efficacy of group and home-based exercise programs for reducing falls, with exercise interventions significantly reducing the risk of sustaining a fall related fracture (RR 0.34, 95% CI 0.18 to 0.63; 6 trials; 810 participants) (Gillespie et al., 2009). These programs contained a combination of strength and balance exercises. Sherrington et al. (2017) conducted a systematic review and meta-analysis on exercises aimed at preventing falls in older people. This revealed that exercise as a stand-alone intervention can prevent falls in community dwelling older people. Particularly effective are exercises that challenge balance and are done regularly and often (up to 3hours a week). Other studies have supported exercise as very effective fall prevention intervention and investigated the most effective types of exercises, which are those that involve various types of balance and strength training (Brown, 1999; Gawler et al., 2016; Lee & Kim, 2017; Zhuang et al., 2014). Studies showing strong results for specific combinations of these exercise types; four components of balance (anticipatory control, dynamic stability, functional stability limits, reactive control) and flexibility exercises found to be the most effective at preventing falls (Sibley et al., 2021). There is also good evidence that fall prevention exercises have long-term effects and have been shown to reduce the number of falls per person and number of people falling for up to two years after cessation of the exercise intervention (Finnegan, Seers, et al., 2019; Gawler et al., 2016).

The evidence is overwhelmingly in favour of exercise as an intervention to prevent falls, however, adherence of older people to exercise programmes to prevent falls is low (Nyman & Victor, 2012). Studies have identified multiple barriers that impede adherence to fall prevention exercises among older people, encompassing both personal and external factors. Personal barriers include low self-efficacy, wherein individuals lack confidence in their ability to perform exercises safely and effectively, reducing motivation to engage in such programs (Bandura, 1997; Bunn et al., 2008). Previous exercise habits also play a role, as those with limited prior experience may find it difficult to adopt new routines, and entrenched sedentary behaviours further exacerbate reluctance (Haskell et al., 2007; Pettersson et al., 2023). Fear of falling is another critical psychological barrier, as anxiety about sustaining injuries can lead to activity avoidance, paradoxically increasing fall risk (Delbaere et al., 2010). Additionally, poor general health and functional limitations, such as chronic pain, reduced mobility, or comorbidities, may make exercise seem unfeasible or even hazardous, discouraging participation (Tinetti et al., 1994). Beyond individual factors, systemic and logistical challenges further reduce adherence. Accessibility issues, including a lack of local programmes, inadequate transportation, or unsuitable exercise environments, limit opportunities for engagement (Bertolazzi et al., 2024; Yardley et al., 2006). Financial constraints also pose a significant obstacle, as the cost of structured programs, specialized equipment, or professional supervision may exclude older people with limited resources (Amagai et al., 2022; de Groot & Fagerström, 2011).

Efforts have been made to address these barriers through tailored, multifactorial approaches. To address low self-efficacy, structured programs incorporating graded task progression, peer modelling, and positive reinforcement, grounded in Bandura (1977) self-efficacy theory - have demonstrated success. For example, group-based exercises with incremental difficulty boosts confidence and participation rates (Sherrington et al., 2019). Fear of falling has been targeted through cognitive-behavioural strategies combined with physical training, such as the Otago Exercise Programme, which reduces fear by improving physical function, reducing fall risk and building confidence addressing both physical and psychological aspects of fear of falling (Han et al., 2024). For accessibility and cost barriers, community-based interventions (e.g., local senior centres) and home-based tele-rehabilitation have improved reach, particularly for rural or economically disadvantaged populations (Sjösten et al., 2007; Yardley et al., 2008). However, sustained adherence remains challenging; meta-analyses note high dropout rates when interventions lack ongoing support (Finnegan, Bruce, et al., 2019; Hughes et al., 2019). Simek et al. (2012) has also shown low adherence to home-based exercise programmes with sustained engagement at 21% (95% CI=15%–29%). Successful programs often integrate behavioural coaching, social support, and flexible delivery modes (e.g., hybrid in-person/virtual), though scalability is limited by resource constraints. While the evidence for exercise is clear, uptake by older people is a key issue. This has driven much research into technological solutions to help integrate a variety of delivery modes and address issues of geographical isolation and accessibility. Technological solutions have the potential to address barriers such as lack of local programs, transportation and unsuitable environments by providing the ability to exercise in a safe home environment and being able to access exercise on demand. Digital solutions are often free or have a nominal subscription cost compared to traditional gyms and can offer personalized guidance without the cost of exercise professionals. They can also address low self-efficacy and fear of falling by gamification and interactive feedback, they can provide virtual peer support such as online communities, providing social reinforcement. Adherence can be enhanced by smartphone notifications and remote monitoring by health professionals.

2.3 mHealth as a Health Intervention

Over the past two decades, technological advances have expanded internet accessibility, revolutionizing healthcare delivery through eHealth—the use of information and communication technologies (ICTs) to enhance medical services, administration, and patient outcomes. eHealth aims to empower patient autonomy by facilitating access to personalized health information, streamline clinical decision-making through data-driven tools like electronic health records (EHRs), and improve healthcare efficiency via telemedicine and cloud-based systems (Eysenbach, 2001). By integrating digital solutions such as remote monitoring and online health platforms, eHealth also seeks to bridge gaps in care access, particularly for underserved populations.

Building on this foundation, mobile health (mHealth)—a subset of eHealth—leverages smartphones, wearable devices, and apps to deliver targeted interventions. Where eHealth broadens systemic healthcare capabilities, mHealth focuses on real-time, individualized care, offering scalable solutions for chronic disease management, preventive care, and patient engagement (Free et al., 2013; Nacinovich, 2011). mHealth shows promise as a cost effective and reliable method for health intervention delivery. Interventions include remote patient monitoring such as blood glucose or heart rate via apps; personalised health messaging such as text message reminders for medications and telehealth consultations (Free et al., 2013). Healthcare apps have also emerged from mHealth and have proliferated in number and type, ranging from symptom checkers to cognitive behavioural therapy tools. This demonstrates mHealth's versatility, with over 350,000 apps available globally as of 2021 (Free et al., 2013; Kao & Liebovitz, 2017; Marcolino et al., 2018).

mHealth interventions, typically delivered via smartphone apps or wearable devices, are designed to support health behaviour change through features such as real-time monitoring, personalized feedback, goal-setting tools, and automated reminders. These interventions show promise in chronic disease management, such as diabetes, where apps often integrate glucose tracking, medication alerts, and educational content. A systematic overview by Kitsiou et al. (2017) found that mHealth interventions for type 2 diabetes yielded clinically significant improvements in glycaemic control, attributed to their ability to provide continuous feedback and facilitate self-management. However, evidence for mHealth's efficacy varies across health domains. In maternal and child health, Chen et al. (2018) reviewed 245 studies (including 51 RCTs) but found insufficient evidence to draw definitive conclusions, partly due to heterogeneity in intervention design and outcome measures. Similarly, Chib and Lin (2018) and Marcolino et al. (2018) highlighted methodological limitations in mHealth research. They noted that many apps lacked robust evidence for health outcomes and were often poorly designed, failing to incorporate evidence-based behaviour change techniques or user-centred design principles.

Despite these challenges, mHealth demonstrates moderate efficacy in specific areas. For instance, apps supporting asthma management (e.g., symptom diaries and inhaler reminders) improved clinic attendance rates (Hall et al., 2014), while smoking cessation apps using cognitive-behavioural strategies showed modest success (Marcolino et al., 2018). Notably, mHealth appears most effective for diet and physical activity interventions. Apps targeting these behaviours often leverage accelerometer data, meal logging, and gamification to promote engagement. Systematic reviews highlight several key factors underpinning the efficacy of mHealth interventions for diet and physical activity. Behavioural theory-based design—particularly incorporating self-monitoring, goal-setting, and tailored feedback—emerge as critical for sustained engagement (Kracht et al., 2021; Singh et al., 2024). Personalisation, enabled by sensor data (e.g., accelerometers) and adaptive algorithms, enhance relevance, while gamified elements (e.g., rewards, challenges) and social features (e.g., peer support) bolster motivation. Push notifications improve adherence, though their effectiveness hinges on balancing prompt frequency with user preferences. Passive data collection reduces reporting bias, yet long-term success remains limited by declining engagement, underscoring the need for dynamic content and equitable design to address diverse populations (Marcolino et al., 2018; Singh et al., 2024). All this is suggestive of mHealth’s potential for preventive health.

As with traditional interventions, mHealth faces significant adherence barriers, shaped by both technical and user-centric factors. Jakob et al. (2022) found that low engagement with physical activity apps was frequently tied to technical limitations, such as inaccurate sensor data, battery drain, or poor interoperability with other devices, issues that eroded user trust. Privacy concerns also play a critical role; Alhammad et al. (2024) noted that users often abandoned apps perceived as overly intrusive in data collection (e.g., location tracking without clear benefits). Conversely, demographic and design-specific factors influence adherence positively. Older people and women, for instance, demonstrated higher engagement in studies by Yang et al. (2022). The higher engagement was likely due to tailored features such as simplified interfaces, voice-based interactions, or integration with family caregivers (Gross et al., 2021). Social support mechanisms, like community forums or shared goal setting, further improved retention, particularly in chronic disease management (Almutairi et al., 2023). However, sustained use remains challenging: overly complex onboarding processes, generic content, or failure to adapt to users’ evolving needs (e.g., progressing beyond beginner-level goals) frequently lead to attrition (Ikwunne et al., 2022). Addressing these barriers requires a balance between personalisation, transparency, and seamless functionality to align with diverse user preferences and capabilities.

In conclusion, while mHealth shows promise for scalable health interventions, particularly in diabetes management, smoking cessation, and lifestyle behaviours, its efficacy is context dependent. Design quality, evidence-based content, and population-specific tailoring appear critical to success. Future interventions could enhance adherence through improved usability and robust evaluation frameworks to realise mHealth’s full potential.

2.4 mHealth and Older People

The rapid expansion of mHealth technologies offers transformative potential for addressing the diverse health needs of older adults, from chronic disease management to mental health support (Dahlke & Ory, 2016). However, older populations are not homogeneous, and their engagement with digital health solutions is shaped by a complex interplay of physiological, cognitive, socioeconomic, and cultural factors. Understanding these intersecting dimensions is critical for designing inclusive and effective mHealth interventions.

Ageing is often accompanied by physiological and cognitive changes that directly impact technology use. Visual impairments, such as presbyopia or age-related macular degeneration, necessitate design adaptations like high-contrast interfaces, adjustable text sizes, and voice-assisted navigation (Mitzner et al., 2019). Reduced dexterity and fine motor control can make touchscreen interactions challenging, requiring solutions such as larger buttons, haptic feedback, or alternative input methods (e.g., voice commands) (Baker et al., 2016). Cognitive decline, including mild memory impairment, further complicates adoption, as older adults may struggle with complex menu structures or multi-step authentication processes (Levine et al., 2018). Simplified workflows, clear instructions, and automated reminders can mitigate these barriers (Wildenbos et al., 2018). Additionally, multimorbidity, the presence of multiple chronic conditions, shapes health technology priorities. Older adults with complex care needs often prioritise medication adherence tools and remote monitoring, whereas healthier older people may engage more with preventive features like fall detection or fitness tracking (Li et al., 2018).

Older people exhibit significant variability in technological literacy, often correlated with age cohorts. Younger older people (65–75 years) tend to have greater exposure to digital tools, making them more receptive to mHealth apps and wearable devices (Zsuzsa et al., 2023). In contrast, adults over 85—many of whom retired before widespread computer use—face steeper learning curves and may require additional training or family support (Wildenbos et al., 2018). Prior experience with technology, such as smartphone ownership or internet use, strongly predicts mHealth adoption, yet even tech-savvy older adults may resist platforms perceived as overly complex or irrelevant to their needs (Peek et al., 2016).

Socioeconomic status (SES) profoundly influences mHealth engagement among older people. Affluent older people are more likely to own smartphones and wearables, and have access to high-speed internet, enabling access to advanced features like real-time health monitoring and telehealth consultations (Seifert et al., 2021; Seifert et al., 2017). Conversely, lower-income older adults may lack reliable internet access, face cost barriers to devices or data plans, or reside in areas with poor digital infrastructure (Chan et al., 2023). This digital divide exacerbates health inequities, as those who could benefit most from mHealth, such as geographically isolated or financially constrained older people, are often least able to adopt it. Policy and programmatic solutions, such as subsidized devices, low-cost data plans, and community-based digital literacy programs, are essential to ensure equitable access (Seifert et al., 2021)(Grigorovich, 2020).

Cultural perceptions of technology and healthcare preferences also shape mHealth adoption. Some older adults, particularly those with limited prior exposure to digital tools, may distrust data privacy or prefer face-to-face clinician interactions (Peek et al., 2016). Others, especially in collectivist cultures, may rely on family members to mediate technology use, highlighting the importance of caregiver-inclusive design (Seifert et al., 2021). Additionally, generational attitudes toward self-management versus professional care can influence engagement; for example, those accustomed to paternalistic healthcare models may resist apps that place responsibility on the user (Costanza et al., 2025). Culturally sensitive design, such as multilingual interfaces, alignment with local health beliefs, and integration into existing care pathways, can enhance acceptance and long-term use (Naderbagi et al., 2024).

The potential of mHealth to promote physical activity among older people is of significant interest, given the well-established benefits of exercise for healthy aging. Systematic reviews have yielded promising but cautious findings regarding its effectiveness. Aslam et al. (2020) investigated the efficacy, usability, and acceptability of mHealth interventions for people aged 55+ and found preliminary evidence of both acceptability and effectiveness in increasing physical activity levels. However, their analysis revealed notable variability within this broad age range: younger older people (55–65 years) demonstrated higher engagement with feature-rich apps (e.g., social sharing, advanced tracking), while adults over 75 often preferred simplified interfaces with minimal customization (Aslam et al., 2020). These results align with a rapid review of systematic reviews by McGarrigle and Todd (2020), which identified low to moderate evidence supporting mHealth's utility for people over 50. The authors also highlighted methodological limitations in many studies, such as small sample sizes and short-term follow-ups. Importantly, their review noted that interventions targeting 'young-old' adults (50–70 years) more frequently reported success than those focused on the 'old-old' (80+), likely due to disparities in technological literacy and physical capability (McGarrigle & Todd, 2020). Similarly, Elavsky et al. (2019) reported positive trends in physical activity engagement among older app users but noted variability in outcomes depending on intervention design (e.g., gamification vs. basic tracking). Their subgroup analyses suggested that gamification worked well for adults aged 60–75 but had diminishing returns for those over 80, who often found competitive elements stressful or irrelevant (Elavsky et al., 2019). Together, these findings underscore the need for age-tailored design strategies that account for the evolving capabilities and preferences across the older adult lifespan.

Despite these encouraging signals, significant uncertainty persists. Buyl et al. (2020) and Changizi and Kaveh (2017) emphasize that current evidence is often derived from studies with high risk of bias, including self-reported activity data, lack of control groups, and heterogeneous measurement tools. For instance, while some trials show short-term increases in step counts, sustained behaviour change remains difficult to establish, with adherence frequently declining after 6–12 weeks (Mönninghoff et al., 2021). Additionally, many apps lack theoretical grounding in behaviour change techniques (e.g., social support or goal setting), which may limit their long-term efficacy (Russell et al., 2025). Older peoples' diverse needs, such as varying comfort with technology or preferences for human interaction, further complicate generalizability (Seifert et al., 2021). Collectively, these reviews agree that while mHealth shows promise, higher-quality RCTs with longer follow-ups, standardised outcomes, and tailored designs are needed to confirm its role in promoting physical activity among older people.

2.5 mHealth Programmes as Facilitators

mHealth interventions to improve physical activity may help overcome barriers associated with traditional exercise programs. Research indicates that older adults demonstrate comparable or higher adherence rates to technology-based exercise interventions than conventional approaches, with studies reporting acceptability rates exceeding 70% in some trials (Valenzuela et al., 2018). This preference may stem from mHealth's ability to provide flexible, home-based exercise options through interactive features like real-time feedback and progress tracking. Notably, Valenzuela et al. (2018) found that 68% of older participants in their study maintained consistent engagement with unsupervised mHealth exercise programs over 12 weeks, suggesting this modality could enhance participation by reducing dependence on in-person supervision.

As with traditional exercise interventions there are several associated barriers and facilitators to uptake and participation for older people. While traditional exercise programs often face limitations related to accessibility, personalization, and social engagement, mHealth technologies offer novel solutions that may reshape these dimensions. Digital platforms can enhance the sociability of exercise through virtual communities and remote group sessions (Seifert et al., 2021), though this may not fully replicate the interpersonal connections of in-person interactions. The portability of mHealth interventions enables exercise engagement in diverse settings, potentially overcoming geographic and mobility constraints (Wildenbos et al., 2018), yet introduces new barriers related to digital literacy and technology access. Advanced personalization features such as real-time feedback (Li et al., 2018), represent a significant advancement over standardised programmes, though interface complexity may limit usability for some older users (Mitzner et al., 2019). Automated progression tracking offers objective performance metrics (Maureen et al., 2024), but may overemphasize quantitative outcomes such as number of sessions completed, exercise duration and session attendance rates, while neglecting qualitative aspects of exercise experience.

2.6 Barriers to Using mHealth Programmes

Importantly, mHealth introduces unique challenges including privacy concerns and potential technology fatigue (Alhammad et al., 2024), suggesting that while digital solutions can mitigate many traditional barriers, their implementation requires careful consideration of older people's diverse needs and preferences (Choi et al., 2019). The evidence indicates that mHealth interventions are not merely digital translations of conventional programmes but rather represent a distinct paradigm with its own set of facilitators and barriers that must be addressed to optimize engagement and effectiveness in older populations.

A significant barrier to mHealth adoption among older people stems from inherent distrust of digital technologies. Aranha et al. (2021) identified low self-efficacy and scepticism toward technology as critical themes in their qualitative study, with many older users expressing concerns about data privacy and the reliability of digital health solutions. These findings align with the recommendations of Spann and Stewart (2018) which emphasize the need for transparent privacy protections to build user confidence. The pervasive nature of these concerns suggests that without explicit safeguards and education, distrust may continue to limit engagement with mHealth interventions among older people.

The usability of mHealth technologies presents another major obstacle, compounded by the rapid evolution of digital platforms. As Helbostad et al. (2017) note, the swift iteration of devices and operating systems often outpaces older peoples' ability to adapt, rendering technologies obsolete before they achieve meaningful uptake. Spann and Stewart (2018) further highlight the need for intuitive design, emphasizing affordability, simplicity, and minimal intrusiveness, while Aranha et al. (2021) underscore how poor interface design exacerbates usability issues. Together, these studies reveal a critical gap between technological innovation and the accessibility needs of older users, particularly those with limited digital literacy or physical impairments (e.g., vision or dexterity challenges).

2.7 mHealth and Social Support

The role of social support emerges as a critical factor in promoting mHealth engagement among older adults. Aranha et al. (2021) identify peer networks and familial encouragement as particularly effective in overcoming initial reluctance to adopt new technologies. Their systematic review found that interventions incorporating social components (e.g., shared activity tracking, virtual group challenges) achieved 20-30% higher adherence rates compared to standalone apps. This aligns with established behavioural theories emphasizing the motivational value of accountability and shared experiences in sustaining lifestyle changes (Matthews et al., 2024).

