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Evaluating the Impact of Economic Empowerment Policies on the South African Rural Elderly-A Sustainable Livelihoods Approach

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Abstract

Following both international and local waves of criticism due to overwhelming high rates of youth unemployment, the South African post-Apartheid government has passed several economic empowerment policies to address the challenge. In addressing the youth unemployment and sustainability of livelihoods, institutions and their policies availed resources to the youth and left a gap in responding to the elderly's livelihoods. The purpose of this is to evaluate the impact of economic empowerment policies on the South African rural elderly and suggest a framework to respond to the challenge. A qualitative, inductive, interpretative approach was used to achieve the research objectives. Data were collected from 34 purposive (social network analysis group) interviews and 35 snowballing (semi-structured one-on-one) interviews with selected participants from the Jozini and Matatiele municipalities. Data were analysed using Nvivo 12. The findings reveal a lack of institutions and policies that focus on the sustainability of rural elderly livelihoods. It is recommended that policymakers collaborate with the rural elderly with the view to ensure economic empowerment policies respond to their economic empowerment and sustainability of livelihoods beyond retirement. The contribution of the article lies in the use of a sustainable livelihoods framework and Institutional Theory to suggest a solution.

Keywords: Economic Empowerment, Policies, Elderly, Impact, Sustainable Livelihoods, Rural, Policymakers

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Introduction

The battle against unemployment and poverty has been taken by global bodies such as the United Nations and appears in many pledges from various international conferences around the globe. Cimadamore (2016:131) corroborate and assert that "During the past decades, ... the international community has consolidated a discourse on the eradication of (extreme) poverty that has been articulated in various international commitments (such as the United Nations Decades for the Eradication of Poverty, the Millennium Declaration, and the Millennium Development Goals (MDGs)/Sustainable Development Goals (SDGs) initiatives)". Farisani (2022a) and Mazibuko (2013) affirm and argue that despite the criticism, the South African government understand their role in ending global poverty. They understand that they need to find a way to employ most of the population that remains unemployed.

Khomo, Farisani and Mashau (2023); Ssekitoleko and du Plessis (2021); Mahadea and Kaseeram, (2018) point out that the South African government has proceeded to pass several empowerment policies meant to empower their people. Bhorat, Asmal, Lilenstein, and van der Zee (2018:2) affirm and state that "SMMEs have been identified as a key component to advancing inclusive growth and development in South Africa's National Development Plan, with government highlighting the importance of these businesses for job creation, innovation and competitiveness". National Development Plan is meant to fast-track other empowerment policies. Empowerment policies such as the Broad-Based Black Economic Empowerment (BBBEE) legislation of 2004, the National Strategy on the Development and Promotion of Small Business (NSDPSB) in South Africa (1995), the National Strategy for the Development and Promotion of Franchising (NSDPF) in SA (2000) and the National Informal Business Upliftment Strategy (NIBUS) (2013). BBBEE and NSDPSB were passed to empower previously disadvantaged communities to participate in the local and national economy while NSDPF and NIBUS were passed to avail opportunities for new markets and important business equipment to rural informal businesses.

Farisani (2022a) and Mazibuko (2013) concur and argue that nowhere is inequality more visible than in rural areas where the design of Apartheid laws remains largely intact. While unemployment and poverty amongst the rural youth are common, there are pockets of South Africa that show the resilience of rural elders in sustaining local livelihoods and creating jobs through farming-related businesses. This study aims to evaluate the impact of economic empowerment policies on the South African rural elderly. i.e. light is shed on the impact of economic empowerment policies on the elder's efforts to sustain the rural local livelihoods using farming-related SMMEs. Critical aspects of the Sustainable Livelihoods Framework (SLF) and the Institutional Theory are relied upon to achieve the aim of the study. The study is conducted in the Jozini and Matatiele rural municipalities due to the active pockets of various elderly-owned farming-related SMMEs there.

Literature Review

To fully appreciate the impact of empowerment policies, we define public policy and discuss the relevant aspects of the Sustainable Livelihoods Framework and the Institutional Theory i.e. relevant aspects to this article such as resources/asset base (SLF) and policies (Institutional Theory's regulative element).

Definition and Use of Public Policy

According to Fowler (2013:5), public policy is “the dynamic and value-laden process through which a political system handles a public problem. It includes a government’s expressed intentions and official enactments, as well as its consistent patterns of activity and inactivity.” Jackson and Allen-Handy (2018) affirm and add that from public policy, the government’s future and current actions in addressing certain public concerns or problems could be stated and understood. Also corroborating, Rizvi and Lingard (2010) assert that public policy is often framed in a manner that addresses public concerns in a way that gives them clarity as to who exercises what authority and for what reason. Rizvi and Lingard (2010) further argue that pre-policy discussions often give hope to all to take part in the discussions and the implementation of the agreed public policy. In affirming, Jackson and Allen-Handy (2018) observe that public policies are originally designed to be a process that has the public good as its outcome.

Researchers such as Ngorora and Mago (2013), Chimucheka and Mandipaka, (2015) and Dubihlela and Van Schalkwyk (2014) are among the researchers who have laid the blame on both the national and local government institutions for unclear procedures that rural SMMEs can follow to access institutions meant to support SMME in their areas. Bhorat et al (2018:46) also observed that "the majority of SMME owners did not participate due to lack of information — either because they did not know the programme existed or because they did not know whom to contact." Nel and Rogerson (2016) agree with this view and further quote Turok (2010:268) who states that “a development state needs to harness the collective power of institutions at every level to alter the growth path and enable all areas to reach their potential." From these researchers' remarks and findings, one can deduce that policies and strategies alone do not translate into problem-solving. Supportive institutions are equally important. Hence the relevance of the Institutional Theory in this article.

Institutional Theory

Scott (2013) posits that Institutional Theory (see Table 1) has three elements i.e. regulative, normative and socio-cognitive elements. Only regulative and Socio-cognitive elements are relevant to this article. That is because the regulative element’s focus is on the institution’s policies, legislation and rules, while the cultural element’s focus is on the institution’s shared values, beliefs and assumptions.

| | Regulative | Normative | Cognitive |
|----------------------------------|----------------------------------|-----------------------------|--|
| Legitimacy | Legal systems | Moral and ethical systems | Cultural systems |
| Central Rudiments | Policies, legislation, and rules | Work role, habits and norms | Values, beliefs and assumptions |
| System Transformation Drivers | Legal obligation | Moral obligation | Transformation values are internalized |
| System Transformation Sustainers | Fear and coercion | Duty and responsibility | Social identity and personal desire |
| Behavioural Reasoning | Have to | Ought to | Want to |

Table 1: Comparison between regulative, normative and cultural-cognitive elements of Institutional Theory (adapted from Palthe, 2014).

Table 1 provides us with a summary and deeper understanding of regulative and cultural cognitive elements and enables us to understand how policies, legislation and rules impact the behavioural reasoning of subjects as compared to the cognitive elements. Thus, the distinction between regulative and cultural cognitive elements assists in understanding why empowerment policies fail or become successful. Farisani (2023) point out that policies will only be successful if government departments and other relevant institutions responsible for the implementation want to accommodate all relevant stakeholders in the implementation of such policies. To determine whether the government departments and institutions want to support the elders in their SMMEs we look at the resources they avail to such rural-owned businesses. Sustainable Livelihoods Framework is well placed to assist in that path.

Sustainable Livelihoods Framework

Smyth and Vanclay (2017:68) argue that Sustainable Livelihoods Framework is well-placed to guide the process that government departments and relevant institutions ought to embark on to support rural SMMEs with relevant resources. Smyth and Vanclay (2017:68) argue that successful livelihood strategies such as SMMEs need key resources such as financial, physical, social, human and natural to actively participate in empowerment policies passed to fight poverty and create jobs in rural areas. In their own words, Smyth and Vanclay (2017:68) state: “In its simplest form, the framework views people as operating in a context of vulnerability. Within this context, they have access to certain assets or poverty-reducing factors. These gain their meaning and value through the prevailing social, institutional and organizational environment. This environment also influences the livelihood strategies – ways of combining and using assets – that are open to people in pursuit of beneficial livelihood outcomes that meet their livelihood objectives”. Farisani (2022b) attest and credit well-maintained rural networks with successful rural businesses in South African rural SMMEs. Well-maintained networks ensure that empowerment policies by the government department lead releasing relevant resources to deserving rural SMMEs directly and through rural SMMEs' supportive local institutions.

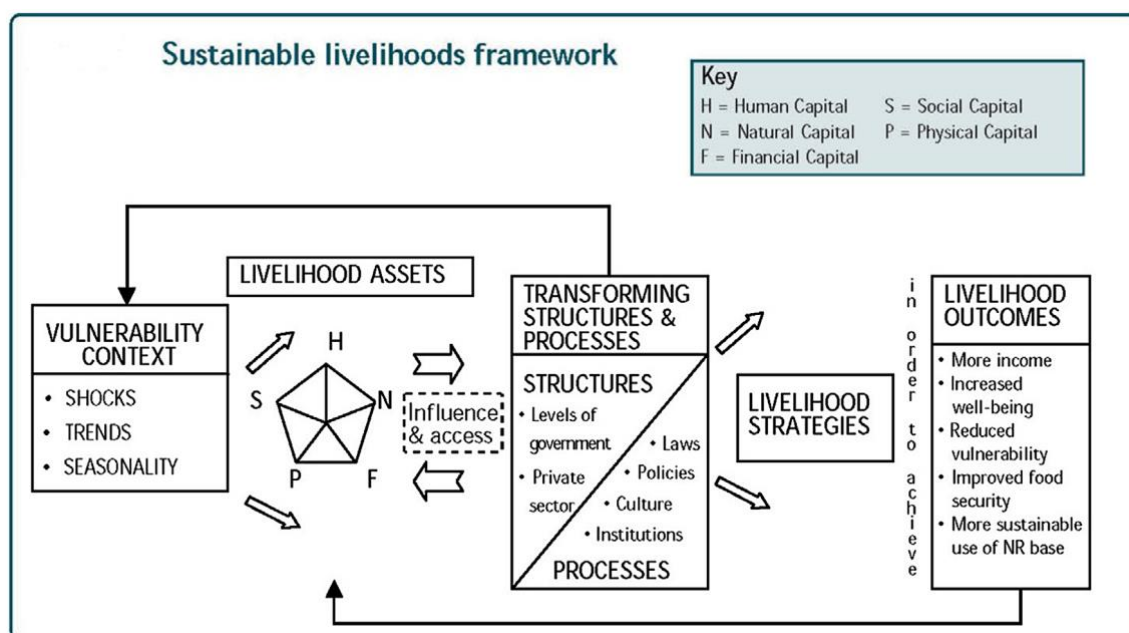


Figure 1: The Sustainable Livelihoods Framework

A careful reading of Figure 1 shows that there is a direct path from institutions and their policies to the provision of resources to livelihood strategies. That path needs the direct collaboration of relevant stakeholders in a particular locality to lead to sustainable rural SMMEs and sustainable livelihoods.

Methodology

A qualitative research methodology was employed in this article. An interpretive paradigm was considered relevant and used in this article due to its ability to provide an understanding of people's lived experiences (Chilisa, 2011; Mertens, 2009). In line with the interpretive paradigm, a Social Network Analysis (SNA), together with one-on-one interviews, were chosen as research instruments for the collection of data from two rural municipalities. Both primary and secondary data were collected.

Purposive sampling was used in this study. Due to the nature of rural areas whereby institutions are not properly documented and are scattered, it was important for the snowball sampling to be carried out to supplement purposive sampling. Snowball sampling assisted in identifying institutions that could give further corresponding information, or other rural SMME-supportive institutions that the researcher was not familiar with, but which other participants knew as they worked together for local SMME sustainability. Both papers of Jaja et al (2017); and that of Ennis and West (2010) agree in pointing out that the SNA tool is instrumental in identifying existing and potential institutions' connections. SNA was particularly important in that it allowed the researcher to go further than with a semi-structured interview tool. SNA goes further because it allowed the participants to correct and remind each other (cross-check) important aspects of policies/rules and assets. A total of 69 participants that represented all stakeholders in the study areas were interviewed. 18 of such participants were interviewed from MLM using SNA and 16 of such participants were also interviewed from MLM using SNA. The balance (69) of the participants were interviewed using semi-structured interviews. All institutions and structures were represented in line with

Jensen and Jankowski, (1991) guide. i.e. all stakeholders who availed themselves to represent their institutions were interviewed in both municipalities.

This study ascribed to the Grounded Theory (GT) analysis as defined by Strauss and Corbin (1990:7). Envivo 12 was used to analyse the vast data collected due to the software's ability to analyse different types of data. Bazeley and Jackson (2007:22) corroborate by pointing out that, "The efficiencies afforded by software release some of the time used to simply 'manage' data and allow an increased focus on ways of examining the meaning of what is recorded". Envivo 12 made it possible to import and analyse and present the data collected during fieldwork using semi-structured interviews, social network analysis, pictures and secondary data.

This study complied with the University of KwaZulu Natal's ethical clearance policy; therefore, all the participants signed the consent form and participated voluntarily. The respondents were assured of anonymity and that the information gathered was for research purposes only. To ensure validity and reliability in this study, the researcher followed Bougie and Sekaran (2009)'s guide. Bougie and Sekaran (2009) point out that the validity and reliability of a study depend heavily on two aspects: how the tools of collecting data were administered and whether the tools chosen can capture the relevant data that the researcher is looking for. The researcher ensured that two different types of tools were used to collect data and that one tool was used to follow up and validate the findings of the first tool. Triangulation was therefore used to validate the collected data repeatedly during the fieldwork.

Findings and Analysis

The findings and analysis are presented in line with the study's objective. The objective is to evaluate the impact of economic empowerment policies on the South African rural elderly. i.e. light is shed on the impact of economic empowerment policies on the elder's efforts to sustain the rural local livelihoods using farming-related SMMEs. As such, three policies are presented: the National Strategy for the Development and Promotion of Franchising (NSDPF) in SA (2000) and the National Informal Business Upliftment Strategy (NIBUS) (2013), and the National Development Plan (NDP). These policies are divided into two to allow NSDPF and NIBUS to be presented together while NDP is presented alone. The policies are grouped as such to allow the analysis of the impact they have on elders' business crucial resources in line with SLF and Institutional Theory.