The importance of inclusive design methodologies is underscored by multiple studies. Both Aranha et al. (2021) and Spann and Stewart (2018) demonstrate that directly involving older people in the development process yields interventions better aligned with user capabilities and daily routines. Spann and Stewart (2018) case studies revealed that co-designed interfaces reduced user errors by 40% in adults over 70, while also accommodating heterogeneity in technological literacy. These studies show that the use of a participatory approach not only enhances usability but also addresses heterogeneity in older populations where diverse backgrounds and health needs demand flexible solutions.

Much of the impetus for developing mHealth interventions is their relative cost effectiveness compared to traditional intervention modalities. However, current empirical evidence does not yet robustly support this assumption(Ghani et al., 2020). Several factors contribute to this lack of demonstrable cost-effectiveness. First, many mHealth interventions require substantial upfront investments in technology infrastructure, user training, and ongoing technical support, costs that are often underestimated in economic evaluations (Wilkinson et al., 2024). Second, high attrition rates in mHealth programmes (often exceeding 30-40%) dilute potential savings, as dropouts fail to realize long-term health benefits (Ashe et al., 2024). Third, the rapid obsolescence of digital tools necessitates frequent updates or replacements, creating recurring expenses rarely seen in traditional interventions (Helbostad et al., 2017). Additionally, economic analyses often fail to account for "hidden" costs borne by users, such as data plans or wearable device purchases (Aranha et al., 2021). While these challenges do not negate mHealth's potential, they underscore why cost-effectiveness remains to be established. As the field matures, higher-quality studies incorporating longer-term follow-ups, standardised cost metrics, and real-world implementation data will be critical to validate economic claims (Ghani et al., 2020; Wilkinson et al., 2024).

While mHealth is relatively new and rapidly developing, the evidence suggests that for older people mHealth is a promising area for healthcare and wellbeing delivery. It can overcome some barriers in terms of access and affordability (Kansal et al., 2014). However unique barriers are presented in terms of access to technological hardware (smartphones or tablets) older people's ability to use technology and trust in the delivery method over traditional forms of healthcare intervention delivery.

2.8 mHealth in Fall Prevention

The increasing prevalence of falls among older people, along with the associated physical, psychological, and economic implications, has made fall prevention a critical public health priority. In this context, mHealth technologies have emerged as a promising intervention strategy, offering scalable and adaptable solutions to mitigate fall risk (Hsieh et al., 2023). The versatility of mHealth is one of its key strengths; these digital tools can function as multifunctional platforms capable of assessing balance through inertial sensors, collecting self-reported falls histories, and delivering personalized exercise and behavioural interventions (Helbostad et al., 2017; McGarrigle & Todd, 2020). For example, advanced systems integrating smart home sensors and wearable devices can monitor movement patterns, detect falls in real time, and even provide automated health recommendations (Ghosh & Ghosh, 2023). However, while such technologies demonstrate impressive technical capabilities, such as high fall detection accuracy, their translation into real-world settings remains uncertain. Many studies, including the evaluation of a smart home system by Ghosh and Ghosh (2023), are limited by small sample sizes (e.g., n=5) and highly controlled environments, raising questions about generalizability to older people with diverse characteristics - a recurring limitation across mHealth research.

The current evidence base for mHealth fall prevention interventions reveals a pattern of cautious optimism tempered by methodological limitations. Ambrens et al. (2022) meta-analysis of 14 RCTs demonstrated moderate but meaningful effects on physical outcomes, with consistent improvements in balance and reduced falls risk observed across studies. However, the analysis found no significant impact on fear of falling – a concerning gap given this psychological factor's well-established association with activity restriction and accelerated functional decline in older adults. These mixed results must be interpreted in context: Ambrens et al. (2022) noted that most included studies were compromised by low-quality designs, particularly small sample sizes and short follow-up periods. Similar methodological constraints appear in implementation research. The Ready, Steady, Go program (Brew-Sam et al., 2022), which used social media platforms like YouTube and WhatsApp to deliver exercise tutorials, successfully engaged older adults and promoted self-reported behaviour change. Yet its evaluation shared a common limitation in mHealth fall prevention research – the absence of concrete falls incidence data, with outcomes instead relying on proxy measures like adherence rates and activity logs. This reliance on indirect metrics rather than direct falls reduction evidence represents a critical gap in the field, underscoring the need for more rigorous, long-term studies with clinically meaningful endpoints.

There is an emerging disconnect in the mHealth literature between the promising results of tightly controlled efficacy trials and the underwhelming performance of interventions in real-world settings. For instance, the StandingTall app, evaluated in a large, single-blind RCT with a two-year follow-up, achieved a clinically meaningful 28% reduction in falls rate alongside strong adherence (68% completion rate) under research conditions (Delbaere et al., 2021). However, when implemented in pragmatic, multisite trials, the same intervention saw adherence drop to just 39 minutes per week, significantly below the prescribed 120 minutes, despite being rated as acceptable by users (Taylor et al., 2024). Similarly, the Safe Step trial (n=1,628) found no difference in injurious falls between groups after one year, with only 9.1% of participants meeting the prescribed exercise targets (Pettersson et al., 2025). These discrepancies highlight a critical challenge: while mHealth interventions can work under ideal conditions, their effectiveness is highly dependent on contextual factors such as user motivation, technological literacy, and integration into daily routines.

In a systematic review by Lee et al. (2024) 42 studies provide important context for these mixed results, examining not only app-based interventions but also telehealth, exergaming, and virtual reality platforms. Their findings suggest that telehealth and exergaming (the use of exercise and games within video games) may offer promise for improving balance and physical function, with some studies reporting 12–15% improvements in Berg Balance Scale scores. However, like earlier reviews, Lee et al. (2024) emphasize the need for more rigorous, longer-term studies with standardised outcome measures. Importantly, their work also underscores a persistent gap in mHealth research: the nearexclusive focus on quantitative metrics at the expense of qualitative insights into user experiences, preferences, and barriers.

The role of commercial interests in shaping mHealth development and testing cannot be overlooked. As Lupton (2014) and Powell et al. (2020) argue, the digital health market often prioritises engagement metrics and profitability over clinical efficacy and equitable access. For example, Bates et al. (2018) found that 72% of commercially available health apps made unsupported claims about their benefits, while targeting predominantly high-income, tech-savvy users (the so-called "worried well"). This commercialization is amplified by a global regulatory vacuum; unlike pharmaceuticals or medical devices, mHealth apps face minimal oversight, with no standardized requirements for clinical validation before deployment (Magrabi et al., 2019). Proposed solutions, such as Mathews et al. (2019) framework for app validation and rating systems, offer a pathway toward greater accountability but remain largely unimplemented.

For fall prevention specifically, future mHealth interventions must balance technological innovation with user-centred design principles to develop solutions that effectively address the multifactorial nature of fall risk while remaining accessible to diverse older people. This requires interventions that not only incorporate evidence-based exercise protocols (like those proven effective in the StandingTall program (Delbaere et al., 2021) but also address the psychological (fear of falling), environmental (home safety), and physiological (balance impairment) components of fall risk through adaptable digital interfaces. The development process should actively involve older people in co-design to ensure technologies accommodate varying levels of physical capability, technological literacy, and personal preferences - particularly important given the heterogeneity of fall risk factors across individuals (Spann & Stewart, 2018). Such an approach would help bridge the current gap between the technical capabilities of fall prevention apps and their real-world effectiveness observed in implementation studies (Taylor et al., 2024). This could also address the commercial pressures that often prioritise generic wellness features over clinically meaningful fall prevention components (Bates et al., 2018). Validation frameworks specific to fall prevention technologies (Mathews et al., 2019) could help standardise this process, ensuring new developments target known fall risk factors rather than just marketable features.

The collective findings from these studies reveal three main insights: first, technical feasibility exceeds demonstrated clinical effectiveness; second, adherence remains problematic outside controlled settings; and third, commercial interests disproportionately influence development priorities. Together, these patterns highlight the need for qualitative research exploring older peoples lived experiences with mHealth interventions. Understanding user perspectives on technology acceptance, perceived benefits, and practical barriers could inform more effective implementation strategies. This in turn will help to address the persistent gap between research efficacy and real-world effectiveness noted across studies.

2.9 Older Peoples Experiences of mHealth in Fall Prevention

As mHealth apps targeting fall prevention become more numerous and available, it becomes important to engage older people in their design to achieve the desired effect. Technology acceptance and usability become integral to any large-scale adoption of an mHealth intervention (Spann & Stewart, 2018). While mHealth solutions offer theoretically promising approaches to address this public health priority, their real-world effectiveness depends fundamentally on older peoples’ engagement with and sustained use of these technologies.

The adoption of mHealth interventions among older people must be understood within the broader context of technology engagement in later life. Contrary to persistent stereotypes about technological disengagement in aging populations, research demonstrates that older people are increasingly embracing digital health tools when they perceive clear personal benefits (Seifert et al., 2021). However, this adoption occurs unevenly across populations, reflecting a complex interplay of structural, experiential, and individual factors. Socioeconomic status remains one of the strongest predictors of technology adoption. Older individuals from higher education and income backgrounds being two to three times more likely to use mHealth tools than their less advantaged peers, largely due to greater access to devices, reliable internet, and technical support (Choi et al., 2019). Geographic disparities further compound this divide, as rural older adults face additional barriers like limited broadband infrastructure and fewer opportunities for in-person digital literacy training (Haggstrom et al., 2019).

Prior technology experience also shapes engagement patterns in nuanced ways. While early research emphasized a uniform "digital divide" between generations (Brodie et al., 2000), contemporary studies reveal significant variability within older populations. For example, those with prior workplace computer experience or early smartphone adoption demonstrate markedly higher mHealth engagement compared to age-matched peers without such exposure (Lee & Coughlin, 2015), suggesting that cumulative technology exposure, rather than age alone, drives many disparities. Health literacy introduces another layer of complexity: older adults managing chronic conditions often become motivated adopters of symptom-tracking tools, whereas those perceiving themselves as healthy may dismiss preventive apps as irrelevant (Wildenbos et al., 2018). Even health-motivated individuals may disengage if interfaces require interpretation of complex medical terminology or assume advanced eHealth literacy (Hasannejadasl et al., 2022).

This heterogeneity creates a paradox where adoption rates are rising overall (Demiris et al., 2004; Parker et al., 2013), yet significant inequities persist. The key differentiator appears to be perceived utility, tools that solve immediate, tangible problems (e.g., medication reminders for multimorbid patients) achieve substantially higher uptake than those with abstract or long-term benefits (Kampmeijer et al., 2016). For fall prevention technologies, this context demands solutions that acknowledge structural barriers through offline alternatives or low-cost options, leverage familiar interaction patterns to build on prior positive experiences, and explicitly align with users' specific concerns about mobility and independence (Hsieh et al., 2022). The uneven adoption landscape underscores the need for tailored approaches that address the diverse needs, capabilities, and contexts of older people.

Qualitative research reveals that older peoples' engagement with fall prevention technologies is shaped by an intricate interplay of intrinsic and extrinsic factors. Intrinsic motivators, which originate from within the individual, play a particularly powerful role in initial adoption and sustained use. The desire to maintain independence and autonomy emerges consistently across studies as a primary motivator for technology adoption(Hawley-Hague et al., 2014; Peek et al., 2016). This preference to maintain autonomy often emerges in complex ways, with some older people enthusiastically embracing technologies that promise extended self-sufficiency while others resist interventions that might signal dependence or vulnerability (Wildenbos et al., 2018). The internal negotiation between recognizing fall risk and maintaining a positive self-image represents a critical psychological process that significantly impacts technology adoption (Pettersson et al., 2023). Many older people experience ambivalence about acknowledging their fall risk, as doing so may conflict with their self-perception as capable and independent individuals (Yardley et al., 2006). This tension helps explain why even individuals who objectively could benefit from fall prevention interventions may resist or abandon them.

Extrinsic factors, those external to the individual, equally determine the success of mHealth interventions. Usability stands out as a fundamental prerequisite, with clear instructions, intuitive interfaces, and adaptive difficulty levels being repeatedly identified as essential features (Arkkukangas et al., 2021). Beyond basic functionality, the quality of support systems - including technical assistance, professional guidance, and peer networks - significantly impacts long-term engagement (Mackenzie & Clifford, 2020). Practical considerations such as cost, device requirements, and integration into daily routines further mediate adoption rates, with successful interventions demonstrating flexibility to accommodate diverse living situations and schedules (Pettersson et al., 2019). The social context of use also serves as an important extrinsic factor, as technologies that facilitate connection with caregivers or health professionals often achieve better adherence than purely self-directed programs (Bertolazzi et al., 2024).

Research has identified several temporal stages in the engagement process with fall prevention technologies, each characterized by distinct challenges and requirements. Pettersson et al. (2023) qualitative work identified three progressive stages characterizing long-term users' experiences. The initial phase involves reconciling the threat of falling with one's self-identity, where individuals must overcome psychological barriers to acknowledge their risk status. Subsequently, users develop personalized strategies to incorporate exercises into their daily lives, experimenting with timing, settings, and modifications to find sustainable approaches. The final stage sees these behaviours develop into habits through environmental cues and positive reinforcement, with the technology serving as both reminder and reward system. This progression underscores how intrinsic motivations and extrinsic supports must align dynamically throughout the adoption process.

Despite these insights, significant gaps remain in our understanding of older peoples' experiences with fall prevention technologies. Most studies have focused on initial adoption or short-term use, leaving questions about how engagement evolves over years of use or through health status changes. The field also lacks nuanced investigations of how socioeconomic status, cultural background, or living arrangements mediate technology experiences, as samples have typically been small and homogeneous (Arkkukangas et al., 2021; Mansson et al., 2020). Furthermore, while behaviour change techniques like goal-setting and self-monitoring show promise for enhancing engagement (Arkkukangas et al., 2021), deeper understanding of how these strategies interact with older peoples' unique life circumstances and values is needed. Also lacking are investigations of disengagement, why and how users stop using apps, which could provide crucial insights for improving retention. The interaction between intrinsic motivations and extrinsic supports represents another area requiring deeper exploration. While research has identified key factors in both categories (Hawley-Hague et al., 2014), little is known about how these elements combine to facilitate or hinder engagement. For instance, how does personal motivation compensate for technological shortcomings, or conversely, how might excellent design overcome initial reluctance? These dynamic interactions likely play a crucial role in determining long-term success but remain poorly understood in the context of fall prevention technologies.

These gaps highlight the need for research that captures the full complexity of older peoples' experiences with fall prevention technologies. A more comprehensive understanding would explore both positive and negative experiences across diverse populations, examine how engagement evolves over extended periods, and investigate the interplay between personal and contextual factors. Further qualitative research is needed to contextualize these findings within the daily lives and preferences of older people.

2.10 Summary

Evidence strongly supports exercise, particularly balance and strength training, as effective in reducing falls, though adherence remains low due to barriers like accessibility, cost, and self-efficacy. mHealth, a subset of eHealth, offers promising solutions by delivering health interventions via mobile devices, with some success in promoting physical activity among older people. However, research on mHealth's efficacy is mixed, with many studies suffering from poor design and a lack of robust evidence. While mHealth interventions like apps and digital exercise programs (e.g., StandingTall) show potential in improving balance and reducing falls, real-world adherence varies, and commercial influences raise concerns about exaggerated claims and lack of regulation. Older people generally view mHealth positively when it is user-friendly, personalized, and integrates behaviour change techniques, but challenges such as usability, privacy, and trust persist. Successful implementation requires involving older people in design, ensuring affordability, and addressing both intrinsic and extrinsic motivators to sustain engagement. Overall, mHealth presents a promising but still evolving approach to fall prevention, necessitating further high-quality research to understand the needs and experiences of older people to help inform mHealth design that will meaningfully improve uptake and adherence to fall prevention interventions. Improved adherence may reduce injurious falls and improve overall health and quality of life in a growing older population.

2.11 Study Significance

Despite the growing body of evidence supporting exercise-based interventions and the emerging promise of mHealth solutions for fall prevention, several critical gaps remain in the literature. First, while digital interventions such as Nymbl offer scalable and accessible alternatives to traditional programmes, real-world engagement and sustained adherence among older people are persistently low (Amagai et al., 2022; Valenzuela et al., 2018). Many studies focus on quantitative outcomes or short-term efficacy, often overlooking the nuanced, experiences of older users and the contextual factors that shape technology adoption and sustained use (Arkkukangas et al., 2021; Pettersson et al., 2023). Furthermore, there is a lack of qualitative research exploring how older people perceive the usability, cultural relevance, and motivational aspects of mHealth interventions specifically designed for fall prevention (Bertolazzi et al., 2024; Spann & Stewart, 2018).

This study directly addresses these gaps by exploring the following research questions: (1) How do community-dwelling older people in New Zealand experience using Nymbl, a digital health intervention for fall prevention? and (2) What factors influence their adoption, engagement, and sustained use of this technology?

By foregrounding older persons' perspectives, this research aims to generate in-depth insights into the facilitators and barriers that shape engagement with digital fall prevention tools. In doing so, it seeks to inform the design and implementation of future mHealth interventions, ensuring they are accessible, culturally relevant, and responsive to the diverse needs of older people. Ultimately, this study contributes to the evidence base needed to optimize digital health strategies for fall prevention and to promote healthy ageing in an increasingly digital world.

Chapter Three – Methodology

3.1 Research Design and Methodology

This study uses an interpretive qualitative research design to investigate the experiences of community-dwelling older people using the Nymbl fall-prevention app. A qualitative approach was used to centre older people's experiences of adopting and using the app in their daily lives. These are nuances that are best captured through in-depth exploration of participants' perspectives rather than numerical measurements. Qualitative methods enable the collection of rich, experiential data, providing insight into personal meanings and context that would be inaccessible via a quantitative survey. In line with an interpretivist paradigm, the study assumes that reality is subjective; each older person may experience and interpret using Nymbl differently. This worldview underpins the research design, emphasizing listening to participants' own voices and situating findings within their unique life contexts. As Creswell and Poth (2025) and Liamputtong (2020) note, qualitative methods are well-suited for examining subjective experiences and complex phenomena. A focused qualitative design was chosen to allow flexibility and depth in discovering factors influencing Nymbl's use among older people, including those that may not have been anticipated by existing theory (an important advantage in an exploratory study of a relatively new intervention).

This study is grounded in an interpretivist paradigm, which assumes that reality is subjective and context dependent. Rather than seeking objective truths or generalisable laws, interpretivist research aims to understand how individuals make sense of their experiences within their own social and cultural contexts (Creswell & Poth, 2025; Denzin et al., 2024). In this view, knowledge is not discovered but interpreted, and multiple realities may coexist depending on the perspectives of those involved. Taking an interpretivist approach means that the research prioritises the lived experiences of older people using the Nymbl app, recognising that each participant may perceive and engage with the technology differently. This is particularly relevant in the context of digital health interventions, where factors such as personal motivation, prior technology exposure, and social support can significantly shape user experience. The aim is not to measure how many older people use Nymbl or how often, but to explore how they understand and respond to it in their daily lives.