NSDPF and NIBUS

NSDPF and NIBUS are critical pieces of legislation in that they enable rural SMMEs to access the market regardless of size or previous economic participation record. Thus, small informal businesses are not only recognised but assisted to thrive.

NSDPF and NIBUS's Impact on Rural Elderly-Owned Local SMMEs

The respondents have credited NSDPF and NIBUS with the development and acquisition of expensive machines in JLM. The respondents in MLM struggled to find good examples of how the strategies have impacted them. As an example, the JLM respondents have acknowledged the role of DSBD in providing critical resources in the form of tractors and other farming equipment. DSBD provides such critical resources as it strives to implement

the NSDPF and NIBUS. The machinery and other resources (already discussed above) provided under the NSDPF and NIBUS are particularly critical as the rural farmers could not afford such much-needed resources.

Strengths and Weaknesses of NSDPF and NIBUS

The findings reveal a general agreement among the respondents from both the MLM and JLM concerning the fair implementation of NSDPF and NIBUS. The SMME representatives interviewed are of the view that only a handful of farmers gain from the implementation of the two national strategies mentioned above. Challenges associated with politics and lack of knowledge in assessing the resources made available through such strategies seem to be a shared opinion among the respondents. The respondents from the local municipalities do acknowledge the lack of own resources such as staff and funding to share the knowledge about the policies with all the local stakeholders.

The respondents in both municipalities have also acknowledged some opportunities for themselves and others they know. These are opportunities for regional new markets and important business equipment. Local municipalities in both MLM and JLM have, in the implementation of the strategies, successfully concluded franchising arrangements with retail giants such as Cambridge, fruit spot and local butcheries. To further elaborate on the opportunities mentioned above, the implementers of the strategies are identified and the working relationships between the stakeholders are further analysed below.

| Policies, rules or regulations | Impact on Rural SMMEs | Weaknesses | Strengths | Leading Institutions and Organisations |
|--------------------------------|---|---|---|--|
| NSDPF and NIBUS | NSDPF and NIBUS are widely credited with the development and acquisition of expensive machines in JLM. Minimum impact of the above-mentioned strategies at MLM. | Challenges associated with politics and lack of knowledge to the elders in accessing the resources made available through such strategies | Opportunities for new markets and important business equipment. Local municipalities in both MLM and JLM have, in their implementation of the strategies, successfully concluded franchising arrangements | DTI, DSBD, SEDA, SEFA, MLM, JLM, SMME representative institutions, NGOs and local retailers. |

Table 2: Summary of NSDPF and NIBUS, leading institutions and organisations, and their impact, weaknesses and strengths

NDP

The analyses of the respondents' views and opinions are based on their experiences as far as the sustainability of rural SMMEs is concerned, that is NDP's position on issues such as job creation, growing the economy and reducing the impact of inequality on the sustainability of rural SMMEs.

NDP's Impact on Local SMMEs

When analysing NDP, special interest is given to three aspects that impact on the sustainability of SMMEs. These are the promotion of the exportation of local produce, investment in the rural infrastructure and partnerships needed in the implementation of NDP. The exportation of locally produced beef from the MLM rural livestock or the exportation of vegetables produced by farmers at MLM is seen by the SMMEs respondents as a potential benefit of NDP's implementation in rural areas. Investment in rural infrastructure has also been pointed out as a rural SMME sustainability factor by SMME and municipality respondents at both JLM and MLM. Partnerships described above between MLM tourism stakeholders are seen as having a positive impact on SMMEs in the areas. At JLM, Mnothophansi's partnership with the local stakeholders including local, provincial and national government departments, NGOs and other stakeholders is seen as having an expected impact on SMMEs. That impact is largely credited to a plethora of resources donated for the local farmers' use.

Strengths and Weaknesses of NDP

The respondents in both MLM and JLM have indicated that there are challenges despite the resources being channelled from the above-mentioned institutions, organisations and departments. These challenges impact the implementation of NDP and impact rural SMME sustainability. According to the respondents, the institutions, organizations and departments mentioned above have done little to implement important aspects of NDP, aspects that matter the most to rural SMMEs such as the promotion of local produce and investment in local infrastructure. Promoting local produce and investment in the local infrastructure is believed by the respondents to be central to NDP's goals of job creation, economic growth and reducing inequality locally and nationally.

The respondents involved in farming at JLM have indicated that they often must resort to selling their good quality products very cheaply as animal feed. If they fail to find a buyer for animal feed at a very low price, they resort to burying their produce, that is, they plough their rotten cabbages or tomatoes back into the soil because they could not transport them (lack of adequate transporting infrastructure) their produce to those who might buy in faraway places. While burying or ploughing back of vegetables is good for the soil, a lot of income is lost. Such loss of income is associated with a weak local economy, lack of new job opportunities and widening inequality that the NDP strategy is meant to address. The lack of alternative markets in MLM (i.e., where they can export locally produced meat) is another example of NDP implementation weakness.

Despite the challenges, the respondents see opportunities associated with the good implementation of NDP. Such opportunities are associated with existing public-private partnerships (Agreements between JLM and local retailers, MLM and local butchereries or even private training Institutions). The SMME owners often take pride in their resilience in

surviving in such challenging rural municipalities being plagued by an extra (unique to their municipalities) double challenge of drought and border-related crimes. The SMME owners have also pointed to their ability (expertise) to produce good quality crops and good quality meat (due to ongoing vaccinating programmes) in large amounts that are ready for exportation.

| Policies, rules or regulations | Impact on Rural SMMEs | Weaknesses | Strengths | Leading Institutions and Organisations |
|--------------------------------|--|---|--|---|
| NDP | Mixed results on NDP's impact point to the failure to promote the exportation of local produce and investment in the rural infrastructure, although there are successes in the area of partnerships needed in the implementation of NDP. | Loss of income due to a combination of lack of new markets and poor infrastructure weighs heavily on rural SMMEs. | Ability (expertise) to produce good quality crops and good quality meat that are ready for exportation despite challenges. | DEDEAT, ECP DRDAR, KZN DARD, DSBD, MLM, JLM, local NGOs, local SMME representatives and Traditional Authorities |

Table 3: Summary of NDP, leading institutions and organisations, and their impact, weaknesses and strengths

Discussion of the Findings

The discussion of findings and analysis are presented in line with the study's objective: to evaluate the impact of economic empowerment policies on the South African rural elderly. NSDPF, NIBUS and NDP policies are divided into two to allow NSDPF and NIBUS to be presented together while NDP is presented alone. The policies are grouped as such to allow the discussion of the impact they have on elders' business crucial resources in line with SLF and Institutional Theory.

NSDPF and NIBUS

NSDPF and NIBUS are critical pieces of legislation in that they enable the rural elderly's SMMEs to access the market. Accessing the market is crucial for the business' sustainability. Sustainable businesses create sustainable jobs and livelihoods for the locals (Farisani, 2022; Smyth and Vanclay, 2017). Palthe (2014) attest and points out that the government and local relevant stakeholders' behavioural reasoning is crucial for the successful implementation of policy. The findings show that most relevant national stakeholders are falling short in their responsibilities to assist local elders' businesses in the implementation of NSDPF and NIBUS in both municipalities, especially the elder businesses in the MLM. Key institutions such as

DTI, SEDA and SEFA are not doing their part in supplying relevant resources according to the mandate given to them as far as NSDPF and NIBUS are concerned. DTI is responsible for assisting businesses to gain access to market while SEDA and SEFA are responsible for financial resources.

The findings at JLM show a rare example of what is crucial for the sustainability of rural elders' businesses. DSBD is amongst those few institutions that provide critical resources as it strives to implement the NSDPF and NIBUS at JLM. Such resources are critical for farmers to comply with the individual standards of retailers who buy their products. The first targeted local market was the nearby retailers that would buy bulk products and resell them at their supermarkets or stores. The findings show that local butcheries and rural-based stores such as Spar and Boxer stores are some of the retailers targeted by local meat and vegetable farmers. The reason for such focus is that they can meet their regulations on the standard of meat and vegetables such customers need for their customers. While relevant national government institutions seem not to be doing enough to support the rural elders' businesses to sustain themselves and their local livelihoods, LG and local retailers behaved differently. LG and local retailers behaved differently and worked together with the elders' businesses to sustain local livelihoods and jobs by creating local opportunities. Creating local opportunities between farmers and local butcheries and retailers. Such finding is consistent with Institutional Theory's regulative element and socio-cognitive element as presented by Palthe (2014) and Farisani (2023).

National Development Plan (NDP)

Special interest is given to three aspects of NDP that impact the sustainability of rural elderly's SMMEs. These are the promotion of the exportation of local produce, investment in the rural infrastructure and partnerships needed in the implementation of NDP.

While NGOs such as Technoserve assisted to sell the elder's produce to other regions within the country, the full implementation of the NDP to enable the exportation of the elders' products never materialised. The elders did not get such assistance from national institutions tasked with such responsibility as the government and policymakers intended. Thus, the goal of the government to create jobs and sustain livelihoods through the elders' businesses did not materialize. It did not materialize because such businesses were not reaching their full potential due to the lack of external markets and financial resources that come with that. Such finding is consistent with Smyth and Vanclay (2017); and Figure 1. Smyth and Vanclay (2017); and Figure 1 provide a guide on how the sustainability of livelihoods depends on the implementation of policies by the relevant institutions.

Relevant national institutions and structures were also found to be wanting when expected to provide infrastructure and partnerships. Relevant national institutions were too far removed from the rural elders' businesses and did not get to understand the need or urgency of critical infrastructure and partnerships needed to grow the elder's businesses. The very elders' rural businesses the national government and policymakers intended to use to create jobs and sustain local rural livelihoods. Such a finding is consistent with Khomo, Farisani and Mashau (2023) and Scott's (2013) linking of institutional Theory with the implementation of policies by fostering impactful partnerships between relevant institutions.

Conclusions and Recommendations

This study aimed to evaluate the impact of economic empowerment policies on the South African rural elderly. i.e. light was shed on the impact of economic empowerment policies on the elder's efforts to sustain the rural local livelihoods using farming-related SMMEs. Critical aspects of the Sustainable Livelihoods Framework (SLF) and the Institutional Theory were relied upon to achieve the aim of the study.

The findings reveal a lack of national institutions, policies and the implementation process that focus on the sustainability of rural elderly livelihoods. It is recommended that policymakers collaborate with the rural elderly with the view to ensure economic empowerment policies respond to their economic empowerment and sustainability of livelihoods in rural areas. The contribution of the article lies in the use of a sustainable livelihoods framework and Institutional Theory to suggest a solution.

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***Patterns of Medication Use Before and After Fall-Related Injury in US Nursing Homes
According to Facility Racial Composition***

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Abstract

Introduction: Fall related injuries (FRIs) are sentinel events for nursing home (NH) residents and serve as an opportune time for medication review. Few studies have examined racial disparities in medication use between facilities. The objective of this study was to identify whether there are disparities in prescribing patterns of medications in NH residents following a hospitalized FRI according to the racial composition of the facility.

Methods: This cohort study included all long-stay US NH residents, aged 65 years or older enrolled in Medicare fee-for-service with a hospitalized FRI between 1/1/2016 and 12/31/2016. Residents were categorized as new users, discontinuers, or continued users according to medication dispensing before and after FRI. Results were stratified by the percentage of Black residents in the facility.

Results: 27,134 NH residents with a hospitalized FRI were included. Mean age was 83.9 years (SD=4.08) and 75.7% were women. Use of sedatives was common (6.0% new users, 14.7% discontinuers, 14.0% continued users). Discontinuation of sedatives after a FRI was more likely to occur in facilities with a high Black population (high vs low Black population: 15.4% versus 13.4%, p-value 0.0003). Overall use, especially new users, of osteoporosis medications was low with no statistically significant difference across facilities.

Conclusions: Despite the known association with falls, sedatives remain commonly prescribed in NH residents before and after a FRI, whereas osteoporosis medications are less commonly prescribed. Our findings suggest that NHs of all racial composition could benefit from models of care that optimize medication reviews in NH residents after FRIs.

Keywords: Fall-Related Injuries, Nursing Home, Racial Disparities, Medication, Deprescribing, Aging

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Introduction

Fall related injuries (FRI), including fracture and hemorrhage, are the leading cause of emergency department visits and hospitalizations for nursing home (NH) residents.¹ These injuries result in disability, diminished quality of life, and increased risk of subsequent injury and death.¹ Medications may be the most common, modifiable risk factor for falls and injury in older NH residents.^{2,3} Therefore, FRIs should be considered a sentinel event that triggers a medication review.

Medication reviews after a FRI should consider deprescribing (i.e., reducing the dose or stopping under clinical supervision) medications associated with falls and initiating osteoporosis treatment. Sedative medications are a good target for deprescribing as strong evidence links these medications with falls, and deprescribing psychotropic medications may be an effective strategy to prevent falls. At the same time, FRIs often result in short-term pain and anxiety, with psychotropic medications added during hospitalization. These new medications may be unintentionally continued after hospital discharge without documented indication.⁴ In contrast, osteoporosis medications increase bone mineral density and may protect against injury in the setting of a fall. Yet these medications are seldom used in NH residents, even after an FRI hospitalization.^{5,6,7}

NHs are highly segregated along racial lines, with resource-poor facilities tending to have larger racial minority populations and lower rates of appropriate healthcare utilization.^{8,10} Research indicates racial disparities in medication prescribing among residents *within* NHs, however, few studies have examined racial disparities in medication use *between* facilities according to racial composition.^{11,12} It is important to identify disparities in prescribing practices across NHs to target quality improvement interventions.

The objective of this study was to identify whether there are disparities in prescribing patterns of medications in NH residents following a hospitalized FRI according to the racial composition of the facility. We hypothesized that in facilities with a high Black population there will be greater use of sedative medications and less use of osteoporosis medications after a FRI.