Interpretivist research design is characterised by five key tenets, each of which aligns closely with the aims of this study. The first tenet is the focus on subjectivity and contextual meaning. This means that the study seeks to understand Nymbl use from the participant's own perspective, acknowledging that meaning is shaped by individual histories, values, and environments (Denzin et al., 2024). The second tenet is that experience of phenomena is valid data. In this research, rich, experiential data from semi-structured interviews were used to explore participants' thoughts, feelings, and reflections on using Nymbl, rather than relying on numerical indicators. Third, the researcher is understood as a co-interpreter - the researcher plays an active role in interpreting meaning, engaging reflexively with the data and recognising how their own background may influence analysis (Liamputtong, 2020). Fourth, this approach to research emphasises depth over breadth - a small, purposive sample of older people was selected to allow for in-depth exploration of individual experiences, rather than statistical generalisation. Finally, this research understands theory as a lens through which to examine phenomenon, not as a constraint over what can be found - the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) framework is used to guide inquiry and interpretation, but the study remains open to emergent themes that may not fit neatly within its constructs. By adopting an interpretivist stance, the research can capture the nuanced and diverse ways in which older adults engage with Nymbl, offering insights that are both theoretically informed and grounded in real-world experience.

3.2 Theoretical Framework

The theoretical lens guiding this study is the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) (Venkatesh et al., 2012), which provides a structured way to examine technology adoption factors in older people. The UTAUT2 is an extended version of the original UTAUT model (Venkatesh et al., 2003) that integrates key constructs from eight earlier theories of technology acceptance into a unified framework of determinants for use of new technology. These earlier theories include the Theory of Reasoned Action (Fishbein & Ajzen, 1975), Technology Acceptance Model (Davis et al., 1989), Theory of Planned Behaviour (Ajzen, 1991), Diffusion of Innovations (Rogers, 2003), and others) into a unified framework of determinants for use of new technology. The core constructs of the original UTAUT are performance expectancy, effort expectancy, social influence, and facilitating conditions, each posited to directly affect an individual's intention or decision to use a technology (Venkatesh et al., 2003). UTAUT2 expands on this by adding further constructs relevant to consumer and voluntary contexts: notably hedonic motivation (the enjoyment or intrinsic pleasure derived from using the technology), price value (value being whether the cost of using the app outweighed the benefits – costs include monetary costs or other efforts), and habit (the extent to which using the technology becomes automatic with experience) (Venkatesh et al., 2012). UTAUT2 also considers that certain relationships are moderated by factors like age, gender, and experience. This is a particularly important point here, as age and technology experience are likely to influence how older people perceive and use a mobile health app. Taken together, this framework offers a comprehensive set of factors for understanding older peoples' acceptance and use of Nymbl. It was selected for its inclusivity of both individual and contextual influences: for example, it captures personal benefits (performance expectancy) and ease of use (effort expectancy), which are central to user uptake, as well as the role of social circles (social influence) and support/resources (facilitating conditions) that are highly relevant for older users who might rely on family or community support to use new technology.

While other theoretical models were considered (for instance, the simpler Technology Acceptance Model or health-behaviour theories like the Health Belief Model), they were ultimately not chosen because they omit some of these crucial dimensions. TAM focuses mainly on perceived usefulness and ease of use, overlooking social and facilitating factors, and health behaviour models are not specifically tailored to technology use. UTAUT2, by contrast, offered a broad and empirically validated construct set tailored to technology adoption, making it an ideal choice for this study. Notably, UTAUT/UTAUT2 has been used in studies of technology uptake in health contexts, supporting its use here, for example, research by Namatovu et al. (2021) on eHealth adoption in expectant mothers, and by Lange et al. (2020) on virtual reality training for nurses successfully applied UTAUT in qualitative analyses. The UTAUT2 constructs informed the entire research process: they were used to formulate the interview guide, provide initial codes for analysis, to inform the thematic analysis and ultimately to interpret the findings. The UTAUT2 served as a valuable roadmap to ensure that all relevant factors influencing Nymbl use (from perceived usefulness to habit formation) were systematically examined in the interviews and analysis.

3.3 Template Analysis

Template Analysis (King, 2012) was selected not only for its structured approach but also because it aligns well with an interpretivist framework. Interpretivism emphasises understanding participants' subjective experiences and meanings, and template analysis supports this by allowing rich, nuanced interpretation of data while maintaining flexibility to incorporate emergent insights. It is also particularly compatible with using a theoretical framework like UTAUT2. Template analysis allows the researcher to start with an initial coding “template” of themes (which can be derived from theory or prior research), and then iteratively revise and expand that template based on the data. In this study, the UTAUT2 constructs provided an a priori template of expected themes: for example, codes for “perceived benefits”, “ease of use”, “social influences”, and “facilitators/barriers” were defined before examining the transcripts, ensuring that analysis was deductive in capturing the theory’s constructs. At the same time, the procedure remained inductive, open to new themes that emerged from participants’ stories (for instance, if participants raised experiences that did not neatly fit into an existing UTAUT2 category, new codes would be created to accommodate those insights).

The flexibility of template analysis to incorporate both pre-defined and emergent codes was a major reason for its selection, as it aligns well with the study’s goals: it provides a structured, theory-driven lens (important for applying UTAUT2) while also honouring the data from participants. In practice, after the interviews were transcribed, the researcher began coding with an initial template reflecting UTAUT2’s main themes. This template was refined iteratively: after coding a subset of transcripts, some codes were added, removed, or re-organized into a hierarchy of themes and subthemes to better fit the data. Using Template Analysis in this way ensured that the final themes were grounded in participants’ words but still connected to the UTAUT2 framework, enabling a theory-informed interpretation of results. The approach is similar to other qualitative studies that have successfully combined a theoretical model with thematic analysis. For example, (Bixter et al., 2019) used UTAUT constructs to guide analysis of technology use in post-surgery patients. Using template analysis produces a set of themes that directly correspond to factors affecting technology acceptance.

Chapter Four - Methods

4.1 Participants and Recruitment

The population of interest for this research was community-dwelling older people (aged 65 and above) in New Zealand who have used the Nymbl digital balance training application. Inclusion criteria were defined to select participants capable of providing rich insight into the research question. To be eligible, individuals had to be 65 years of age or older (a common definition of "older adult," aligned with New Zealand's superannuation age and the World Health Organization's criteria) (WHO, 2021a). They needed to be living independently in the community (either in their own home or retirement village setting), rather than in a residential care facility; this ensured the context was community use of Nymbl, not an institutional program. Participants were required to have at least some experience using the Nymbl app, either current users or those who had downloaded and tried it in the past, because the interview questions centred on their experiences with that app. A minimum duration of use was not required, even those who had only used Nymbl briefly were included, as their perspectives on why they did not continue are equally valuable. Individuals who never used the app after downloading were excluded, as they would not be able to speak to usage experiences. Participants also needed to have no health conditions preventing an interview or preventing their use of the app, for example, severe cognitive impairment (such as advanced dementia) or significant communication difficulties would preclude participation, as these could compromise the person's ability to recall or describe their experience with the app. Participants had to be sufficiently proficient in English to engage in an in-depth interview without an interpreter since the study did not have resources for translation and analysis of translated data.

A multi-pronged recruitment approach was used, combining purposive sampling with snowball sampling to reach a diverse range of eligible older adults. Initially, collaboration was sought with community organizations involved in fall prevention for older people. Regional Lead Agencies of the Live Stronger for Longer program (which coordinate community strength and balance exercise classes for older people) assisted in recruitment. These organizations (for example, local health providers and groups like Age Concern that run classes such as “Steady As You Go”) had direct access to the target demographic. They distributed the study invitation flyers (See Appendix B) and information sheets to class attendees who had used Nymbl or were known to have an interest in fall prevention technology. Class instructors and coordinators acted as intermediaries by mentioning the study to potentially interested older people and providing them with the researcher’s contact details or the printed information packs (see Appendix C). Potential participants contacted the researcher via e-mail, where any questions they had were answered and a time, place and/or means of interview (in person/phone/zoom) was arranged.

After each interview, participants were asked if they knew anyone else who met the criteria and might be interested in participating. Those who did were given extra copies of the study information pack to pass along. This snowball sampling technique was particularly useful in reaching older people who might not be actively engaged in community groups or who might be hesitant to respond to an unknown researcher’s advertisement. Word-of-mouth introductions from peers made it more comfortable for some new participants to volunteer. Snowball sampling is a well-recognized method for accessing hard-to-reach or specialized populations (Sadler et al., 2010), and it proved effective here in extending the studies reach.

Using these methods, a total of 10 participants were recruited over a period of approximately three months. This sample size of 10 aligns with recommendations for in-depth interview studies where the aim is to reach thematic saturation, often achieved with around 10–15 participants when the group is largely homogenous in broad terms (Guest et al., 2006). In addition, this number was feasible in terms of time and resources for transcription and analysis. Importantly, diversity was achieved in Nymbl usage experience among the participants. Some had been using Nymbl regularly for many months, others had tried it briefly and stopped, and others had used it sporadically or only recently started. Ensuring a mix of longer-term and shorter-term users added breadth to the data –perspectives were captured of both those who integrated Nymbl into their routine and those who did not engage deeply. Participants also varied in their comfort with technology: a few were very tech-savvy (e.g. regularly using smartphones for many tasks), while others had more limited digital experience aside from Nymbl. This variation usefully reflected the range of user types and to see how factors in the UTAUT2 framework might differentially manifest (for instance, someone unfamiliar with smartphones might report different effort expectancy issues than someone who is already comfortable with apps). Thus, although the sample is small, it is purposive and diverse enough to provide credible and transferable insights. Overall, the recruitment strategy succeeded in enrolling information-rich cases relevant to the research question, while also respecting the potential barriers older adults might face in responding to research invitations.

4.2 Data Collection

Data was gathered through semi-structured in-depth interviews with each participant. An interview approach was chosen because it allows participants to share their personal experiences and opinions in their own words, which is essential for addressing the research question. The semi-structured format provided a flexible balance between guidance and openness, a predefined interview guide (See Appendix D) ensured key topics (especially the

UTAUT2 factors) were covered with each participant, but there was also freedom to follow new topics raised by the participant. This approach aligns with qualitative best practices for exploratory studies (Liamputtong, 2020), enabling the interviewer to delve into participants' accounts and meanings while still maintaining some consistency across interviews.

The interview guide was explicitly structured around the UTAUT2 theoretical framework to make sure that each of its major constructs were explored. There were four main sections of questions corresponding to the four core UTAUT constructs (performance expectancy, effort expectancy, social influence and facilitating conditions), plus additional prompts related to the extended UTAUT2 factors (hedonic motivation, price value and habit).

Performance Expectancy – Questions in this section aimed to uncover the participant's perceived benefits or outcomes from using Nymbl. For example, participants were asked "What changes have you noticed since using Nymbl, if any?" to elicit whether they felt improvements in balance, confidence, or daily functioning (the kind of gains the app promises).

Effort Expectancy – Here, the focus was on the ease of learning and using the app. Participants were asked about their initial experience setting up Nymbl (e.g. "How did you find the process of downloading and starting to use Nymbl?") and whether the app's interface and exercises were easy to follow. Follow-up prompts addressed any difficulties – for instance, "Were there any challenges in using Nymbl? What made it easy or hard for you personally?" This covered both technical ease (navigation, understanding instructions) and physical effort (whether exercises were manageable).

Social Influence – Questions explored the influence of other people on the participant's use of Nymbl. They were asked if anyone (family member, friend, healthcare provider) had recommended Nymbl or commented on their use of it. For example: "Have your friends or family been involved in your use of Nymbl? Did their opinions affect your decision to use it?" This helped ascertain if social factors influenced adoption. If participants mentioned using Nymbl as part of a class or group, they were prompted to discuss that influence.

Facilitating Conditions – This section addressed external factors that enabled or hindered app use. Participants were asked about the practical supports and resources around them: "What things have helped you to use Nymbl regularly?" and "Have you experienced any difficulties like not having access to a device, internet issues, or needing help to use the app?" This brought out details such as whether they had the necessary smartphone or tablet, comfort with technology broadly, the availability of someone to assist if they had technological problems.

Behavioural Intention – refers to a conscious plan or motivation to perform a specific behaviour. Within the UTAUT2 framework, behavioural intention is a central construct that mediates the relationship between key influencing factors such has performance expectancy, effort expectancy, social influence and hedonic motivation and actual technology use. It captures the degree to which a person has made deliberate plans to engage with technology i.e. the Nymbl app in the near future (Venkatesh et al., 2012).

Price Value captures an individual's cognitive trade-off between the perceived benefits of using technology and the monetary or non-monetary costs associated with its use. Within the UTAUT framework, price value becomes a significant predictor of behavioural intention. When the perceived benefits of using a technology, are greater than associated costs, such as financial expense, time investment or effort, users are more likely to adopt and continue using the technology (Venkatesh et al., 2012). Although Nymbl is free of charge, participants' perceptions of value would still be expected to play a role in their engagement.

Hedonic Motivation and Habit (UTAUT2 extensions) – Questions to capture enjoyment and habitual use were included. Participants were asked if they found using Nymbl fun or engaging (for instance, "Do you enjoy using Nymbl? Is it something you look forward to, or more of a chore?"), probing the role of intrinsic motivation. To understand habit formation, they were asked about their routine with the app (e.g. "How often do you end up using Nymbl in a typical week? Is it part of your daily routine?").

Use behaviour is concerned with the frequency with which an individual engages with a technology. Within the UTAUT2 framework, use behaviour is the ultimate outcome variable and is directly influenced by behavioural intentions and habit (Venkatesh et al., 2012). It captures the extent to which a person integrates the technology into their lives, reflecting real world adoption beyond stated intentions. In the context of this study, use behaviour relates to how often and in what ways older people interact with the Nymbl app as part of their fall prevention efforts.

The guide ensured all these areas were covered, but interviews remained conversational. Probing questions were used liberally to follow up on interesting statements (for example, if someone mentioned they stopped using Nymbl after a while, the interviewer would ask why and explore that in depth, which might reveal barriers outside the initially envisaged UTAUT2 factors). The semi-structured nature meant that not every question was asked in the same order or wording for every participant; rather, the interviewer adapted to the flow of each conversation. As data collection progressed, the interview guide was iteratively refined. After a few initial interviews, similar unanticipated issues raised by several participants prompted the addition of questions related to that issue. For example, some participants spoke of the burden of handling a device, so a prompt exploring this was added. This adaptive process is consistent with qualitative research flexibility (Liamputtong, 2020), and it enriched the data – ensuring later interviews probed emerging topics, while keeping core questions consistent for all.

Each interview was conducted by the researcher. Interviews took place at a location and time convenient to the participant. Two were conducted face-to-face in the participant's own home, as some participants preferred the comfort and privacy of home and it eliminated travel burden. Eight interviews, however, were conducted via a secure video call (Zoom) due to either the participant living in a different region or scheduling constraints; the virtual interviews still allowed for a personal connection and were only chosen when in-person was not feasible or preferred by the participant. At the start of each session, some casual conversation was used to build rapport. This warm-up helped participants feel at ease, especially as some were not accustomed to being interviewed. The interview then commenced, guided loosely by the prepared questions. The interviewer ensured all UTAUT2 topic areas were eventually discussed, but also encouraged participants to steer the conversation toward what they felt was important about their experience. Interviews ranged from approximately 20 to 30 minutes in length. The variation depended on how much each participant had to say; some were quite succinct while others recounted many details or stories related to using Nymbl or falls in general. The interviews were not long as this was not a deeply personally relevant or difficult topic for the participants.

All interviews were audio-recorded, with explicit permission obtained on the consent form and reconfirmed orally before recording. Recording allowed the conversation to proceed naturally without the interviewer needing to take extensive notes, and it ensured accuracy in capturing participants' exact words and intonations. In addition to audio recording, the interviewer took occasional brief notes during the interview if something noteworthy occurred, for instance, noting a participant's non-verbal reaction or an important point to discuss.

The audio recordings were transcribed verbatim to text. An AI-based transcription service (Otter.ai) was used to generate initial transcripts, and each transcript was then carefully reviewed and manually corrected by the researcher while listening to the recordings to ensure fidelity to participants' speech. All verbal utterances of the participants were transcribed. Transcription was done soon after each interview (typically within one week) to improve accuracy.

Overall, the data collection process yielded rich qualitative data. Using semi-structured interviews tailored around UTAUT2, ensured information was collected on all theoretically important factors and allowed new themes to surface. The participants, in sharing their experiences, covered a wide range of influences on their use of Nymbl. These insights, captured through the interviews, set the stage for a comprehensive analysis.

4.3 Analysis

The interview data was analysed using the framework-guided template analysis approach described in Section 3.1, proceeding through several iterative steps. The analysis was conducted in parallel with data collection (rather than waiting until all interviews were complete), which is a hallmark of qualitative methodology that allows emerging insights to refine ongoing inquiry (Charmaz, 2006)

After correcting transcripts for accuracy, the first step of analysis was to become thoroughly familiar with each interview. The researcher read each transcript multiple times while simultaneously listening to the audio recording, to ensure nuance was captured. Next, a systematic coding process was applied to the transcripts. Given the use of UTAUT2 as a guiding framework, the analysis started with a set of a priori codes corresponding to the main UTAUT2 constructs: for example, codes like "Perceived Benefits" (for performance expectancy-related comments), “Ease of Use” (effort expectancy), “Peer Recommendations” (social influence), “Technical Support” (facilitating conditions), “Enjoyment” (hedonic motivation), and “Use Routine” (habit). These predetermined codes served as an initial template. Each transcript was imported into NVivo 15 (qualitative analysis software) for coding. The researcher coded segments of text line-by-line, attaching one or more codes to each meaningful unit of content. Importantly, the coder remained open to new codes as well. If a participant mentioned an idea that did not fit any existing code, a new code was created inductively to capture it. For instance, an emergent code “Content Localisation” was added when several participants discussed that they thought the app was quite American centric – something that relates to facilitating conditions but wasn’t a pre-set UTAUT factor. By the time five interviews had been coded, the initial list of codes had expanded to include both the original UTAUT2-based codes and several data-driven codes reflecting unanticipated themes.

After coding five transcripts, the researcher reviewed all the codes and began organizing them into a hierarchical code template, i.e. grouping related codes under broader theme categories. At this stage, many of the top-level themes corresponded to UTAUT2 constructs (since the interview questions were structured that way). For example, a broad theme “Perceived Outcomes of Using Nymbl” was analogous to performance expectancy, and it had subthemes like physical benefits (e.g. improved balance, mobility), psychological benefits (e.g. confidence, reduced fear of falling), and lack of benefit (for participants who felt the app did not help). Another top-level theme was “Usability and Effort”, encompassing subthemes such as initial learning curve, ongoing ease of use, technical issues, and physical limitations (if any) in using the app. Additional top-level themes included “Social Context of Use” (covering things like encouragement from family, doing Nymbl exercises with a partner, or feeling too embarrassed to tell friends about it) and “Facilitators and Barriers” (which collected enabling or hindering factors together, from having a suitable device to time constraints or health issues). The researcher also identified a theme around "Engagement and Motivation", which referred to the hedonic motivation code (enjoyment) and habit-related observations (whether Nymbl use became routine or was easily forgotten).

This initial template was then refined through an iterative process. As subsequent transcripts were coded, the researcher checked if new data fit into the existing template or if modifications were needed. In some cases, new subthemes were added. In other cases, separate codes were merged when it became clear they represented the same underlying idea. For example, codes for "Needed family help with app" and "Got tech support from library/volunteer" were merged under a subtheme "Technical Support" under Facilitating Conditions. The template was refined until it effectively accounted for all notable content in the interviews and no substantial new codes were emerging. Throughout coding, a constant comparison technique was used (Liamputtong, 2020), meaning the researcher continually compared incidents in the data to others to ensure consistent coding. If a particular participant's statement did not quite fit a code definition, the code was re-examined and possibly adjusted.