Methods

Data Source and Study Design

This was a retrospective cohort study of NH residents with a hospitalized FRI in 2016. Data were ascertained from Medicare fee-for-service claims (MedPAR, Carrier file, and Part D) linked with the Minimum Data Set (MDS). The MDS is a comprehensive, federally mandated resident assessment instrument that is completed on all US NH residents at admission and quarterly thereafter.¹³ The Residential History File was used to provide a daily account of the location where the resident received health services.¹⁴ This research was approved by the Institutional Review Board of Hebrew SeniorLife.

Study Population

The source population began with 2,795,409 Medicare beneficiaries aged 65 years or greater who received care in a NH for one or more days in 2016. We restricted the population to persons with a claim for a hospitalized FRI that occurred between 1/1/2016 and 12/31/2016

and after their first NH admission. Among those injuries, we selected the first FRI for each participant as an initial sentinel event appropriate for medication review. Repeat FRIs were excluded. We next restricted to residents who were long-stay residents, defined as persons who spent at least 90 of 100 days in the same facility before the FRI admission date. Residents with a claim for hospice in the 90 days before the FRI, residents without Part D during the study period, and residents without one or more Part D dispensing in the 100 days before FRI were excluded. The final sample included 27,314 residents who had available MDS data regarding the racial composition of their facility (Figure 1). Residents were followed starting from the date of the hospitalized FRI discharge or for patients who received SNF care following hospitalization, from the date of SNF discharge.

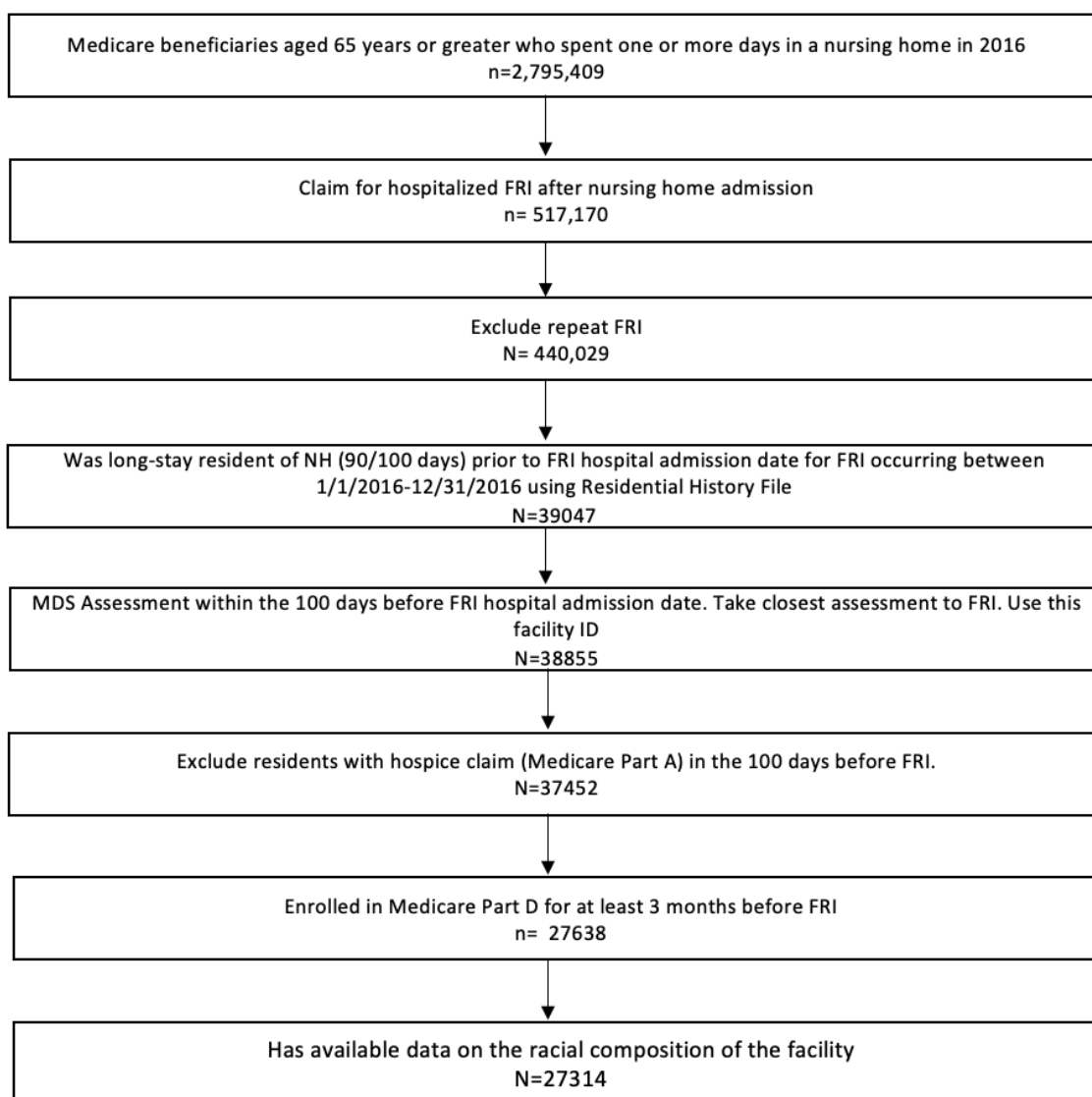


Figure 1: Study Population selection

Fall Related Injuries

FRIs, defined as a hospitalized fracture, dislocation, intracranial hemorrhage, concussion, or other hemorrhages, were identified using an established algorithm that relies upon Medicare claims.¹⁵

Prescriptions

Dispensing of individual medications associated with FRIs were ascertained using Part D prescription medication claims in the 100 days before and 100 days after hospital (or SNF) discharge. This length of medication use was intended to exclude new medications that might not be considered in a post-FRI medication review. Sedatives included benzodiazepine and non-benzodiazepine sedatives, whereas osteoporosis treatment included oral bisphosphonates. A list of medications included in these classes is in Supplement 1.

Among residents with a dispensing of a sedative or osteoporosis medication before FRI, we categorized residents as continued users and discontinuers. Continued users had a medication claim in 100 days before the FRI and in the 100 days after discharge. Discontinuers had a claim in 100 days before the FRI but not in 100 days after discharge. Among residents with post-FRI medication use, we categorized new users as anyone with a claim in the 100 days after discharge, but not in the 100 days before the FRI.

Facility Characteristics

Using the MDS Race/Ethnicity variable (A1000) from a valid MDS assessment (admission or quarterly assessment), we calculated the percentage of Black residents in each facility during the study period. Percentage of Black residents was chosen to represent facility racial composition as the percentage of other racial minority groups was very low in all NHs.

Using tertiles, we classified facilities as having a as low (zero to 1.5%), medium (1.6%-10.5%), or high ($\geq 10.5\%$) percentage of Black residents.

Statistical Analysis

Chi-square tests were used to compare percentage of sedative discontinuation in facilities with a low Black population versus facilities with medium or high Black populations. Percentage of new osteoporosis medication users was also compared according to racial composition of the facility.

Results

27,134 NH residents with a hospitalized FRI were included. Mean age was 83.9 years and 75.7% were women. The racial composition of the cohort was 84.8% White, 6.6% Black, 1.4% Asian, and 7.2% other race. Approximately half of residents (49.3%) were moderately or severely cognitively impaired. The mean 28-point ADL score was 14.8 (\pm SD 6.3). Psychiatric comorbidities were common: anxiety disorder was documented for a third (35.6%) of residents and depression for over half (55.7%).