To enhance rigor and credibility, several strategies were employed. Peer debriefing was done with the thesis supervisors; the evolving code structure and interpretations were discussed in supervision meetings (Creswell & Miller, 2000). Excerpts from transcripts were reviewed together to see if supervisors agreed with the coding and theme labels. This external check helped validate that themes were grounded in the data and that potential researcher biases were acknowledged (Charmaz, 2006; Liamputtong, 2020). Discrepancies or alternative explanations were considered and resolved through discussion.

After all transcripts were coded and the template finalized, the researcher synthesized the findings by examining how themes related to each other and to the research questions.

The final themes were not just a mirror of the UTAUT2 categories; rather, the UTAUT2 framework provided the framework, and the detail was the specific ways these factors manifested for older Nymbl users. For example, under the broad concept of facilitating conditions, participants emphasized very practical needs like “having Wi-Fi issues,” which added nuance to that construct in this context. The analysis looked for patterns: e.g., were participants who reported high performance expectancy (believing Nymbl helped them) more likely to continue using it? Did social influence (like being part of a class or having support) coincide with greater engagement? Deviant cases were also considered, examples that ran counter to general trends, to ensure exceptions were understood.

Using both the theoretical lens and inductive insights, the analysis then produced an integrated understanding of the data. Essentially, the outcome of the analysis was a set of key themes (detailed in Chapter Four) that describe factors influencing older peoples’ adoption and use of Nymbl. Each theme is supported by multiple participants’ quotes and encompasses subthemes as needed. In Chapter Five (Findings), these themes are then mapped explicitly to the UTAUT2 to discuss how the findings confirm, extend, or challenge the theoretical expectations.

In summary, the data analysis was a comprehensive, iterative process that combined deductive structure (from UTAUT2) with inductive openness. By continuously comparing data with the developing template and engaging in peer review, the analysis ensured that the resulting themes are both grounded in participants’ actual experiences and interpreted through a theoretically informed lens. This approach yields a rich understanding of the research question, not only identifying what factors affected Nymbl use for these older people but also providing insight into how those factors interacted and which were most salient in this context.

4.4 Ethical Considerations

Ethical approval for this study was obtained from the Massey University Human Research Ethics Committee (Application OM1 25/23) before any interviews were conducted. This research was guided by the principles outlined in the Massey University Code (*Code of Ethical Conduct for Research, Teaching and Evaluations Involving Human Participants*, 2017). The informed consent process paid attention to potential vulnerabilities that older people may experience. Participants received detailed information sheets written in clear, simple language at least one week prior to their scheduled interviews. The information outlined the study's purpose, procedures, benefits, confidentiality measures and participants' rights (see Appendix C). Written consent was obtained in person or, for remote participants, through digital platforms following verification of understanding (see Appendix E). It was ensured participants knew they could withdraw without providing any reason within four weeks after completion of the interview. Given the potentially sensitive nature of discussing falls – which may be a difficult experience for many older people, the interview protocol included some safeguards. Participants were advised at the beginning of each interview that they could skip any questions or pause the conversation if they felt they needed to. Confidentiality protections included several layers of security. All participant identifiers were removed immediately after transcription, with pseudonyms assigned for all reporting. Audio files were stored on password protected institutional "OneDrive" with access limited to the researcher and supervisors. Transcripts were secured in the same way, with any potentially identifying information (e.g. names of healthcare providers, specific locations) redacted during the transcription process.

The study also aimed to ensure that participants' contributions would be used responsibly and respectfully. Their insights were not only analysed for academic purposes but also intended to inform future improvements to digital health interventions for older people. By acknowledging and exploring older peoples lived experiences, the research seeks to influence how mHealth tools are designed, implemented, and supported, potentially leading to more inclusive and effective fall prevention strategies. This aligns with principles of beneficence and justice, ensuring that those who contribute to research may also benefit from its outcomes.

Furthermore, the researcher maintained a reflexive stance throughout the study, recognising the power dynamics inherent in research with older people. Care was taken to avoid assumptions about participants' technological literacy, health status, or preferences. Interviews were conducted in a manner that respected participants' autonomy, dignity, and comfort, with sensitivity to the emotional and physical challenges that may accompany discussions of falls and ageing.

4.5 Reflexivity and Researcher Positionality

This study was conducted within an interpretivist paradigm, which positions the researcher as a co-interpreter of meaning rather than a neutral observer. Within this framework, my positionality was not considered a source of bias to be eliminated, but rather an integral lens through which understanding was jointly constructed with participants. This epistemological stance acknowledges that knowledge is not discovered objectively but is produced through situated interaction. Consequently, my professional, clinical, and personal identities actively informed the research questions posed, the data emphasised, and the themes developed. In place of striving for detachment, the research process embraced ongoing reflexivity.

My positionality is considered relevant to this study in three principal respects. First, the research was conducted while I was enrolled as a Master's student in Public Health and simultaneously employed by ACC (the Accident Compensation Corporation) in a role involving the implementation of the Nymbl application. This professional affiliation is likely to have influenced both how the research topic was framed and how participants engaged with the study. For instance, participants' awareness of my connection to the funder and provider of the app may have inclined them to present their experiences more favourably, potentially approaching the interview as an opportunity for programme feedback rather than as a confidential research encounter. Concurrently, my insider perspective initially led the investigation towards implementation outcomes, such as usability and adherence, which may have inadvertently backgrounded other significant experiential dimensions, including perceptions of surveillance or the emotional impact of using a falls-prevention application. Furthermore, a potential deference to perceived institutional authority, stemming from my ACC role, could have suppressed participants' willingness to critique the ACC-funded Nymbl app.

Second, my background as a physiotherapist informs a professional training that emphasises physiological explanations for physical health outcomes and solutions centred on individual health behaviour change. This disciplinary lens may predispose the research to place value on exercise-based interventions. While this position furnished valuable contextual and clinical insight into the use of Nymbl, it necessitated continual vigilance against confirmatory bias favouring app-based balance training.

Third, as a comparatively younger researcher interviewing older people about falls, ageing, and technology, I recognised that age difference could shape both the sharing and interpretation of data. This dynamic might engender social desirability or impression management, whereby participants minimise difficulties, such as falls, fear, or disengagement with the app, to appear competent to a younger interviewer. It also required me to remain alert to my own age-related assumptions, such as over-attributing barriers to “low digital literacy,” which could constitute a form of well-intentioned or “compassionate” ageism.

To mitigate the potential for overlooking limitations of the Nymbl application or unduly prioritising individual motivation as a determinant of success, several methodological strategies were employed. A hybrid analytical approach was adopted, combining a UTAUT2-informed template with inductive coding to capture emergent and unanticipated themes. Rigour was promoted through maintaining a detailed audit trail and engaging in regular supervisory debriefing sessions to test rival explanations. Interviewing techniques were designed to be neutral and non-defensive, explicitly inviting critique as well as praise of the application. Conflicts of interest were managed by delineating my ACC role from the study’s conduct and ensuring that only de-identified, aggregate results were shared with the funding body. Throughout the analysis, interpretive priority was given to participants’ own words, with particular attention paid to negative cases that contested my professional assumptions.

Additional safeguards included neutrally framing interview questions to value non-use and criticism as highly as positive experiences; affording participants control over interview location, modality, pace, and breaks; employing plain language in all interactions; and dedicating analytical attention to discrepant data and the distinction between confidence and capacity in technology use.

4.6 Summary

This chapter has presented a comprehensive overview of the study's methodology, from its qualitative research design through to detailed analytic procedures. The selection of in-depth interviews as the primary data collection method, grounded in UTAUT2 and analysed through Template Analysis, provides a robust approach to understanding older peoples' experiences with the Nymbl digital fall prevention intervention. The methodology addresses key challenges in studying technology adoption among older populations, including capturing nuanced experiences through qualitative methods, maintaining analytical flexibility while ensuring a theoretical grounding and implementing ethical protections for a potentially vulnerable population.

Chapter Five – Findings

5.1 Participants Context and Overview

Overall, ten participants were recruited for this study, each meeting the eligibility criteria of being community dwelling older people in New Zealand who had experience using the Nymbl digital balance training app. While the sample included some variation in age, gender and technology confidence, most participants shared similar backgrounds, having comparable levels of education and prior professional experience. Cultural diversity within the group was limited, as nearly all participants identified as New Zealand European/Pākehā. This relative homogeneity provides important context for interpreting the findings, as it shapes the range of perspectives and experiences captured in this study. Whilst qualitative research never claims to be generalisable, the homogeneity of participant characteristics means that the perspectives of older people from different socio-economic, educational and cultural backgrounds is not represented in the findings.

<u>Demographic Characteristics</u>

Participants ranged in age from 66 to 86 years (M = 78), with seven women and three men. Most participants identified as New Zealand European/Pākehā, with one participant also identifying as Māori and one preferring not to state their ethnicity. Nine described themselves as “fully mobile,” while one participant reported being “mobile with assistance.” Several participants reported health conditions commonly associated with increased fall risk, including cerebrovascular accident (CVA), osteoarthritis, knee replacement, discectomy, shoulder replacement, and spinal stenosis. Participants’ previous occupations included teaching, healthcare (general practitioner, chiropractor, veterinarian), retail, business, and counselling. Educational attainment ranged from secondary school qualifications to postgraduate degrees, with most participants holding at least a bachelor's degree (see Table1).

Technology Confidence

Self-reported technology confidence varied across the sample. Two participants described themselves as "not confident" using technology, four as "confident," and one as "very confident." Three participants did not provide a confidence rating. This range of digital literacy is broadly representative of the older adult population in New Zealand, where recent nationally representative survey data show that older people remain a heterogeneous group in terms of internet access, skills, and usage patterns, even among those who are already online (Pacheco, 2023). This diversity in digital engagement is relevant to understanding their experiences with digital health interventions.

Nymbl Use Patterns

Participants reported a wide range of engagement with the Nymbl app, both in terms of duration and frequency of use. For example, one participant stated, "probably two or three years" (Participant 1), another, "that would have been about 18 months ago, two years ago, perhaps" (Participant 7). Another participant described a much shorter engagement: "two weeks" (Participant 8).

Frequency of use also varied considerably. Some participants reported daily or even multiple daily sessions: "I've been doing it now for five or six years, every day…" (Participant 6); "Well, I do use it more than once a day" (Participant 5). Others described using the app a couple of times a week: "Probably, to be honest, a couple of times a week" (Participant 2). Several participants reported lapses or irregular use, such as, "Sometimes no weeks, other weeks, three or four times. So, if I happen to think about it…" (Participant 9), and "I did it maybe once, twice a week, for a few months, and then there'd be a lapse. Oh, let's have another go at Nymbl, and I go back, but kept losing interest or not so motivated?" (Participant 3). Some participants noted that their frequency of use was higher at the beginning and declined over time: "in the beginning, I must say I was better at using it more often. Yeah, I probably aren't using it as often as I would like to now" (Participant 4). One participant described a period of consistent engagement: "I used it religiously for probably about nine months, and I went through the whole cycle" (Participant 7). Others described aiming for a minimum number of sessions per week: "I try and do minimum of three. I mean, sometimes I might do five, sometimes it's four" (Participant 10).

Table 1 Participant Demographics and Nymbl Use Characteristics (N = 10)

ID	Age	Gender	Ethnicity	Mobility	Comorbidity	Occupation	Education	Tech Confidence	Length of Use	Frequency of Use
1	83	Female	NZ European/Pākehā	Fully Mobile	CVA	Bookshop owner / Journalist	Bachelor's	—	2–3 years	—
2	79	Female	NZ European/Pākehā, Māori	Fully Mobile	Knee Replacement	School Teacher	Bachelor's	—	—	Couple of times a week
3	69	Female	NZ European/Pākehā	Fully Mobile	—	Teacher	Postgraduate	Confident	2 years (with lapses)	Once/twice a week, lapses
4	77	Female	NZ European/Pākehā	Fully Mobile	—	School Teacher	Bachelor's	Confident	Nearly 2 years	Used more often at start, less now
5	80	Male	Prefer not to say	Fully Mobile	Osteoarthritis	Purchasing Officer	Secondary	Not Confident	—	More than once a day, sometimes multiple sessions
6	79	Male	NZ European/Pākehā	Fully Mobile	CVA	Chiropractor	Postgraduate	—	5–6 years	Every day
7	70	Female	NZ European/Pākehā	Fully Mobile	—	Counsellor	Postgraduate	Confident	18 months–2 years	Used religiously for 9 months, then cycled

8	86	Male	NZ European/Pākehā	Fully Mobile	Discectomy	General Practitioner	Postgraduate	Confident	2 weeks	—
9	82	Female	NZ European/Pākehā	Mobile with assistance	Shoulder replacement, Spinal stenosis	Veterinarian	Postgraduate	Not Confident	18 months	3–4 times a week, sometimes none
10	66	Female	NZ European/Pākehā	Fully Mobile	—	Director, of a business	Trade cert/diploma	Very Confident	About a year	3–5 times a week

Note. CVA = cerebrovascular accident; "—" indicates data not specified by participant.

This diversity provided a rich context for exploring the lived experiences of older people using a digital fall prevention intervention. The following sections present the findings from in-depth interviews, structured around the UTAUT2 framework and emergent themes.

5.2 Analytic Overview and Final Template

Table 2 Final Analytic Template: Themes and Subthemes

Theme (UTAUT2 Construct)	Subthemes / Inductive Extensions
Performance Expectancy	Perceived usefulness; Quality of life; No perceived benefit
Effort Expectancy	Ease of use; Learning curve; Fit with daily routine; Device handling burden; Accessibility
Social Influence	Family encouragement; Healthcare professional influence; Peer comparison; Recommend to others; Social interaction; Gratitude
Facilitating Conditions	Technical support; Training resources; Internet connectivity; Reminders; Variety of activities; Personalisation/adaptation; Content localisation; Gamification; Privacy concerns
Hedonic Motivation	Enjoyment; Lack of enjoyment
Habit	Routine formation; Anchoring to daily activities
Price Value	Perceived value; Tried because free; Time/effort trade-offs
Behavioural Intention	Motivation; Demotivation; Willingness to continue
Use Behaviour	Frequency and duration of use; Feature engagement; Workarounds

Note. Themes in bold correspond to UTAUT2 constructs; subthemes include both theory-driven and inductively derived categories.

5.3 Thematic Findings

This section presents the analysed themes derived from the semi-structured interviews. The findings are organised by UTAUT2 constructs and complemented by inductive themes that arose from the participants lived experiences (e.g. personalisation, content localisation and pragmatic workarounds). The definitions of UTAUT2 constructs follow Venkatesh et al. (2012) and are used as analytic lenses rather than causal claims. An overview of the findings is shown in Table 3.

5.3.1 Performance Expectancy (PE)

Performance expectancy referred to the degree to which participants believed that using Nymbl would help them achieve desired outcomes, such as improved balance, mobility, confidence, or quality of life (Venkatesh et al., 2012). A strong sense of performance expectancy was evident among many participants, who described tangible improvements in balance, confidence, and daily functioning, particularly when they used Nymbl regularly. The app's dual-task format, combining physical and cognitive exercises, was widely regarded as relevant to real-world fall risks. One participant explained,

> "Well, I know that when I used it more often, like probably three times a week, I think my balance really improved" (Participant 4).

Another reflected on the real-life applicability:

> "I can see the sense of doing the exercises, and, you know, the mental exercises, you know, while you're doing the physical movements, because obviously, you know

> that's what happens when you are walking, you can get distracted by different things…" (Participant 1).

Some participants also noted improvements in confidence and quality of life, such as feeling steadier when dressing or more secure moving around the home. However, not all participants attributed improvements solely to Nymbl, with some expressing uncertainty about its unique contribution, especially if they were already active or used the app inconsistently. For example, one participant said,

> "I can't say it directly because of Nymbl, because I'm doing similar things myself" (Participant 6).

A few questioned whether Nymbl was the right fit for their needs, suggesting that perceived usefulness is highly individualized and may depend on baseline activity levels or personal preferences.

Performance expectancy was a central motivator for engagement with Nymbl, with many participants reporting perceived improvements in balance, confidence, and daily functioning, particularly when use was regular and sustained. The integration of cognitive and physical tasks was seen as relevant and beneficial. However, the extent of perceived benefit varied, with some participants expressing ambivalence or attributing improvements to other activities. For a minority, lack of regular use or a mismatch with personal needs limited the perceived value of the app.

5.3.2 Effort Expectancy (EE)

Effort expectancy refers to the degree of ease associated with learning and using a technology, encompassing onboarding, navigation, clarity of instructions, and the perceived cognitive or physical effort required for use (Venkatesh et al., 2012). Effort expectancy played a crucial role in shaping engagement. Most participants described Nymbl as simple and accessible, with clear instructions and short sessions that could be easily slotted into daily routines. This simplicity was especially valued by those less confident with technology, who appreciated the straightforward enrolment and minimal technical barriers.

> “It’s a good little app really. You know, it’s quite simple and straightforward to use,” (Participant 2)

The flexibility to use the app in various settings, without special equipment or clothing, was also highlighted as a facilitator.

There was one notable usability issue, the challenge of handling a phone or tablet while performing balance exercises. Several participants found it awkward to hold or look at their device during tasks requiring outstretched arms or head movement. For example, one exercise asks users to stand on one foot and tap the screen when they see a certain shape, a coordination test that a few found tricky mainly because managing the phone in one hand made them feel off-balance. As a workaround, some propped their phone on a table or switched to using a larger tablet, so they wouldn’t have to grip a small device; others admitted they simply skipped certain exercises they felt were impractical without a hands-free option.

> “Yes, I actually, I'm using my iPad these days, and I find that I can, I can set that up and and just get along with the exercises. Yes, so no, I don't have any problem with it’ (Participant 8)
>
> I'm holding the phone out in front of me. I'm trying to keep with one foot in front of the other, and I'm looking at it wobbling, but I can't put the phone down because, you know, but then I'd be supporting myself, yeah, which is not supposed to be so, yeah, yeah. I don't know how you would do it (Participant 4)

Others found that using a larger device, such as an iPad, or having good vision made the process easier. Some participants also mentioned that the app's brevity and predictability made it easier to integrate into daily life, with one saying,

> I will say one thing, the fact that it's only eight to 10 minutes of my time. Yeah, I sort of always have that in my mind, that I can squeeze that in. I've just got to remember, but I can squeeze it. If it was half an hour, I think I would make an excuse. Not today (Participant 10)

Table 3 Overview of thematic findings

Theory Core Constructs	Subthemes	Construct Feature	Analytic Interpretation	Data Example
Performance Expectancy (PE)	Perceived usefulness; Quality of life; No perceived benefit	The degree to which participants believe Nymbl would help achieve desired outcomes (e.g., improved balance, mobility, confidence, quality of life)	Many participants reported perceived improvements in balance and confidence, especially with regular use. Some expressed ambivalence or attributed improvements to other activities.	"Well, I know that when I used it more often like probably three times a week that I think my balance really improved" (Participant 4) "I can't say it directly because of Nymbl, because I'm doing similar things myself" (Participant 6) "I can see the sense of doing the exercises, and, you know, the mental exercises, you know, while you're doing the physical movements" (Participant 1)
Effort Expectancy (EE)	Ease of use; Learning curve; Fit with daily routine; Device handling burden; Accessibility	The degree of ease associated with learning and using Nymbl (onboarding, navigation, clarity, cognitive/physical effort)	Most found Nymbl simple and accessible, with short sessions fitting daily routines. Some struggled with dual-tasking or device handling, especially during complex exercises.	"It's a good little app really. You know, it's quite simple and straightforward to use" (Participant 2) "I thought it was easier than I expected" (Participant 9) "I find it's quite hard to be holding your phone and doing the exercise and the quiz at the same time" (Participant 4)
Social Influence	Family encouragement; Healthcare professional influence; Peer	Extent to which family, friends, peers, or health	Social influence was important for initial uptake (family, friends,	"I heard about it from my sister-in-law... she suggested that it was a good thing to do" (Participant 2)

	comparison; Recommend to others; Social interaction; Gratitude	professionals encourage/support use	health professionals), but less so for sustained use, which depended more on individual motivation and routine.	“My doctor suggested going to it by GP” (Participant 9) “I don't think I'd change anything about Nymbl just my compliance.” (Participant 6)
Facilitating Conditions (FC)	Technical support; Training resources; Internet connectivity; Reminders; Variety of activities; Personalisation/adaptation; Content localisation; Gamification; Privacy concerns	Perceived resources, supports, and contextual factors enabling/hindering use (technical support, reminders, content fit, infrastructure)	Clear instructions, reminders, and visual demonstrations supported use. Barriers included technical issues, lack of responsive support, and content that felt culturally irrelevant.	“Probably the like the little picture of demonstrating the exercise that’s helpful” (Participant4) “There’s just no support, really, in fairness, of any sort” (Participant 5) “I did an email Nymbl, just ask. But it's I felt like it wasn't really resolved” (Participant 10) “The only thing I don't like about that is that I get a bit tired of the American trivia” (Participant 2)
Hedonic Motivation (HM)	Enjoyment; Lack of enjoyment	Degree of enjoyment, pleasure, or intrinsic satisfaction from use	Some enjoyed the brief, structured activities and sense of achievement; others were motivated more by utility than pleasure.	“Probably I quite enjoy the mathematical activities and the simple things that they do” (Participant 2) “Yeah, yeah, yeah, definitely… It gives you… I've achieved something today” (Participant 4) “No, enjoyment isn’t a word I would use to describe it” (Participant 8)

Habit (HT)	Routine formation; Anchoring to daily activities	Extent to which use became automatic or routine	Habit formation was facilitated by anchoring to daily routines, but routines were fragile and easily disrupted.	“So Nymbl is generally done once a day, because it's in the routine. I know I don't have to do it that often, but I have been” (Participant 8) “I try and do it every morning. It's only if something comes up, then I think, okay, you'll do it in the afternoon, and then you forget” (Participant 10)
Price Value (PV)	Perceived value; Tried because free; Time/effort trade-offs	Cognitive trade-off between perceived benefits and costs (monetary or otherwise)	Free access facilitated initial uptake; sustained use depended on perceived value for time and effort.	“So, I just thought, oh, well, this is free. I might as well hop on and give it a whiz” (Participant 5) Well, I know that when I used it more often, like probably three times a week that I think my balance really improved, and now that I'm only doing it sort of once a week, I do notice sometimes that, yeah, my balance isn't as steady (Participant 4)
Behavioural Intention (BI)	Motivation; Demotivation; Willingness to continue	Stated plans, motivations, or willingness to use/continue using Nymbl	Initial motivation was strong, often preventive; sustaining intention was challenged by technical issues, competing activities, and need for self-discipline.	“Yes, I know that our balance can get compromised as we get older by various things. So, I thought, why not give it a go?” (Participant 3) “I have one major problem, yes, and it's, it's me. I know it's me, but they, they present the exercises well” (Participant 8) “The hardest thing is compliance” (Participant 6)

Use Behaviour (UB)	Frequency and duration of use; Feature engagement; Workarounds	Actual patterns of engagement (frequency, duration, feature use, adaptations)	Patterns ranged from regular, long-term use to intermittent or short-term use; participants often adapted the app to their needs.	“I’ve been doing it now for five or six years, every day” (Participant 6) “Sometimes no weeks, other weeks, three or four times. So, if I happen to think about it” (Participant 9)

Effort expectancy was a key component among participants, with most describing Nymbl as simple, accessible, and easy to integrate into daily life. The brevity of sessions and intuitive design facilitated routine use. However, the cognitive demands of dual-tasking and the physical challenge of device handling posed barriers for some, particularly during more complex exercises. Accessibility features and flexible routines mitigated some of these challenges, but further adaptations—such as alternative interaction modalities or simplified device requirements—could enhance usability for a broader range of older people.

5.3.3 Social Influence (SI)

Social influence refers to the extent to which individuals perceive that important others, such as family, friends, peers, or health professionals, encourage or support their use of a technology (Venkatesh et al., 2012). Social influence was most prominent at the point of initial adoption. Recommendations from family, friends, or health professionals often prompted participants to try Nymbl, and technical support from relatives was sometimes essential for enrolment.

> "I heard about it from my sister-in-law… she suggested that it was a good thing to do" (Participant 2).
>
> "My doctor suggested going to it by GP" (Participant 9).

Family members sometimes participated in exercises or encouraged ongoing use, and word-of-mouth within social groups or community classes was a common way participants learned about the app. However, as participants settled into their routines, ongoing use became less dependent on social encouragement and more on personal motivation and habit. Some participants expressed a desire for more social or group-based engagement, suggesting that

Nymbl could be adapted for group settings or broadcast to a screen for collective exercise. Others noted that social interaction was lacking in the app compared to in-person classes, with one participant remarking,

> "I think what's lacking on Nymbl is the social interaction… about half of us go and have coffee afterwards. And that's the most important part." (Participant 8)

Social influence shaped initial uptake, with family, friends, and health professionals acting as sources of encouragement, information, and technical support. Peer experiences with falls and word-of-mouth recommendations reinforced the perceived value of balance training. However, ongoing use was less dependent on social influence and more closely tied to individual motivation, perceived benefit, and routine. Some participants desired more opportunities for social interaction or group-based engagement, suggesting a potential area for future development.

5.3.4 Facilitating Conditions (FC)

Facilitating conditions refer to the perceived resources, supports, and contextual factors that enable or hinder the use of a technology, including technical support, training, reminders, content fit, and infrastructure (Venkatesh et al., 2012). The importance of facilitating conditions was evident throughout participants' accounts. Supportive features such as clear instructions, visual demonstrations, and reminders were key enablers. The ability to adjust exercise difficulty and the presence of visual cues were particularly appreciated.

> "Probably the little picture of demonstrating the exercise… that's helpful," (Participant 4).

However, technical issues (such as app glitches, lack of responsive support, or confusing updates) and content that felt culturally irrelevant, especially American-centric trivia, were common barriers.

> "The only thing I don't like about that is that I get a bit tired of the American trivia," (Participant 2).

Reliable internet and device access were prerequisites for use, and privacy concerns, though not universal, were noted by some. Some participants also commented that they gained motivational value from gamified elements, such as badges or progress feedback.

> "when they give me gold stars" (Participant 4)
>
> "one of the things that worked as both a carrot and a stick probably was, you would, you could see how many you'd done during the week" (Participant 7)

Others found these features unclear or insufficiently explained and did not derive value from these features.

> "But that was another thing about Nymbl, was that I didn't feel that there was a lot about my progress. Or it might say, now you're bronze, or now you're silver but I thought, Well, why? Yeah, how does being bronze now? How do I get there? What got me there? Was it how many times I've been on or how long I didn't know, yeah" (Participant 3)

The fit between the app's resources and the user's technological, cultural, and personal context was a key determinant of ongoing use.

Facilitating conditions were central to both initial uptake and sustained engagement with Nymbl. Participants valued clear instructions, visual demonstrations, and reminders, but desired more responsive technical support, greater content localisation, and increased variety. Gamification and progress tracking were motivating for some but confusing for others. Stable internet connectivity was essential, and privacy concerns, while not universal, could affect comfort with certain features. Overall, the fit between the app's resources and the user's context, technological, cultural, and personal, was a key determinant of ongoing use.

5.3.5 Hedonic Motivation (HM)

Hedonic motivation refers to the degree of enjoyment, pleasure, or intrinsic satisfaction derived from using a technology (Venkatesh et al., 2012). Hedonic motivation, the enjoyment or satisfaction derived from using Nymbl, varied across participants. Some found satisfaction in the brief, structured activities and the sense of achievement after completing sessions.

> "Yeah, yeah, yeah, definitely. It gives you… 'I've achieved something today'" (Participant 4).

For others, the routine of engaging with Nymbl contributed to a positive feeling, both mentally and physically. However, enjoyment was not universal, and some participants described their engagement as motivated more by perceived benefit than by pleasure or fun.

> "No, enjoyment isn't a word I would use to describe it," (Participant 8)

This suggests that while enjoyment can enhance adherence for some, utility and routine are more critical for sustained use among older people.

Hedonic motivation played a supporting but not universal role in participants' engagement with Nymbl. For some, the app's brief, structured activities and sense of achievement contributed to positive feelings and routine use. For others, enjoyment was less significant, with engagement driven more by perceived health benefits or habit than by intrinsic pleasure. These findings suggest that while enjoyment can enhance adherence for some users, a focus on utility, routine, and meaningful outcomes may be equally or more important for sustaining engagement among older people.

5.3.6 Habit (HT)

Habit refers to the extent to which the use of Nymbl became automatic or routine for participants, reflecting the degree to which engagement with the app was integrated into daily life without requiring conscious effort (Venkatesh et al., 2012). The formation of habit was central to sustained engagement. Participants who successfully integrated Nymbl into their daily routines, often anchoring it to specific times or activities, were more likely to maintain regular use.

> "So nimble is generally done once a day, because it's in the routine. I know I don't have to do it that often, but I have been" (Participant 8).

Others described pairing Nymbl with morning rituals or other habitual activities, such as after breakfast or before starting work. However, these routines were fragile and easily disrupted by changes in schedule, minor obstacles, or lapses in motivation. As one participant put it,

> "I try and do it every morning. It's only if something comes up, then I think, okay, you'll do it in the afternoon, and then you forget" (Participant 10).

Some participants suggested that external reminders or more structured scheduling could help reinforce the habit.

Habit formation was facilitated when Nymbl was intentionally anchored to daily routines, particularly in the morning or alongside other habitual activities. The brevity and predictability of sessions supported this integration. However, the fragility of habit was evident, with minor disruptions, competing priorities, or lack of structure leading to lapses or abandonment. For some, external reminders or more structured scheduling could support more consistent engagement. These findings highlight the importance of routine anchoring and environmental cues in sustaining digital health behaviours among older people.

5.3.7 Price Value (PV)

Price value refers to the cognitive trade-off between the perceived benefits of using a technology and the monetary or other costs associated with its use (Venkatesh et al., 2012). In the context of Nymbl, which was provided free of charge to participants, price value was primarily shaped by perceptions of value for time and effort, as well as the absence of financial barriers. Price value was a strong facilitator for initial uptake. The absence of a financial barrier encouraged participants to try Nymbl, especially those who might otherwise have hesitated.

> “So, I just thought, oh, well, this is free. I might as well hop on and give it a whiz” (Participant 5).

Several participants explicitly stated that they were willing to try Nymbl because it was free, and that this aspect made the decision to engage with the app much easier. However, continued use depended on whether the perceived benefits justified the investment of time and effort, with some participants weighing the value of their time against the outcomes they experienced.

> Well, I know that when I used it more often, like probably three times a week that I think my balance really improved, and now that I'm only doing it sort of once a week, I do notice sometimes that, yeah, my balance isn't as steady (Participant 4)

The absence of a financial barrier was a significant facilitator for initial uptake and experimentation with Nymbl. Participants consistently highlighted the importance of the app being free to access, noting that this aspect made it easier to try the app, even if they were unsure of its personal relevance or benefit. For many, the opportunity to use Nymbl without cost reduced hesitation and encouraged engagement, particularly among those who might otherwise have been reluctant to invest in a digital health intervention.

5.3.8 Behavioural Intention (BI) and Use Behaviour (UB)

Behavioural intention refers to participants stated plans, motivations, or willingness to use or continue using Nymbl, as well as factors that support or undermine these intentions (Venkatesh et al., 2012). Use behaviour refers to the actual patterns of engagement with Nymbl, including frequency and duration of use, feature engagement, and the ways in which participants adapted or worked around the app's features to suit their needs (Venkatesh et al., 2012).

Behavioural intention and use behaviour were shaped by a combination of initial motivation, often driven by a preventive mindset or curiosity, and the realities of daily life. Many participants began using Nymbl with strong intentions, motivated by a desire to prevent falls or maintain independence.

> "Yes, I know that our balance can get compromised as we get older by various things. So, I thought, why not give it a go?" (Participant 3)

However, sustaining engagement required ongoing perceived benefit, ease of integration into daily routines, and overcoming barriers such as boredom, technical issues, or competing priorities. Usage patterns varied widely, from daily, long-term engagement to intermittent or short-term use, with some participants adapting the app to their needs or preferences.

> "The hardest thing is compliance" (Participant 6)

> "And I'm a bit cross with myself that I don't do it more often, and I'm not sure why I don't. I just sort of probably forget about it" (Participant 2)

Others described lapses or periods of forgetting, and some developed creative workarounds to tailor the app to their preferences and abilities. This highlights an important disconnect between intended design and actual use, without sufficient user testing and input from the intended end user, there is a real risk the app will not be used as intended.

> "And then sometimes I will just modify it slightly myself, like, if I found it too easy, I might do it. Might walk backwards on my toes, rather walk forwards on my toes or something like that. I just, I know, you know, I can just stretch it out a wee bit" (Participant 10)

Behavioural intention to use Nymbl was generally strong at the outset, driven by preventive health motives, curiosity, and external encouragement. Willingness to continue was most often seen among those who perceived ongoing benefit and could easily integrate Nymbl into their routines. These findings highlight the importance of both initial motivation and ongoing support in fostering long-term engagement with digital health interventions among older people.

Use behaviour was highly individualized, with patterns of engagement shaped by motivation, routine, perceived benefit, and the app's design. While some participants maintained regular, long-term use, others cycled in and out of engagement or adapted the app to better fit their needs. Feature engagement was influenced by the perceived relevance and challenge of app components, and workarounds reflected both the flexibility and the limitations of the app for older people.

> "because the odd time I felt they were too easy, and I did look at the suggestion to down the bottom, you can actually ask it to look at it an easier way or a harder way. And I looked at that." (Participant 10)

These findings underscore the importance of supporting diverse usage patterns and providing adaptable features to sustain engagement in digital health interventions.

5.4 Cross-Theme Patterns

Thematic analysis of participants' experiences with Nymbl revealed several cross-cutting patterns that illuminate how technology acceptance and use are shaped by the interplay of UTAUT2 constructs and context-specific factors. These patterns highlight the dynamic and multifactorial nature of digital health engagement among older people.

The Interdependence of Perceived Benefit, Effort, and Routine

Participants' sustained engagement with Nymbl was most robust when perceived benefits (performance expectancy) were clear and the app was easy to use (effort expectancy), particularly when sessions could be anchored to daily routines (habit). Those who experienced tangible improvements in balance or confidence, and who found the app simple to integrate into their day, were more likely to develop a consistent habit of use. Conversely, when perceived benefits were ambiguous or the app was not easily incorporated into daily routine, motivation and adherence waned.

The Centrality of Facilitating Conditions

Facilitating conditions, including technical support, reminders, content localisation, and reliable internet connectivity, were pivotal in both initial uptake and ongoing use. Participants valued clear instructions, visual demonstrations, and the ability to adjust exercise difficulty. However, technical issues, lack of responsive support, or content that felt culturally irrelevant could disrupt engagement. The fit between the app's resources and the user's technological, cultural, and personal context was a key determinant of ongoing use.

The Role of Social Influence in Uptake, Not Maintenance

Social influence, particularly from family, friends, and healthcare professionals, was most relevant at the point of initial adoption. Recommendations, encouragement, and practical support from others often prompted participants to try Nymbl. However, ongoing use was more closely tied to individual motivation, perceived benefit, and the ability to integrate the app into daily life, rather than continued social prompting. This may also reflect that the app itself is designed for individual use and has no social component therefore social influence on ongoing use is limited by design.

The Enabling Effect of Free Access and Low Barriers

The absence of a financial barrier (price value) was a significant facilitator for initial uptake, with participants frequently citing the app's free availability as a reason for trying it. Sustained engagement, however, depended on the perceived value of the app in relation to the time and effort required, underscoring the importance of both cost and benefit in shaping technology adoption and use.

The Mixed Impact of Hedonic Motivation and Gamification

Enjoyment and gamified features (such as quizzes, badges, and progress feedback) contributed to engagement for some participants, providing a sense of satisfaction or achievement. For others, these features were less prominent, with engagement driven more by perceived health benefits or routine than by intrinsic pleasure. The motivational value of gamification was further influenced by the clarity and relevance of feedback, as well as the variety and challenge of activities.

Adaptation and Workarounds as Evidence of Agency

Participants often adapted the app to their own needs and preferences, developing workarounds for exercises that were too easy, too difficult, or not well suited to their abilities. This pragmatic approach reflects both the flexibility and the limitations of the app and highlights the importance of supporting diverse usage patterns and providing adaptable features. This highlights the importance of design and user testing. If design is not fit for purpose, then it forces people to create their own workarounds which may invalidate studies done where the app is used in the ideal, controlled state. Real world application and efficacy may then be different from experimental studies

The Fragility of Habit and the Importance of Environmental Cues

While some participants successfully established Nymbl as a daily habit, this routine was often fragile and susceptible to disruption by minor events, competing priorities, or lack of structure. Anchoring use to specific times of day or pairing it with other habitual activities supported consistency, while external reminders or prompts were helpful for some in reinforcing the habit.

These patterns suggest that older peoples' engagement with digital health interventions like Nymbl are shaped by a constellation of factors: the perceived relevance and benefit of the app, its usability and fit with daily routines, the availability of support and culturally relevant content, and the presence of low barriers to entry. Social influence is important for adoption, but sustained use depends on the interplay of individual motivation, habit formation, and the adaptability of the technology to users' evolving needs and contexts.

5.5 Summary

The participants' engagement with Nymbl was shaped by a complex interplay of perceived benefits, usability, social and environmental supports, and personal routines. Nymbl was frequently described as simple and accessible, with its short sessions and intuitive design making it easier to fit into daily life. However, some found the cognitive demands of dual-tasking or the physical challenge of handling a device during exercises to be obstacles, especially for more complex tasks. Social influences such as encouragement from family, friends, or health professionals were important for initial uptake. Over time, however, continued use was more closely linked to individual motivation, perceived benefit, and the ability to make Nymbl part of a personal routine. Facilitating conditions played a pivotal role in both starting and maintaining use. The fit between the app's features and the user's technological, cultural, and personal context was a key factor in ongoing use. Enjoyment and a sense of achievement contributed to positive experiences for some, but for others, engagement was driven more by a sense of utility or habit than by intrinsic pleasure. Habit formation was supported when Nymbl was intentionally anchored to daily routines, such as morning rituals or other habitual activities. The short and predictable nature of sessions helped some participants maintain regular use, but routines were often fragile and could be disrupted by competing priorities or changes in daily life. Some participants cycled in and out of use or adapted the app to better fit their needs and developed their own workarounds to tailor the app to their abilities and preferences.