Overall, 34.7% of residents were prescribed sedatives (6.0% new users, 14.7% discontinuers, and 14.0% continued users) (figure 2). Sedative use before an FRI was more common in facilities with a high Black population as compared with a low Black population (30.0% vs 26.8%). Discontinuation of sedatives after a FRI was more likely to occur in facilities with a high Black population (high vs low Black population: 15.4% versus 13.4%, p-value 0.0003) and medium Black population (medium vs. low Black population 15.1% versus 13.4% p-value 0.0017). The number of discontinuers (14.7%) was higher than new users (6.0%) across the strata of racial composition of facilities.

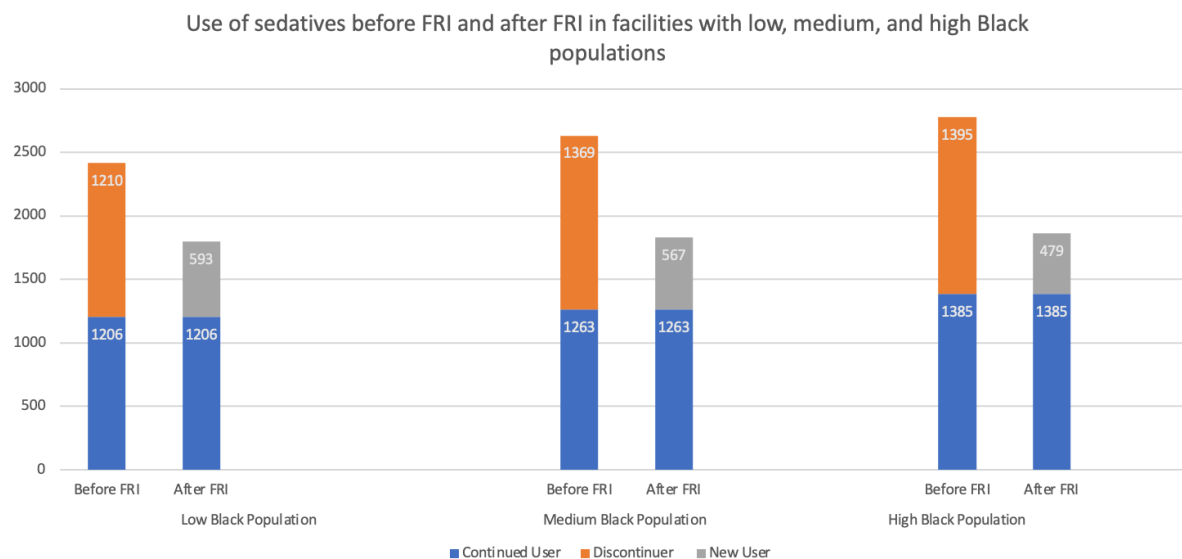


Figure 2: Use of sedatives before FRI and after FRI in facilities with low, medium, and high Black populations

Overall use of osteoporosis medications was low with little variation according to facility racial composition (figure 3). Discontinuation of a sedative or osteoporosis prescription occurred more frequently than a new sedative or osteoporosis prescription across facilities with low, medium, and high Black residents. New users of osteoporosis medications after a FRI were similar across facilities regardless of racial composition (0.9% in low Black population facilities versus 1.0% in high Black population facilities, p-value 0.28).

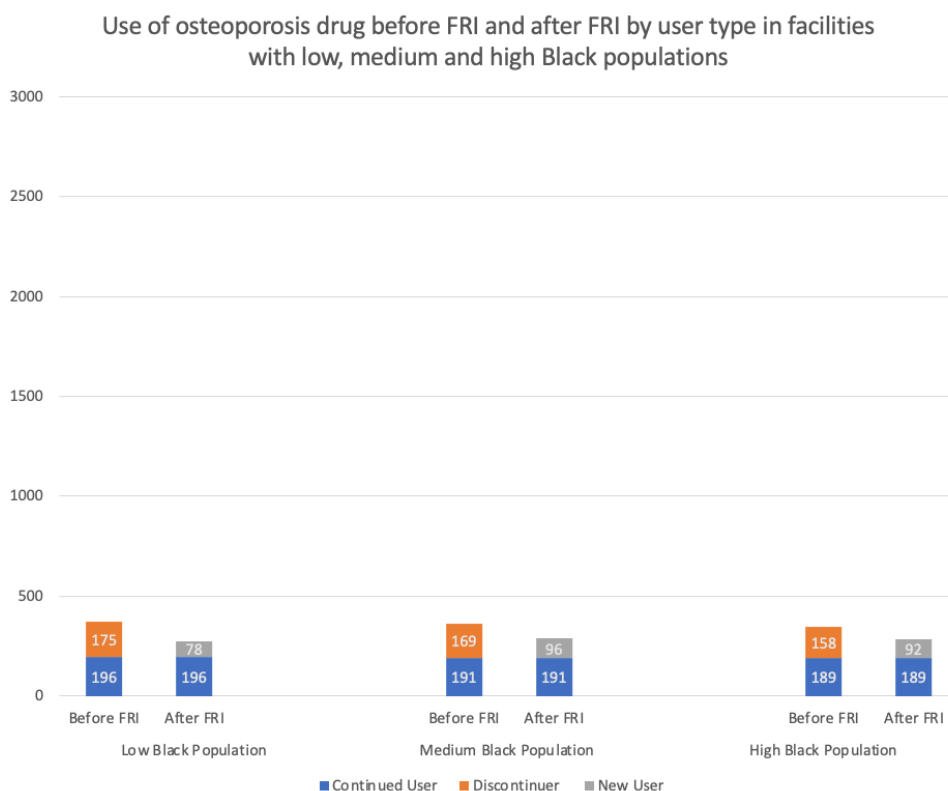


Figure 3: Use of osteoporosis medication before FRI and after FRI by user type in facilities with low, medium and high Black populations

Discussion and Conclusion

FRI are sentinel events that serve as an opportune time for medication review. We found that sedative use was common, whereas osteoporosis medications were seldom prescribed in US NH before and after an FRI. For both sedatives and osteoporosis medication users, NH residents were more likely to discontinue the medication after an FRI than start as new users, regardless of the racial composition of the facility. Overall sedative use was greater in facilities with a large Black population, and so discontinuation of sedatives after a FRI was more likely to occur in facilities with a medium or high Black population compared to facilities with a low Black population.