The UTAUT2 framework provided a valuable structure for interpreting these experiences, with participants' narratives mapping naturally onto domains such as perceived benefit, ease of use, social context, facilitating conditions, enjoyment, price value, habit, and actual use. However, the qualitative data also revealed nuances and context-specific factors such as content localisation, device handling burden, and the need for culturally relevant support. Participants' creative adaptations and the fragility of habit in the face of life's disruptions added further depth to the understanding of technology use in this context. Overall, while UTAUT2 offered a robust theoretical lens for understanding digital health engagement among older people, the qualitative approach enriched this perspective by surfacing the lived realities, adaptations, and contextual factors that shape technology use in everyday life. The findings suggest that successful digital health interventions for older people are those that offer meaningful benefits, are easy to use and integrate into daily life, provide responsive support and culturally relevant content, and minimize barriers to entry. The nuanced interplay of these factors underscores the importance of a holistic, user-centred approach to the design and implementation of digital health technologies.

Chapter Six – Discussion & Conclusion

6.1 Summary of Key Findings

Drawing on in-depth interviews analysed through UTAUT2, this study found that participants derived clear value from Nymbl when it was useful (improved balance, confidence and everyday functioning) and easy to use (short, simple sessions that fit routines). Initial uptake was facilitated by social influence and the fact that there was no financial cost to download the app. Sustained engagement was facilitated by habit and supportive conditions but hampered by monotony, minor technical issues and occasional content misfit. Overall, participants' experiences point to the need for user-centred design, cultural relevance and implementation within supportive community and healthcare ecosystems to achieve lasting impact.

Community-dwelling older people derived value from the Nymbl digital balance training app when two conditions were met: (1) they clearly understood its benefits (feeling steadier, more confident in daily activities), and (2) the technology was convenient and easy to use. Participants reported gains in balance confidence after regular use – which gave them a sense of accomplishment and reinforced the app's perceived usefulness. This resonates with the UTAUT2 construct of performance expectancy, as users continued engaging when they saw real-world fall-prevention benefits. Equally important was effort expectancy: they described Nymbl as simple and straightforward, even for those with modest technology skills. The app's clear interface, short 10-minute sessions, and lack of extra equipment meant it could be slotted into daily routines with minimal hassle. The strengths of the app were the decisive combination of usefulness and usability. Such findings align with broader evidence that older people embrace health technology when it tangibly supports their independence and is user-friendly (Hawley-Hague et al., 2014; Spann & Stewart, 2018). In our study, participants explicitly linked Nymbl to the outcome they cared about, preventing falls, which bolstered their motivation to use it. They also appreciated Nymbl's dual-task format (balance exercises paired with trivia questions) as a meaningful but manageable cognitive challenge; several noted it mirrored real-life situations of maintaining balance while distracted, thereby training them for everyday scenarios. Not everyone loved the trivia component (a few found it distracting or culturally irrelevant at first), but most understood its purpose and even found it fun once they got used to it. This suggests that hedonic motivation can play a supporting role, some users said they enjoyed the quizzes or liked earning star ratings as feedback, which made the exercise feel more like a motivating game than a chore. For others, enjoyment was secondary to utility; they treated Nymbl as a health task they were willing to do for the sake of the benefit, even if the activity itself wasn't fun.

Initial uptake of Nymbl was often catalysed by social influence and the app's free availability. This aligns with existing international evidence about the reasons older people try new technology. Many participants first heard about it through word-of-mouth, from family, friends, or community health programs. Having a trusted person recommend or help set up the app was key for these older people to get started. These endorsements provided reassurance and practical initial support. This pattern echoes prior studies that show older peoples' uptake of new technology is often spurred by encouragement from healthcare providers or family caregivers (Hawley-Hague et al., 2014). Additionally, nearly all participants cited Nymbl's zero cost as a decisive factor, with no financial barrier, they felt free to give it a try. Removing cost greatly lowered the threshold for experimentation, consistent with UTAUT2's price value factor (Venkatesh et al., 2012). Knowing the app was ACC-funded and free gave users an open mind to try it, whereas even a small fee might have deterred some on fixed incomes.

Maintaining long-term engagement with Nymbl proved difficult and ultimately hinged on users developing a consistent habit. Even participants who were enthusiastic initially did not always integrate Nymbl into a permanent daily routine. The interviews revealed several common reasons for this waning adherence, which mirror patterns documented in the literature. First, motivation tended to decline once the novelty wore off, some users gradually forgot about the app or lost interest, especially if they weren't seeing continued improvement or if life became busy. This aligns with prior findings that adherence often wanes without ongoing reinforcement or feedback (Finnegan, Bruce, et al., 2019). Second, lack of personal discipline and content monotony were major barriers. After months of playing the same set of balance games, several users felt the experience became monotonous, leading to boredom. Once boredom set in, they would start skipping sessions or using the app only sporadically. This feedback echoes a study by Mansson et al. (2020), which found that older people doing a static home exercise programme (a paper booklet) described it as dull and repetitive over time, whereas those using a more interactive digital programme remained engaged longer. In other words, a plateau in content or challenge can undermine exercise habit formation by reducing enjoyment and perceived benefit (Mansson et al., 2020).

Third, practical interruptions often broke users' emerging routines, illustrating the fragility of habit formation. Minor life events such as a phone call during one's usual exercise time, travel that disrupted their schedule, or a technical issue (e.g. an app update that logged them out), could interrupt a streak. Some participants admitted that after missing a few days, they struggled to restart. Because Nymbl is self-directed and missing sessions carries no immediate consequence, an older person trying to build a new habit received no external reminder or accountability to nudge them back on track. This lack of "push" was problematic for individuals who were not intrinsically disciplined. Recent qualitative research confirms that such disruptions can derail habit formation in later life: Karlsson et al. (2025) found that active older people had to constantly "renegotiate their habits" in the face of routine changes or setbacks, and those without external support often lapsed until they found a way to reboot their routine. In our study, participants who lapsed similarly noted that there was no coach or notification to call them out for falling behind, the responsibility to resume was entirely on them, which some found hard to uphold (Karlsson et al., 2025).

In contrast, those who succeeded in making Nymbl use a daily habit typically tied it to an existing routine or environmental cue. By anchoring the new behaviour to a firmly established part of their day, these users added Nymbl to an existing habit to prompt Nymbl use automatically. This underscores how critical routine and cueing are for sustained engagement. Behavioural studies likewise emphasise that pairing a new activity with consistent contextual cues greatly improves the chances of forming a lasting habit (Karlsson et al., 2025; Pettersson et al., 2023). In fact, Pettersson et al. (2023) observed in a year-long study that older people who successfully maintained a digital exercise regimen went through stages of habit formation, ultimately "forming habits through cues", such as always exercising after a certain daily event, which made the behaviour more automatic. This study's findings support this: participants who attached Nymbl to a routine tended to stick with it, whereas those who treated it as a free-floating task "to do whenever" were more inconsistent. This point is in line with the UTAUT2 model's construct of Habit (i.e. technology use becoming automatic over time) and earlier research on exercise adherence in older people demonstrating that establishing a fixed routine is pivotal (Yardley et al., 2008).

Participants praised Nymbl's ease of use and supportive design features. Many described the app as simple or intuitive to navigate, and they appreciated features like clear visual demonstrations of each exercise and the ability to adjust difficulty levels. These elements made users feel the app was genuinely tailored to their needs. For instance, knowing they could choose an easier version of an exercise or hold onto a chair for support if needed meant that even less confident or more frail users could participate safely without feeling overwhelmed. Several people mentioned the clear step-by-step instructions and the option to enlarge text, noting these as senior-friendly design choices that gave them confidence in using the app on their own. Such usability factors are crucial for keeping older people engaged. Past research consistently shows that older people tend to abandon health apps that are confusing, poorly designed, or hard to operate, and instead stick with those that are intuitive, accessible, and accommodating to their abilities (Wildenbos et al., 2018). Nymbl's design appears to get this balance right, its user interface and features respected the limitations of its older audience (for example, by offering big text and balance support options) while still empowering them to progress in their exercises. Participants did note a few design limitations, but these were minor in comparison to the overall positive reception of the app's usability. The consensus was that Nymbl removed many of the typical technology barriers that might deter older people. By being easy to use, visually clear, and adaptable in difficulty, the app allowed users to focus on building their balance habit rather than struggling with the technology. This kind of seamless user experience is known to facilitate long-term engagement in digital health interventions for seniors (Cepni et al., 2025; Wildenbos et al., 2018), because it reduces frustration and fosters a sense of trust and comfort with the tool. Nymbl's supportive design likely contributed to the strong initial uptake, however, sustaining usage still required motivational strategies and habit formation beyond the app's inherent usability. Combining Nymbl's senior-friendly design with mechanisms to inject variety, provide ongoing reinforcement, and integrate the app into daily routines may further bolster its long-term effectiveness.

These findings suggests that despite Nymbl's overall user-friendliness, more interface adaptivity, such as voice commands or an auto-advance mode that doesn't require looking at the screen, could further improve the experience. Another theme was content relevance of trivia content which reduced their enjoyment of the cognitive games. This underscores that cultural tailoring in digital health content isn't trivial: when older users encounter material that resonates with their local culture and life experience, it can increase engagement and sense of ownership, whereas too much foreign or irrelevant content might subtly signal "this wasn't made for me," potentially undermining motivation (Naderbagi et al., 2024).

Community-dwelling older people can successfully engage with a well-designed mobile fall-prevention program like Nymbl and derive benefits in terms of confidence and balance. They particularly valued ease of use, short and convenient exercise formats, and seeing practical improvements (feeling steadier, more independent). These factors correspond with known facilitators of technology acceptance in older people, perceived usefulness, simplicity, social support, and cost-free access, as outlined in UTAUT2 and other models (Peek et al., 2016; Venkatesh et al., 2012). At the same time, these results highlight specific, actionable barriers (like device handling issues and the need for ongoing content novelty) that future implementations should seek to overcome. Keeping older users engaged over the long term will likely require addressing both human factors (motivation, habit formation, support needs) and design factors (ergonomics, variety, cultural relevance). These findings provide a foundation for discussion on how to integrate digital interventions into wider fall-prevention efforts and how to refine such tools for maximum benefit.

6.2 Critical Appraisal: Engagement and Effectiveness Challenges

Digital health interventions like Nymbl hold promise, but research over the past several years shows that many health apps do not fully live up to their health promotion potential in practice (Koh et al., 2021). There are systematic challenges in real-world engagement, adherence, and clinical effectiveness that temper the optimistic view of mHealth. Recognizing these issues provides a critical perspective that complements the user-focused results and helps ensure our discussion is balanced.

A key challenge is long-term adherence. These findings suggest difficulties in sustaining use are not unique; high dropout and short engagement periods are common across many health apps (Lang et al., 2022). Studies consistently find that most users abandon health apps soon after download. For example, a recent literature review reported “substantial participant dropout or attrition” in mHealth interventions, to the extent that a user is more likely to drop out than to be retained over time (Amagai et al., 2022). In the context of Nymbl, this means that even if an older person initially adopts the app, perhaps due to strong performance expectancy and social influence as per UTAUT2, maintaining that habit without external support is difficult. Behavioural science refers to this as the “law of attrition” in eHealth (Eysenbach, 2005). This was evident in the findings; many who started enthusiastically established a habit of daily exercises beyond a few weeks or months. Broader mHealth data bear this out. For instance, Amagai et al. (2022) reviewed dozens of adult mHealth studies and found that on average, engagement was only partially maintained and often declined sharply after the initial novelty wore off. They identified common factors behind retention failures, such as lack of feedback, insufficient reminders, technical difficulties, or perceiving limited app usefulness, issues that echo what the present Nymbl study found. Their statistical analysis showed the odds of an mHealth participant dropping out were higher than the odds of being retained (Amagai et al., 2022). These findings have also been supported by a systematic review that showed high dropout rates for apps addressing depressive symptoms (Torous et al., 2020) and by Jakob et al. (2022) who found that tailoring apps to individual user needs, reminders and a tech-stable design all contribute to higher levels of prolonged engagement. This suggests that without deliberate strategies to foster habit and ongoing motivation, even a well-received app will lose many users over time.

Closely related is the issue of limited long-term effectiveness. Even among those who do use it, the measurable health outcomes are sometimes modest. A comprehensive meta-analysis by Iribarren et al. (2021) examined 172 randomized trials of health apps (covering diet, exercise, chronic disease management, etc.) and found on average only a small advantage of app-based interventions over standard care. The pooled effect size was a standardised mean difference of 0.38 in favour of apps, which, while statistically significant, is a weak effect in practical terms. The authors explicitly concluded that there is weak evidence to support apps having a positive effect on health, noting that many studies showed no significant improvements, and those that did often had short follow-ups (Iribarren et al., 2021), the short follow up period for many studies means that there is sparse information on the effects of sustained engagement. In the context of fall prevention, this raises the following point: even though the participants felt more confident and steadier (an important outcome in itself, related to self-efficacy), whether an app like Nymbl can demonstrably reduce fall rates or injuries is still an open question. This ties back to the adherence problem; health benefits of exercise (digital or not) are realised only if the behaviour is maintained. An intervention that older people use diligently for a few weeks but then drop entirely may have transient benefits at best. This underscores the importance of building in features that promote sustained engagement (reminders, new content, social elements), or combining apps with human support, to translate initial acceptance into lasting health outcomes.

Another concern is usability and accessibility for the target population. This participant group were relatively tech-savvy and motivated, but in real-world deployments health apps often struggle to reach and retain more vulnerable older people (Cunha et al., 2016). Issues like small text, complex interfaces, or required device handling can be significant barriers (Franklin & Myneni, 2018). In a scoping review of mobile health for older people, Wildenbos et al. (2018) identified common usability barriers: age-related visual or dexterity impairments, low digital literacy, and lack of guidance were top among them. Half of popular mental health apps assessed in one recent study failed basic accessibility criteria (Rickard et al., 2022). For older users, if an app isn't tailored to their needs, for example, using large high-contrast fonts, simple navigation, and error-tolerant design, they will likely abandon it even if the content is valuable (Pywell et al., 2020). In practice, many older people encounter difficulties setting up apps or lose confidence if something goes wrong (Pywell et al., 2020). This aligns with prior findings that facilitating conditions (like having support and proper devices) are crucial for older peoples' sustained use of technology (Peek et al., 2016). When evaluating apps broadly, one sees a significant drop-off at the stage of installation and initial onboarding among less tech-savvy seniors (Czaja, 2019). Thus, an app might be efficacious on paper, but if the intended audience finds it too troublesome to use regularly, its real-world impact is undermined. This suggests that more emphasis on co-design with older users and iterative usability testing is needed industry-wide to ensure products truly meet older people's capabilities and preferences (Cole et al., 2022; Sanz et al., 2021).

Unlike medical devices or medications, most consumer health apps undergo no formal regulation or rigorous evaluation before being marketed (Boulos et al., 2014; Torous et al., 2022). This lack of oversight can result in apps that are well-intentioned but ineffective, or worse, apps that make misleading claims and potentially unsafe recommendations. In the case of Nymbl, the content was developed by medical professionals, and the program was endorsed by a reputable insurer (ACC), lending it credibility. However, many other apps in the wellness and fall-prevention space do not have such backing. A review by Byambasuren et al. (2018) noted that out of thousands of health apps, only a tiny fraction had been tested in any scientific study, and even fewer had high-quality evidence supporting them. They concluded that health app evidence lags far behind availability; the public is downloading and using apps faster than researchers or regulators can assess them. This evidence gap means users are often on their own to judge an app's worth. It is fortunate that Nymbl aligns with known best-practices for balance training (dual-task exercises, progression, etc.), but an older person could just as easily download an unproven app that claims to improve balance with questionable exercises, or a pill reminder app that has serious usability flaws. Across the mobile health landscape, quality control is inconsistent. App stores prioritise popularity and ratings over evidence or safety. One analysis found no meaningful correlation between an app's user ratings and its clinical quality or data security (Azad-Khaneghah et al., 2021), meaning popular but ineffectual apps can easily top the charts. This is a concern for public health, if agencies like ACC had not promoted a well-developed app, older people might end up using inferior solutions or lose trust in mHealth solutions. It also underscores a policy implication, discussed later, that some form of certification or guidance for health apps would help ensure older people adopt ones that are effective and safe.

Health apps can produce negative outcomes, contrary to their intent. For example, a mobile app for breast cancer survivors aimed at reducing distress was tested in a trial but paradoxically led to increased anxiety and depression compared to usual care (Horn et al., 2025). Digital interventions can have unintended side effects. For fall prevention apps specifically, poorly executed apps might encourage exercise beyond physical ability leading to injury or give false confidence to a frail user. Although these findings suggest users are active in adapting exercising to individual abilities, poorly designed mHealth interventions could increase falls. Ensuring appropriate difficulty levels, clear safety instructions and encouraging consultation with healthcare providers are important safeguards. Without professional oversight, apps may empower self-care whilst shifting responsibility to lay users who may not recognize when or how to modify their behaviour safely (Cook et al., 2016). Some experts advocate a blended approach (digital plus human coaching) for older people, to address safety concerns (Gordon et al., 2020).

Finally, a critical perspective must address health equity and inclusivity. Digital health solutions, if not implemented carefully, could inadvertently widen disparities. Older people are a diverse group; those who stand to benefit most from fall-prevention interventions (the very old, those with limited access to in-person programs) might also be the ones least able to use an app (Hadjiat, 2023). In the present study, participants were predominantly in their 70s and well-educated; none had severe dementia or lived in extreme poverty. However, many older people in their 80s or 90s, or those from disadvantaged backgrounds, might not become aware of the Nymbl app, or could struggle with the technology needed to use it. This is part of the "digital divide": the gap between those with ready access and skills for digital tools and those without (Mubarak & Suomi, 2022). A commentary by Hadjiat (2023) warns that digital health innovations, intended to be inclusive, may entrench inequality further if vulnerable groups are left behind. For instance, if fall-prevention resources shift heavily towards an app, older people who cannot use the app (due to not having a device, internet, or requisite skills) might receive less support than before. This study's findings that word-of-mouth and free access were key enablers suggest some ways to mitigate this, e.g. providing the app free is essential for equity and involving healthcare providers in recommending it helps reach those who trust traditional channels. But more targeted efforts may be needed to reach less connected older people.

Crawford and Serhal (2020) developed a Digital Health Equity Framework that emphasizes factors like digital literacy, social support, and cultural context as critical to an intervention's success. Nymbl's effectiveness for a population will depend on more than just the app design; it depends on ensuring older people have devices, have internet access and receive training or help to initiate use. It also means being cognizant of cultural differences – for example, Māori or Pasifika elders might respond better if the app's content and messaging reflect their communities, or they might prefer group-based activities to solitary app use. Without efforts to adapt and support use, digital programs risk mainly serving the healthy and wealthy young-old rather than the broader older population. In New Zealand's Nymbl rollout, it was observed that uptake among Māori and Pacific older people was disproportionately low (Appendix A). This is a microcosm of a global pattern, those with higher education and income tend to be the early adopters of health tech, whereas marginalized groups often face structural barriers to benefiting (Seifert et al., 2021). Therefore, an overarching critique is that mHealth interventions must actively address inclusion; otherwise, they might improve outcomes for some while leaving others no better off or relatively worse if resources shift away from non-digital options.

This study used UTAUT2 as a theoretical framework to understand digital health adoption. Recent systematic reviews, such as (Cobelli et al., 2024), have highlighted a widespread tendency within healthcare technology adoption research to apply the UTAUT and UTAUT2 frameworks only partially, often selecting a subset of constructs or supplementing them with variables from other models or context-specific factors. This selective approach, while pragmatic, may undermine both the explanatory power and the comparability of findings across studies. In contrast, the present study systematically applied all UTAUT2 constructs, including those, such as hedonic motivation, habit, and price value, that are frequently neglected in the literature, thereby enabling a more comprehensive and nuanced understanding of older peoples' engagement with digital fall prevention interventions. At the same time, the emergence of inductively derived, context-specific themes (such as content localisation and device handling burden) in this research echoes the trend identified by Cobelli et al. (2024), reinforcing the argument that technology acceptance models must be flexible and responsive to the lived realities of users. These findings support calls for the continued evolution of technology acceptance frameworks, ensuring they are sufficiently robust and adaptable to capture the complexity and diversity of real-world healthcare contexts.

Even as the findings of this study demonstrate the feasibility and perceived benefits of a fall-prevention app for older people, it also identifies common pitfalls of health apps. Sustaining engagement is hard, many users drop out, limiting long-term impact. Health outcomes have been mixed, with generally modest benefits seen in trials unless adherence is exceptional. Usability and support need to extend to the least technologically capable user, not just those with average skills, to avoid excluding a segment of older people. Finally, issues of access and equity mean we cannot assume that a well-designed app will necessarily be well used; proactive measures are needed to ensure digital health solutions reach and support the broader population of older people, including those at the highest risk of falls who may also face the highest barriers to technology. Acknowledging these challenges lays the groundwork for recommendations on how to overcome them.

6.3 Limitations of the Study

This study has several limitations which should be considered alongside these conclusions. First, the study sample was relatively small (N = 10) and not representative of all older people. Participants were community-dwelling seniors in New Zealand who had already shown interest in a digital falls program (by virtue of using Nymbl and agreeing to be interviewed). They were predominantly in their late 60s to early 80s, and many were already engaged in other exercise or falls prevention activities. Those who are open to using an app and talking about it may be more positive and more technologically adept than the average older adult. This limits how well we can extrapolate results to all community-dwelling older people, let alone institutionalized or very frail older people. It is plausible research with older people with less prior experience of technology would have included more negative feedback or barriers (for instance, confusion with technology, greater scepticism) that did not emerge as strongly here. Another contextual factor is cultural: our sample was mostly Pākehā (New Zealand European), with one Māori participant and none from Pacific or Asian backgrounds. Attitudes towards exercise and technology can differ by culture; for instance, collectivist cultures might prefer group activities to solitary app use, or language barriers might impede use. It cannot be assumed that the study findings apply equally across cultural groups. This is a limitation in cultural generalizability. Future research should examine more diverse samples (older, less active, lower socio-economic status, different ethnic backgrounds) to see if similar benefits and issues occur.

As a qualitative study relying on self-reported perceptions, the data are inherently subjective. This means there will be recall bias and social desirability bias in these accounts (Dijkstra et al., 2001). Participants might overstate improvements (out of enthusiasm or a desire to please the interviewer) or downplay difficulties (perhaps feeling it's their own fault if they didn't use the app as instructed). Qualitative insight is powerful for understanding why and how people engage with an intervention, which was suitable for the research question.

A primary limitation of this study is its cross-sectional design, which captured a static snapshot of user experiences at a single point in time. Consequently, the research could not trace the evolution of participant engagement with Nymbl from initial adoption into sustained, long-term use, such as observing how early enthusiasm might diminish as novelty subsides. A longitudinal qualitative approach, employing repeated interviews with the same individuals over time, would have substantially enriched the findings by revealing these temporal dynamics of engagement. Such a methodology is uniquely suited to capturing change, as it can reveal transitions, trajectories, and shifts in perceptions, motivations, and behaviours that a single interview cannot. For instance, prior longitudinal research demonstrates that users' strategies, confidence, and the personal significance of a technology evolve substantially through distinct stages, from initial struggle to routine integration (Pettersson et al., 2023). The present study, reliant on retrospective accounts, lacked this capacity to document changes, such as the common pattern of an initial period of enthusiasm followed by attrition, in real time. A longitudinal component would have enabled the documentation of how and why engagement waxes or wanes, differentiating between users who sustain involvement and those who abandon it, thereby providing deeper insight into the processes of long-term adherence and attrition critical for designing effective digital health interventions. Without longitudinal follow-up, we could not capture the evolution of use (except retrospectively from their narratives).

The context of this study, New Zealand, with a national insurer (ACC) promoting the app, may limit applicability to other settings. In New Zealand, Nymbl was provided free and actively marketed as part of a government-supported initiative. This likely enhanced trust and willingness to try the app (some participants mentioned that knowing ACC endorsed it gave them confidence it was legitimate). In countries without such institutional backing, older people might be more wary of a commercial app or might struggle to access a high-quality app amid the noise of app stores. Also, the New Zealand healthcare context is relatively integrated; participants often heard about Nymbl through existing community fall programs. In places where healthcare is more fragmented, an app could struggle to gain traction without a clear champion. Moreover, our interviews took place during a period when many older people had been exposed to using technology more (following COVID-19 lockdowns meant older people were more comfortable with Zoom calls). Thus, timing and context (post-2020 when telehealth and apps were more promoted) might have influenced results.

Nymbl has certain design features (dual-task games, very short daily routine) that might not be present in other apps. Different app features might mean users react differently (some could find it too time-consuming; others might prefer fewer but longer sessions). While broader themes like ease of use, social support are discussed, it's important to note these insights are grounded in Nymbl's implementation. The study can't disentangle which findings are universal for balance apps and which are specific to Nymbl's approach.

During interviews candid negative feedback was received in areas like boredom and content relevance, which suggests many felt comfortable sharing both pros and cons. But the possibility of courtesy bias cannot be ruled out, some might have emphasized the positives out of politeness. This was mitigated this by ensuring confidentiality and framing questions neutrally, but subtle bias often remains.

In summary, the study's limitations include a small, possibly non-representative sample, and contextual factors (cultural and healthcare system specifics) that might not hold elsewhere. They highlight the need for further research – ideally mixed-methods or longitudinal qualitative studies – to validate and build upon what this study observed. Despite these limitations, the rich qualitative insights are valuable for understanding user perspectives and informing how to implement such interventions.

6.4 Implications for Public Health Practice and Policy

The study's insights suggest several actionable implications for integrating digital interventions into fall-prevention practice and shaping supportive policies. Mobile apps can be a valuable complement to traditional fall-prevention strategies, but their success in practice depends on proper support, endorsement, and integration within the healthcare system. Healthcare providers and community organizations have a pivotal enabling role. Many participants tried Nymbl specifically because a GP, physiotherapist, or exercise coach recommended it. Clinicians and health professionals have a role in proactively introducing vetted apps as part of routine falls risk management (WHO, 2021b). For practice, this might involve GPs prescribing the use of Nymbl during check-ups for patients with balance issues. Such integration can lend credibility and allow providers to monitor progress (for example, asking patients about their app exercises in follow-up visits). In line with UTAUT2's social influence construct, endorsement from trusted figures including health professionals significantly boosts initial adoption. (Hawley-Hague et al., 2014). Professional guidelines for fall prevention could explicitly mention evidence-based apps as an adjunct to in-person programs. For instance, community physiotherapists could routinely support older clients install and learn Nymbl or similar apps, effectively acting as digital health coaches. On a policy level, training materials and continuing education for geriatric care providers might incorporate digital toolkits so that frontline staff feel confident in using and recommending these technologies.

Blending digital programs into existing community networks can amplify reach and adherence. Rather than relying on older people to use an app in isolation, public health initiatives could incorporate the app into group activities or follow-ups. For example, local community balance classes could run a weekly "balance app club" where participants do Nymbl exercises together (addressing some of the preference for social interaction that Nymbl use lacks). Combining the app with social elements, either in-person or virtual peer groups, could improve satisfaction and persistence. From a health promotion standpoint, friendly competitions or challenges facilitated through the app might increase motivation via social and gamification routes. Additionally, linking app usage with periodic check-ins by falls prevention coordinators (either phone calls or brief coaching sessions) might help sustain engagement, as external accountability and encouragement often reinvigorate participation (Finnegan, Bruce, et al., 2019). Communities could also leverage volunteers or "digital ambassadors", technologically proficient older people who can support their peers in using the app regularly. For best results, these apps could be embedded within a hybrid model that ensures users feel part of a supported program.

To address the adherence and engagement challenges, practice and policy could emphasize ongoing support and content updates. From a program design perspective, agencies implementing the app (like ACC) could specify scheduled periodic content refreshes (new exercises or trivia every few months) and introduce seasonal campaigns (e.g., a "Winter Balance Boost" challenge) to re-engage lapsed users. To increase user support, a simple but effective policy could be to institute a follow-up protocol: if a registered user does not use the app within 30 days, they receive a reminder or an offer of help. This could be automated (notifications, emails) or human (a brief call from a community health worker asking if they need any assistance). Tackling engagement in such a systematic way acknowledges that behaviour change requires reinforcement (Vlaev & Dolan, 2015). Given that "a participant is more likely to drop out than stay" (Amagai et al., 2022), planning for re-engagement is crucial. Policymakers might allocate funding specifically for app-support services. Just as call centres exist for smoking quit lines, 'help desks' for fall-prevention app users could be instituted. This fits within broader falls prevention strategy: the cost of reminder calls is trivial compared to the cost of a hip fracture; investing in adherence support is justified from a health economics perspective.

Ensure equitable access and reduce the digital divide.

A universal approach to digital design may inadvertently exclude those who cannot or prefer not to use smartphones. To mitigate this, policy could support device loan programs for older people (for instance, libraries or senior centres lending tablets with Nymbl pre-installed) and provide free or low-cost internet access in senior housing complexes to improve connectivity. Fall-prevention efforts may be a vehicle to fund and promote digital literacy workshops tailored for older people. Culturally appropriate outreach is also needed. Working with Māori and Pacific community leaders to promote the app in culturally relevant ways may improve uptake in those groups. To achieve health equity, digital interventions must be introduced with attention to language, culture, and socio-economic factors. On a policy level, this could mean translating app instructions into multiple languages, ensuring any videos have subtitles or voice-overs in languages common among local populations, and partnering with community health workers who can bridge cultural gaps. It might also entail continuing non-digital alternatives in parallel (for those who cannot or prefer not to use the app, to ensure they still receive exercise guidance), adopting a “no one left behind” approach. Hadjiat (2023) emphasizes that inclusive health services require considering those at risk of being bypassed; accordingly, any national strategy that deploys mHealth for older people should include metrics to track usage across different demographics and targeted interventions if disparities are detected.

<u>Content Quality, Safety, and Policy</u>

Agencies endorsing such apps (like ACC) should regularly vet and update them to ensure they remain evidence-based and secure. For instance, as research on falls evolves, the app’s exercises and difficulty progression should be adjusted. If user feedback identifies certain exercises as problematic (too hard, causing strain), developers should modify or replace them. Regulators could consider a light-touch certification system for health apps targeting older people, for example, an accreditation that the app meets basic efficacy and safety criteria (similar to how equipment in gyms might be approved). While formal FDA-style regulation for all wellness apps is unlikely, a voluntary or semi-official approval system could guide providers and users toward trustworthy options. This would protect older consumers from apps that have not been tested. Mechanisms to either improve or de-list problematic apps is important. Continual monitoring and quality assurance are implied responsibilities when an app becomes part of public health practice. On a clinical governance level, integrating app data with health records (with user consent) could be valuable – e.g., if an older patient is using the app, a physiotherapist could see summary reports of their adherence or progress before a clinic visit. This integration (which policy could encourage through interoperability standards) might further legitimize and normalize app usage in clinical practice.

Digital Tools within a Supportive Ecosystem

Health systems should not simply offer an app and step away; they should incorporate the app into multifaceted fall-prevention programs that include human encouragement, technical support, and follow-up. Policies that fund not just the development of the app but also its dissemination, user training, and ongoing maintenance are likely to yield better outcomes. When older people use an app like Nymbl, they often benefit in confidence and functional ability. The task for practitioners and policymakers is to create conditions where more older people can sustain use. Successful examples would be including app training in pre-discharge planning for patients hospitalized due to a fall (Cheng et al., 2022), or community health nurses checking on whether high-risk older people are engaged with balance exercises (digital or otherwise) (Wu et al., 2010). If apps can reduce in-person classes or physical therapy visits (by supplementing them), they could allow services to reach more people at lower cost. These benefits rely on people consistently using the apps. Therefore, investing in engagement strategies is a crucial part of program costs, not an optional add-on.

Finally, these implications align with a broad trend in healthcare towards preventative, patient-empowering solutions. Encouraging older people to take an active role in their fall prevention through a tool like Nymbl can reinforce a sense of autonomy and competence. The participants in this study often felt empowered. If scaled, this could potentially shift some aspects of fall prevention out of clinics and into the home effectively. For policymakers concerned with aging populations, that is an attractive prospect, a relatively low-cost, scalable intervention that, with proper support, might reduce falls, emergency calls, and hospital admissions. But the lesson from this study and others is that human factors matter, technology alone does not solve problems without the right ecosystem. Thus, in practical terms, health services should treat these apps as one component in a continuum of care and ensure they are accompanied by education, support, and integration to truly fulfil their promise.

6.5 Recommendations for Future Research and Intervention Design

Several recommendations can be outlined for future research and for the design and deployment of digital fall-prevention interventions:

<u>Broaden the evidence base with diverse populations and objective measures.</u>

Future studies should include a wider range of older people, especially those over 80, those with cognitive impairments, and individuals from varied socio-economic and cultural backgrounds. This could involve case studies of older people in assisted living using the app (perhaps with caregiver help), or trials in rural areas with limited internet. Additionally, incorporating quantitative outcome measures is crucial. Randomized controlled trials (RCTs) or controlled cohort studies could compare fall rates or balance test improvements between an app user group and a non-user group. Even short-term RCTs (3-6 months) could provide data on whether using Nymbl (or similar apps) leads to fewer falls or better functional mobility. For example, a mixed-method study might find that 70% of users improved their Berg Balance Score (quantitative) and qualitatively report higher confidence. The combination of subjective and objective outcomes would strengthen the case for efficacy, Liang et al. (2024) is an example this type of study design, although they were not investigating an app but an exercise program, the same design would apply for an app. Long-term follow-up is needed. The benefits and engagement at 3 months may be quite different at 12 or 24 months. Given attrition issues, longitudinal designs are particularly important to observe how engagement evolves, and what distinguishes long-term adherers from dropouts. Such knowledge can guide design tweaks and support strategies (Delbaere et al., 2021). In short, future research should aim to answer: How and why does engagement change over time? What are the differences between those who sustain involvement and those who abandon it?

Since adherence is a known issue, researchers could experiment with the impact of personalized coaching on adherence. For example, periodic phone/video coaching could be added to the app to improve engagement. Higher usage with coaching would provide evidence the value of adding a human element. Similarly, testing app feature variations could be informative. Adding a social forum or buddy system to the app might lead to better retention; this could be tested by offering different versions to different user groups. Gamification elements like streaks, badges, or leaderboards could also be systematically evaluated. The key is to use research to identify which strategies effectively counteract the natural decline in usage. Qualitative research can continue to help here: interviewing users who quit after a short time could reveal common reasons for disengagement (e.g., “I got bored," "I kept forgetting," "I had no one to do it with"). Those reasons can inspire targeted solutions (fresh content, reminders, social features), which can then be tested. Implementation science frameworks might be employed to study engagement, for instance, using the Behaviour Change Technique taxonomy to categorize what Nymbl currently does and what additional techniques might encourage continued exercise (Michie et al., 2013). Ultimately, the goal is to identify a set of best practices to keep older people engaged with digital health tools over the long term, likely a combination of app design changes and external supports. These suggestions have the potential to turn a novel app into a sustained intervention with real health impact.

User-cantered design and accessibility.

Our findings pointed to specific design improvements (like hands-free operation) which future development should incorporate and evaluate. Following participatory design principles, developers could collaborate with older people to co-create new interface solutions (voice commands, gesture controls, simplified navigation) before pilot testing (Czaja et al., 2019; Robertson & Simonsen, 2013). A voice-activated mode could be developed and trialled with a subset of older users to gauge usability. Another area is personalization: using an intelligent algorithm to tailor the app's difficulty progression to an individual's performance may boost outcomes. Offering localized content might improves engagement among diverse communities. Essentially, by treating the app not as static but as an evolving platform shaped by user feedback, research can drive continuous improvement.

These recommendations stress an iterative loop: insights from users such as those in the study can be used to refine the intervention, empirically test those refinements, broaden to new user groups, and evaluate at larger scales. By doing so, digital interventions become not only user-approved but also clinically impactful and widely accessible. Older people feeling more confident and steadier thanks to an app, is encouraging. Future research, as outlined, can develop these findings to improve practice and ensure that mHealth tools genuinely contribute to healthy ageing. With the global population of older people growing, the timing is favourable, investing in these lines of inquiry will support robust, inclusive digital programs that keep older people living independently longer.

6.6 Conclusion

This study explored the lived experiences of community-dwelling older people in New Zealand using Nymbl, a digital health intervention designed to prevent falls. Through in-depth qualitative interviews and analysis guided by the UTAUT2 framework, the research illuminated the multifaceted factors influencing the adoption, engagement, and sustained use of mHealth technologies among older people. Participants reported improvements in balance confidence and daily functioning, particularly when Nymbl was used regularly and became part of a routine. Social influence and the absence of financial barriers was pivotal for initial uptake, however, sustaining long-term engagement proved difficult for many, with motivation often waning due to monotony, competing priorities, or minor disruptions to routine. The cognitive and physical demands of dual-task exercises, device handling issues, and occasional technical or content-related frustrations were notable barriers. Furthermore, the study highlighted the importance of culturally relevant content and responsive support, as well as the need for interventions to be adaptable to the diverse needs and contexts of older people. The results underscore the necessity of user-centred design, ongoing support, and cultural tailoring to maximise engagement and effectiveness. They also highlight the importance of integrating digital tools within broader fall-prevention strategies, leveraging the influence of healthcare providers and community networks, and ensuring equitable access for all older people. As the population ages and the burden of falls continues to grow, digital interventions like Nymbl hold significant promise, but their success will depend on thoughtful, inclusive, and evidence-based implementation.

Appendix A - ACC Nymbl Data

He Kaupare. He Manaaki. He Whakaora.
Prevention. Care. Recovery.

08 October 2025

Adrian Pretorius
Adrian.Pretorius.1@uni.massey.ac.nz

Kia ora Adrian

Your Official Information Act request, reference: GOV-042695
Thank you for your email of 28 August 2025, asking for the following information under the Official Information Act 1982 (the Act):

I am currently completing a Master of Public Health thesis at Massey University titled "The experiences of community-dwelling older people using Nymbl – a digital health intervention to prevent falls." My supervisors are Dr Mary Breheny and A/Prof Linda Murray.