Racial and ethnic disparities in NH care are widely described, existing both within facilities (between racial/ethnic groups) and between facilities.¹⁰ Within facility racial and ethnic disparities in care can be grounded in bias of NH providers and staff.¹⁰ Studies examining disparities *within facilities* found that Black residents are less likely to receive newer, first-line psychotropic medications as compared with White residents.^{11,12} Additionally, Black NH residents are less likely to receive warfarin after a stroke or osteoporosis medications after fracture than White residents of the same NH.^{16,17} Less research exists exploring whether facility racial composition impacts disparities in prescribing practices between facilities. Vaccination rates are lower in facilities with higher racial minority populations, suggesting less optimal healthcare utilization in such low-resourced facilities.¹⁸ Vaccinations require less resources to administer as compared with medication review. A series of case studies of tribal NHs with primarily racial minority residents revealed nearly three fourths of residents were identified as having suboptimal prescribing patterns.¹⁹ A previous study comparing antipsychotic use as a chemical restraint found no difference in inappropriate antipsychotic use in facilities according to racial composition, the results instead showing differences in facilities according to resources with Medicaid-reliant NHs having a higher use of antipsychotic medications. It is key when studying disparities in NHs to consider whether bias is driven by practices *within facilities* because of race or *between facilities* due to limited resources.²⁰

Evidence suggests that medications associated with falls and injury are seldom deprescribed in older community-dwelling adults after a fragility fracture, and osteoporosis medications are seldom initiated after an injury due to barriers to conducting effective medication reviews in NHs.^{3,11} In our study sedative discontinuation was more likely to occur in facilities with a high Black population, likely because sedative use was higher in facilities with a high Black population. The high sedative use may suggest that facilities with larger Black populations have less ability to use non-pharmacological interventions to improve sleep or control the behavioral and psychological symptoms of dementia. The higher sedative discontinuation in NHs with high Black population should be considered in conjunction with the low rates of new users of osteoporosis medications across all facilities after a FRI. If sedative discontinuation is thought to be a result of effective medication review, then it would be expected to see more new users of osteoporosis medications in NHs with high Black population. These incongruous findings suggest sedative discontinuation may be the consequence of unintentional prescribing changes rather than intentional, evidence-based practices. Previous studies have found that one of the only predictors of whether a NH is treated for osteoporosis is whether the resident was taking the medication at admission.¹⁷ Our results concord with these findings and suggest that the majority of NHs with hospitalized FRI return to their facility without medication changes.

Despite pharmacy reviews being mandated in all NHs, there are a number of barriers to conducting effective medication reviews in this setting. First, care is fragmented and siloed across hospitals, NHs, and other care settings leading to uncertainty as to which provider should make medication changes.²¹ Second, staff turnover in NHs is high such that it is challenging for the frontline staff to recognize and communicate clinical changes to the prescribing providers.²² Third, the consultant pharmacists who conduct medication reviews typically work remotely.²³ While the intent of these reviews is to reduce adverse effects from medications, experience suggests that these reviews seldom result in deprescribing or new osteoporosis medication prescribing because the pharmacists do not interact with front-line staff, patients, or proxies. Finally, physician presence is limited in NHs with many providers feeling as though they only have time to manage acute medical problems that is communicated by frontline nursing staff, rather than preventative care such as deprescribing or osteoporosis treatment.²³ Novel models of care that support interprofessional collaboration and patient/proxy engagement are needed to enact meaningful medication reviews across all NHs.

Our study has limitations. The MDS Race/Ethnicity variable is not specifically an indicator of Black race. This study examines potential disparities between facilities. We cannot examine potential disparities within facilities with high Black populations as there were too few events within individual facilities. We cannot separate purposeful deprescribing from discontinuation, nor are we able to determine whether the rates of prescribing represent clinically appropriate or optimal use. Results were similar for a class of medications that is associated with harms and a class of medications associated with benefits, suggesting that there are opportunities to improve post-FRI medication reviews.

In conclusion, despite the known harms associated with sedatives, these medications remain commonly prescribed in NH residents before and after an FRI, whereas osteoporosis medications are seldom prescribed. Our findings suggest that most NHs could benefit from models of care that optimize medication reviews in NH residents after FRIs.

Supplement

The following short and long-acting benzodiazepine sedatives were included in this study: Alprazolam, amitriptyline, chlorthalidone, chlorthalidone, chlorthalidone-clidinium, chlorthalidone-hydrochloride, clonazepam, clonazepam, estazolam, flurazepam, lorazepam, oxazepam, temazepam, and triazolam. Non-benzodiazepine sedative hypnotics included Eszopiclone, suvorexant, zaleplon, and zolpidem. Osteoporosis medications included the following oral bisphosphonates: Alendronate, Alendronate-cholecalciferol, Denosumab, Ibandronate, Pamidronate, and Risedronate.

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Pre- And Post-COVID-19 Vaccination: Stories of Elderly Persons At-Risk

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Abstract

Using an exploratory sequential mixed research design, this study aimed to capture the lived experiences of 23 elderly persons at-risk during the pre- and post- COVID-19 vaccination seen at Department of Geriatric Medicine St. Luke's Medical Service Center Quezon City, Philippines from August 2021 to November 2021. Specifically, it aimed to: (1) explore the participants lived experiences in relation to their concept and understanding of COVID-19, their conflicts and struggles, and coping resolutions during pre and post COVID-19 vaccination, (2) determine the perception of elderly at-risk patients on their mental, physical, and social-emotional wellness using the Wellness Questionnaire, and (3) interface the lived experiences of the participants to their mental, physical, and social-emotional wellness. Data collection employed a one-on-one personal interview and a Wellness Questionnaire in form of a rating scale. Obtained data from the interview and questionnaire were analyzed using NVivo 12 Plus software program. The themes from the lived experiences of the participants dealt mainly on health protocols, vaccine confidence, and wellness. The participants rated their state of well-being during pre-vaccination as "fair" with an improved rating of "good" at post vaccination. Comparative analysis of the means of their state of wellness from the pre-vaccination to the post-vaccination periods were found significantly different at the .05 significance level using the Wilcoxon Signed-Ranks Test. These findings may lead to improvement of existing geriatric practices amid sustained pandemic.

Keywords: Elderly, At-Risk, Lived Experience, Vaccination, Wellness

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Introduction

The COVID-19 pandemic has posed several challenges particularly among the aging population. Adults 65 years and older and those with underlying medical conditions such as cardiovascular disease, hypertension, and diabetes are at higher risk for developing more serious complications from COVID-19 (Applegate and Ouslander, 2020; Rocklov and Sjodin, 2020). Heid, et al (2021) highlighted the fact that constraints in social interaction and restriction of physical activities were the greatest stressors among the older adults during the initial period of the pandemic. Studies of Buenaventura, Ho & Lapid (2020) and Goethals, et al (2020) confirmed that the impact of lockdowns, quarantine and social distancing have affected not only the decline in the physical and mental health of older adults living at home but also in the estrangement of social connectedness and engagement, unmet spiritual needs and feelings of uncertainty and loneliness.

With 262 males and 377 females with an average age of 73 across Flanders, Belgium as respondents, De Pue et al (2021) used self-report measures on the impact of the COVID-19 on well-being, activity level, sleep quality and cognitive functioning using the Cognitive Failures Questionnaire, Geriatric Depression Scale and Personal Well-being Index. Results showed that 76% of the participants reported significant decrease in well-being, prominently in general life satisfaction, safety, community connectedness and future security. Paired-samples *t*-tests with Bonferroni correction ($\alpha=0.0045$) indicated that participants reported that they had been significantly less active compared to before COVID-19 and experienced poorer quality of sleep. As to cognitive functioning the participants reported problems with remembering, concentration, doing two things at the same time, recalling and forgetfulness although the changes were not statistically significant. Regression analysis revealed that depression is a significant single predictor in the changes of life satisfaction, physical activity, quality of sleep and the total well-being of older adults.