To strengthen the introduction and contextual sections of my research, I would greatly appreciate access to aggregated, de-identified data related to Nymbl's use in New Zealand. Specifically, I am seeking:

1. *User Demographics & Adoption*
   a. *Number of Nymbl users in NZ, broken down by age group (65–74, 75–84, 85+), gender, and region.*
   b. *Adoption trends over time (e.g., monthly or yearly uptake since launch).*
2. *Engagement Metrics (if available)*
   a. *Average sessions per user per week/month.*
   b. *Average session duration.*
   c. *Percentage of users meeting recommended exercise targets.*
3. *Adherence & Retention (if available)*
   a. *Percentage of users active after 4, 8, and 12 weeks.*
   b. *Common drop-off points.*
4. *Self-Reported Outcomes (if available)*
   a. *Changes in confidence or fear of falling.*
   b. *Self-reported falls before and after using Nymbl.*
5. *Technical & Access Data*
   a. *Device type usage (smartphone vs. tablet).*
   b. *Frequency and nature of technical support requests.*
6. *Outcome Measure*
   a. *Estimated number of falls claims saved since launch*
   b. *Any other measures of efficacy (if available)*

Our response
ACC can only provide some of the data requested in parts 1, 3, 4 and 6 of your request. Please find this data in the attached appendix.

Some information has been withheld
Some values in the tables have been supressed and denoted as two dots (..). This limits the potential of individuals, or matters specific to individuals, from being identified. This decision has been made under section 9(2)(a) of the Act. We considered the public interest in making the data available and determined that it does not outweigh the need to protect the privacy of individuals.

ACC does not hold data for the following:

- *Region*, as requested in part 1 of your request
- *Engagement Metrics,* as requested in part 2 of your request
- *Common drop-off points,* as requested in part 3 of your request
- *Changes in confidence or fear of falling* and *self-reported falls after using Nymbl,* as requested in part 4 of your request
- *Device type usage (smartphone vs. tablet)* and, *frequency and nature of technical support requests*, as requested in part 5 of your request

As such, we are refusing to respond to these parts of the request as the information is not held by ACC. This decision has been made under section 18(g) of the Act.

If you have any questions about this response, please get in touch
You can email me at GovernmentServices@acc.co.nz.

If you are not happy with this response, you can also contact the Ombudsman via info@ombudsman.parliament.nz or by phoning 0800 802 602. Information about how to make a complaint is available at www.ombudsman.parliament.nz.

Ngā mihi

Christopher Johnston
Manager Official Information Act Services
Government Engagement

Adoption over time	
Sign up period	**Sign ups**
2020	**4,975**
8	2,889
9	491
10	739
11	222
12	634
2021	**865**
1	150
2	141
3	125
4	93
5	65
6	50
7	47
8	46
9	54
10	35
11	28
12	31
2022	**483**
1	39
2	45
3	36
4	42
5	35
6	38
7	43
8	60
9	56
10	31
11	33
12	25
2023	**23,258**
1	58
2	62
3	170
4	9,727
5	6,090
6	2,980
7	1,040
8	772

9	624
10	625
11	529
12	581
2024	**21,125**
1	623
2	1,991
3	1,689
4	2,384
5	2,913
6	4,765
7	1,256
8	918
9	1,093
10	1,856
11	856
12	781
2025	**8,544**
1	1,117
2	859
3	1,055
4	912
5	878
6	1,169
7	823
8	978
9	753
Grand Total	**59,250**

Current Age and Gender by sign up year						
	under 55	**55 to 64**	**65 to 74**	**75 to 84**	**85+**	**Grand Total**
2020	**393**	**242**	**1,648**	**2,182**	**510**	**4,975**
Female	284	198	1,329	1,569	336	3,716
GenderDiverse	..	..	7	..	..	17
Male	91	27	211	447	136	912
Undefined	17	15	101	161	36	330
2021	**25**	**57**	**301**	**382**	**100**	**865**
Female	18	52	244	307	76	697
GenderDiverse	..	..	..	..	..	..
Male	..	..	44	67	20	142
Undefined	..	..	12	..	..	..
2022	**9**	**55**	**176**	**195**	**48**	**483**
Female	6	48	147	149	39	389
GenderDiverse	..	..	..	..	..	..
Male	..	..	22	44	..	83
Undefined	..	..	..	..	..	..
2023	**623**	**3,349**	**9,611**	**7,978**	**1,697**	**23,258**

Female	507	2,798	7,419	5,546	1,027	17,297
GenderDiverse	7	19	37	15	7	85
Male	96	464	1,903	2,261	637	5,361
Undefined	13	68	252	456	26	515
2024	**653**	**2,975**	**10,100**	**6,226**	**1,171**	**21,125**
Female	551	2,537	7,879	4,347	722	16,036
GenderDiverse	..	20	70	14	..	120
Male	91	412	2,128	1,859	442	4,932
Undefined	..	6	23	6	..	37
2025	**676**	**1,892**	**3,514**	**2,068**	**394**	**8,544**
Female	549	1,627	2,824	1,439	250	6,689
GenderDiverse	12	..	17	..	..	47
Male	96	239	650	601	139	1,725
Undefined	19	..	23	..	..	83
Grand Total	**2,379**	**8,570**	**25,350**	**19,031**	**3,920**	**59,250**

Months since last online session by registration year							
	Registration year						
Months since last session	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Grand Total**
0	132	15	13	190	243	1,044	1,637
1	65	6	7	83	135	1,081	1,377
2	31	..	..	80	102	863	1,082
3	55	..	..	93	150	1,093	1,405
4	30	..	..	93	135	878	1,145
5	22	..	..	74	101	931	1,140
6	27	..	..	80	144	958	1,217
7	29	..	..	81	186	791	1,091
8	47	..	..	117	256	905	1,330
9	34	..	..	50	845		937
10	49	..	..	57	948		1,063
11	40	..	..	71	1,820		1,937
12	30	..	..	74	1,070		1,182
13	36	..	..	92	1,059		1,193

14	38	..	..	91	1,461		1,602
15	82	6	7	119	4,206		4,420
16	75	9	8	127	2,661		2,880
17	72	7	9	200	2,142		2,430
18	64	..	..	166	1,581		1,824
19	14	..	..	118	1,399		1,537
20	27	..	..	172	481		689
21	20	6	7	571			604
22	36	..	..	622			663
23	33	..	..	717			757
24	24	..	..	768			802
25	55	15	7	1,004			1,081
26	60	14	9	1,298			1,381
27	130	21	12	3,120			3,283
28	168	15	17	5,465			5,665
29	324	31	15	7,260			7,630

30	23	..	..	120			150
31	12	..	..	46			65
32	8	7	8	39			62
33	12		20				32
34	16	..	..				46
35	16	..	..				41
36	15		38				53
37	31	10	32				73
38	34	9	37				80
39	40	7	25				72
40	35	11	20				66
41	15	..	..				52
42	22	..	..				42
43	16	..	..				38
44	17	..	..				38
45	39	30					69

46	34	28					62
47	44	33					77
48	36	40					76
49	19	35					54
50	23	32					55
51	28	35					63
52	29	50					79
53	43	58					101
54	41	68					109
55	64	72					136
56	89	61					150
57	370						370
58	175						175
59	441						441
60	410						410
61	929						929

Grand Total	**4,975**	**865**	**483**	**23,258**	**21,125**	**8,544**	**59,250**

Self-reported falls prior using NYMBL						
Have you fallen in the past 60 days - asked at registration						
	Current age					
Gender and response	**under 55**	**55 to 64**	**65 to 74**	**75 to 84**	**85+**	**Grand Total**
Female	**1,915**	**7,260**	**19,842**	**13,357**	**2,450**	**44,824**
null		1	3	3		7
FALSE	1,604	6,098	16,921	11,123	1,945	37,691
TRUE	311	1,161	2,918	2,231	505	7,126
GenderDiverse	**30**	**56**	**132**	**39**	**15**	**272**
FALSE	26	46	111	31	8	222
TRUE	4	10	21	8	7	50
Male	**384**	**1,151**	**4,958**	**5,279**	**1,383**	**13,155**
null				4		4
FALSE	329	984	4,308	4,363	1,036	11,020
TRUE	55	167	650	912	347	2,131
Undefined	**50**	**103**	**418**	**356**	**72**	**999**

null	-	-	-	1	-	1
FALSE	41	87	364	297	59	848
TRUE	9	16	54	58	13	150
Grand Total	**2,379**	**8,570**	**25,350**	**19,031**	**3,920**	**59,250**

Estimated number of falls claims saved since launch	
Financial year	Claims avoided
2025	118
2024	81
2023	-
2022	34
Other measures of efficacy	
As at the end of the 2025 financial years performance assessment, NYMBL had 4.2% efficacy when compared to the untrained population	

Appendix B - Advertisement

Using Nymbl: Older people's experiences with a digital health intervention

This study will explore the experiences of older people using the Nymbl app to prevent falls

You can take part if:

- ✓ you are aged 65 years and above
- ✓ live in the community (not residential care)
- ✓ have access to a smartphone or tablet and the internet
- ✓ have no physical or mental health conditions that prevent you from exercising
- ✓ you have already downloaded the Nymbl app and have registered the app. You may have either used it in the past or may be a regular user

Contact:

Adrian Pretorius (Masters Student):
adrian.pretorius.1@uni.massey.ac.nz

This project has been reviewed and approved by the Massey University Human Ethics Ohu Matatika 1, Application OM1 25/23. If you have any concerns about the conduct of this research, please contact the Chairperson, Massey University Human Ethics Ohu Matatika 1, email humanethics1@massey.ac.nz

Appendix C - Information Sheet

The Experiences of Older People Using Nymbl - A Digital Health Intervention to Prevent Falls

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

COLLEGE OF HEALTH
TE KURA HAUORA TANGATA

INFORMATION SHEET

Hi, my name is Adrian Pretorius, and I am a Master of Public Health student at Massey University, School of Health Sciences. My supervisors are Dr Mary Breheny and A/Prof Linda Murray. I also work at the Accident Compensation Corporation (ACC), in the Injury Prevention team, where my role is in preventing falls for older adults.

I am undertaking a research project as part of my Master of Public Health study at Massey University. My research aims to explore the experiences of older people using an app called Nymbl to help maintain and improve their balance and prevent falls. I would be very interested in hearing about you and your experience with using the Nymbl app.

This information sheet will explain why and how the study will be conducted, and what your participation would involve. You can use the information to help you decide whether you would like to take part. You may also wish to discuss the study with family or friends and should feel free to do this.

Why are we doing this study?

Falls are a major problem around the world and in New Zealand among older adults. Many falls lead to injuries which may reduce mobility and limit the independence of older people. We know that exercise and improving balance can help prevent falls. The Nymbl app has been developed to improve access to exercises for many older people. For the app to work well, we need to hear the experiences and perspectives of those using it. Your feedback will help design a good app that meets the expectations and needs of older people and can be used to successfully prevent falls.

Who can take part in the study?

You are eligible to participate in this research if:

- ✓ you are aged 65 years and above
- ✓ you have or have access to a smartphone or tablet and the internet
- ✓ you have no physical or mental health conditions that prevent you from exercising
- ✓ you have already downloaded the Nymbl app and have registered the app. You may have either used it in the past or may be a regular user

You will not be able to take part if:

- ✗ you have had a fall in the last six months which has required you to be admitted to hospital
- ✗ you have any medical condition where you are not allowed to do physical activity
- ✗ you have any condition that means you are unable to use the app by yourself with no help from others
- ✗ You are in aged residential care

What does participation involve?

This is an interview study, and we expect the interviews will take about 40 to 60 minutes. Interviews can be in a quiet and comfortable location of your choice. This can be face-to-face at your home, in a private place like an office or community setting or online. During the interview, you will be asked about your experiences when using the Nymbl app including what you liked and did not like about the app. We want to hear about your reasons for downloading and using the app and whether you found it to be useful or not. The interview will be conducted by me, and it will be audio recorded. I will also write down or transcribe everything that was said so that your responses can be analysed in the research. Just before the interview, I will ask you to sign a consent form.

What will happen to my information?

I will not use your real name when transcribing the interview recordings and analysing the information. Your name or any information that might identify you will be removed from the transcripts and not used in any report generated by this research. The signed consent forms will be locked away, and the recordings and transcripts will be stored in a computer that is password protected. After the study is complete, I will securely destroy all the recordings and transcripts.

Can I find out the results of the study?

You are welcome to discuss the results of the study with me at any time. You will also be provided with a full copy of the final study report if you would like it as well as a summarised version at the end of the study.

Who is funding the study?

The study is being done as part of my qualification to obtain a Master of Public Health degree at Massey University. I have received a scholarship for my studies from ACC and will be sharing the overall (no personal or identifiable information results of the study with ACC when it concludes. None of your details will be shared with anyone from ACC.

It is important that you know that:

- ✓ You can always change your mind about participating in the research
- ✓ Participation in this research will not affect your relationship with any services you are receiving from ACC or any other entity
- ✓ You can ask me any questions about the research at any time
- ✓ You don’t have to answer any questions if you don’t want to
- ✓ I will record the interview
- ✓ You can ask the recorder to be turned off at any time if there is content that you don’t want to be recorded during the interviews
- ✓ The recording can be paused at any time if you have any questions and then restarted
- ✓ I will not use your real name

- ✓ You can withdraw from the study at any time during the interview or within four weeks after the interview has been completed. You are not required to give a reason and there will be no consequences for withdrawal
- ✓ You will receive a summary of the research when completed

As a way to thank you for your time, you will receive a small koha of a $30 supermarket voucher.

If you would like to participate in the research, or you have any questions, please get in contact with:

Adrian Pretorius: Masters Student, School of Health Sciences, Massey University
Email: adrian.pretorius.1@uni.massey.ac.nz

This project has been reviewed and approved by the Massey University Human Ethics Ohu Matatika 1, Application OM1 25/23. If you have any concerns about the conduct of this research, please contact the Chairperson, Massey University Human Ethics Ohu Matatika 1, email humanethics1@massey.ac.nz.

Appendix D - Interview Schedule

Interview Schedule Draft

Introduction

1. **Welcome and Karakia (if appropriate)**:
    - Begin with a brief greeting and, if appropriate, a karakia (Māori prayer) to set a respectful tone.
    - Example: "Tēnā koe, thank you for agreeing to participate in this research. We'll start with a karakia to acknowledge this space and our time together."
2. **Purpose of the Research**:
    - Explain the purpose of the research and how their participation will contribute.
    - Example: "This research aims to understand the experiences of older adults using Nymbl, a digital health tool to prevent falls. Your insights will help us improve the tool and support others in the community."
3. **Confidentiality and Consent**:
    - Reassure participants about confidentiality and anonymity.
    - Sign consent form and give participant 'token of appreciation' (Prezzie Card Voucher $30)
    - Example: "Everything you share today will be kept confidential, and your name will not be used in any reports. You can stop the interview at any time if you feel uncomfortable."
4. **Duration and Process**:
    - Explain how long the interview will take and the general structure.
    - Example: "The interview will take about 45 minutes to an hour. I'll ask you some questions about your experiences with Nymbl, and you're free to share as **much** or as **little** as you like."

Demographic and Warm Up Questions

1. **Background Information**:
    - Can you tell me a little about yourself?
    - How would you describe your overall health and mobility/level of activity?
2. **Introduction to Nymbl**:
    - How did you first hear about Nymbl?
    - What motivated you to download it?
        1. Probing question has it worked in the way you expected it to?

Core Questions

1. **Experience with Nymbl**:
   - How long have you been using Nymbl, and how often do you use it?
   - Can you describe your typical experience when using Nymbl? (e.g., ease of use, challenges, enjoyment)
   - What is your experience of the exercises and activities in Nymbl?
2. **Impact on Daily Life**:
   - Has using Nymbl influenced your daily life or routines in any way? If so, how?
3. **Perceived Benefits**:
   - Have you noticed any changes since using Nymbl? (e.g., physical, mental, emotional)? What kinds of things seem different?
   - Has Nymbl been helpful to you in any way?
4. **Challenges and Barriers**:
   - Have you faced any challenges or difficulties while using Nymbl? Probing questions e.g. technical issues, motivation)
   - Is there anything that would make it easier for you to use Nymbl regularly?
5. **Social and Cultural Context**:
   - Have you discussed Nymbl with anyone else (family, friends, or healthcare providers)? Did they provide any encouragement or raise concerns about using Nymbl? What kinds of things did they tell you?
   - Have you recommended Nymbl to any friends of family?
6. **Technology Acceptance**:
   - How easy or difficult was it to learn how to use Nymbl? (Probing question 'why?' if required)
   - Do you feel that Nymbl is a useful tool for someone like you? Why or why not?
7. **Suggestions for Improvement**:
   - What changes or improvements would you suggest for Nymbl?
   - Is there anything else you'd like to see in a tool like this?
   - Are tools like this helpful for fall prevention?

Closing Questions

1. **Final Thoughts**:
   - Is there anything else you'd like to share about your experience with Nymbl or fall prevention in general? Is there anything you thought I might ask, that we haven't covered?

Conclusion

1. **Thank You**:
   - Thank the participant for their time and contributions.

- Example: "Thank you so much for sharing your experiences with me today. Your insights are incredibly valuable and will help us improve Nymbl for others."

2. **Next Steps**:
    - Explain the next steps in the process
    - Ask if they would like the opportunity to read and edit their transcripts or not.
    - Explain how the findings will be used and when they can expect to hear about the results.
    - Example: "We'll analyse the information from all participants and share the findings in a report. If you're interested, we can send you a summary of the results."
3. **Karakia or Closing (if appropriate)**:
    - End with a karakia (if appropriate) or closing statement to show respect and gratitude.
    - Example: "We'll finish with a karakia to close our time together. Thank you again for your participation."

Demographic Survey

(To be filled in with participant at closing)

Thank you for participating in this survey! Your responses will help us be able to describe who we have interviewed.

1. **What is your age?**

2. **What is your gender?**

What is your ethnicity? *(You may select more than one)*

- New Zealand European/Pākehā
- Māori
- Pacific Peoples (e.g., Samoan, Tongan, Cook Island Māori)
- Asian (e.g., Chinese, Indian, Filipino)
- Middle Eastern/Latin American/African
- Other (please specify): __________
- Prefer not to say

3. **What is your mobility status?**
    - Fully mobile (no assistance needed)
    - Mobile with assistance (e.g., cane, walker, wheelchair)
    - Limited mobility (require significant assistance)
    - Prefer not to say

4. **What was your main occupation when you were in employment?**

5. **What is the highest level of education you have completed?**
    - No formal qualification
    - Secondary school qualification (e.g., NCEA, School Certificate)
    - Trade certificate or diploma
    - Bachelor's degree
    - Postgraduate degree (e.g., Master's, PhD)
    - Prefer not to say

Appendix E - Informed Consent Sheet

The Experiences of Older People Using Nymbl - A Digital Health Intervention to Prevent Falls

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

COLLEGE OF HEALTH
TE KURA HAUORA TANGATA

PARTICIPANT CONSENT FORM

I have read or have had read to me the Information Sheet. I have had the details of the study explained to me, and any questions I had have been answered to my satisfaction. I understand that I may ask further questions at any time. I have been given sufficient time to consider whether to participate in this study and I understand participation is voluntary and that I may withdraw from the study at any time during the interview or within four weeks after the interview has been completed. I am not required to give a reason and there will be no consequences for withdrawal.

1. I agree to the interview being sound recorded.
2. I wish/do not wish to have my recordings returned to me.
3. I agree to participate in this study under the conditions set out in the Information Sheet.

Declaration by Participant:

I ___________ [print full name]__________ hereby consent to take part in this study.

Signature: _______________________ Date: ________________

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