Consequently, the on-going fight against COVID-19 has remained critical in all regions of the country posing greater dangers to the elderly population. Buenaventura et al (2020) mentioned the Philippines aging population as greatly vulnerable to COVID-19 due to high population density. The Philippine population density is 337 persons per square kilometer, although in the National Capital Region (NCR) Luzon, the population density is a staggering 20,785 persons per square kilometer (Philippine Statistics Authority, 2016b). Since the spread of COVID-19 is related to population density (Rocklov and Sjodin, 2020 cited in Buenaventura et al), the high densities in the Philippines where people are in relatively close contact with each other in both personal and public spaces make social distancing difficult, facilitate virus spread more easily, and lead to higher rates of infection and death. Moreover, Buenaventura et al cited that a large proportion of senior citizens in the country receive no pension thus making it difficult for them to avail of quality health care and pay for healthcare bills. Adding to the factors that make Philippines vulnerable to the spread of the virus are the cultural beliefs and practices such as the rituals during religious events and the multi-generational households making social distancing difficult to implement. Within Southeast Asia, the Philippines has the highest number of coronavirus infection, with a mortality of 40% (Lema and Morales, 2020) Latest situation report of the Philippines Department of Health (May 10, 2021) showed that 43.2% of the total number of cases are from the National Capital Region (NCR). This datum made NCR as the epicenter of the pandemic in the country.

While the government's efforts has been successful in reducing COVID-19 cases, DOH recently reported the detection of COVID variants such as the Delta, Alpha, Beta, 9P.3 and very recently Omicron variants in the country (DOH, July 25, 2021) raising fear of another surge in densely populated areas. Recent pandemic Philippines profile report (Ritchie, et al, 2021) showed an increase of 29.92 percent from August 22, 2020 to August 22, 2021 confirmed cases of COVID-19 although this can be lower than the actual cases due to limited testing. Daily death cases had reduced by 89 per cent from its highest day of April 12, 2021 to August 22, 2021. In comparison with other countries, Philippines had recently a mortality rate due to the pandemic of 1.92 percent per one million of the population (Ritchie, et al).

The vaccination campaign to arrest the spread of the virus was another challenge for the government among the elderly population regarding their willingness to receive vaccination. Vergara (2021) opined that despite of the government's effort to persuade the public to participate in its vaccination program against COVID-19, vaccine hesitancy remains to be a big challenge in the Philippines due to the social traumas associated with Dengvaxia vaccine in 2016. However, according to Reyes et al (2021) recent surveys, have shown that vaccine confidence has begun to improve with the lessons from the past highlighting the importance of a strong partnership between health leaders and the local community.

Despite these numerous challenges and the government's efforts to cope with the situation, there is very minimal literature to understand the elderly persons' cope during this pandemic before and after being inoculated against COVID-19. Knowing how elderly persons respond to the pandemic could provide an opportunity for the government and medical professionals to revisit their approaches to minimize the problems, dangers and deaths during any pandemic.

Thus, this study aimed to capture the lived experiences of elderly Filipinos at-risk during the pre- and post- COVID-19 vaccination from August 2021 to November 2021. Specifically, it aimed to (1) explore the themes derived from the participants lived experiences through their stories related to their concepts and understanding of COVID-19, their conflicts and struggles, and coping resolutions during pre and post COVID-19 vaccination, (2) determine the perception of elderly at-risk patients on their mental, physical, and social-emotional wellness using the Wellness Questionnaire, and (3) interface the lived experiences of the participants to their mental, physical, and social-emotional wellness.

Study Design and Procedure

This study employed the exploratory sequential mixed method research design. Sequential exploratory mixed method research obtains two types of data. It begins with qualitative data then collects quantitative information to estimate the proportion of the sample experiencing the particular phenomenon. (Creswell, 2008: 561; Mertens, 2015: 312-313). Qualitative data were obtained using the phenomenological approach while a validated researcher-made Wellness Questionnaire in the form of a rating scale was utilized to obtain the quantitative data.

Study participants were recruited and selected from the list of outpatients seen at the Department of Geriatric Medicine Social Service St. Luke's Medical Center, Quezon City, Philippines from August 2021 to November 2021. Using the purposive convenient sampling technique based on an inclusion criteria, 40 patients qualified for the study. However, out of the 40, only 23 indicated their willingness to participate after the orientation session. As an

ethical principle, an Informed Consent Form for participation and recording responses was shown and read to them together with his or her guardian by the researcher after which the participant affixed his/her signature to indicate the willingness to participate.

Average age of the 23 participants was 81 categorized as middle-old (Little, 2016) the youngest being 68 years old and the oldest 93. The participants composed a homogenous group of low-income families and residents of Metro Manila officially known as the National Capital Region (NCR). Figure 1 shows the demographic profile of the study participants as to age, sex, educational attainment, source of income and family.

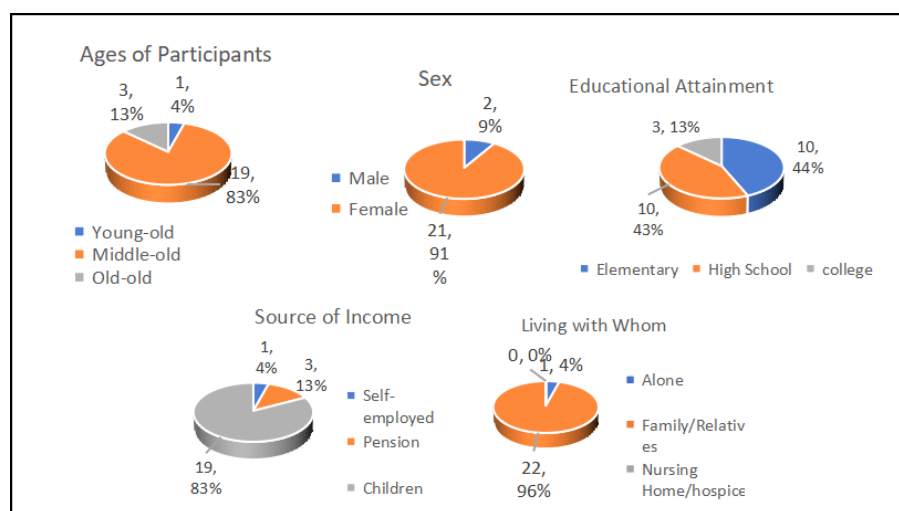


Figure 1: Demographic profile of the study participants

Data collection was conducted in two phases. To obtain data from the stories of the participants, an interview guide was constructed by the researcher. The questions focused on the participants' concepts about COVID-19, their conflicts or struggles, and how they coped to resolve their conflicts before and after they were vaccinated. Filipino was the language used in the interview primarily because it is the native tongue of the participants. Schedule of the interview was provided each participant indicating the date and time in a virtual meeting via Google Meet due to health restrictions during that time. The interview was conducted by the researcher as a Geria Fellow trained in interviewing elderly persons. A guardian (a family member or a caregiver) was permitted to assist the participant during the procedure when needed. The interview lasted approximately for 45 minutes but at times longer, depending on the capability of the interviewee. To check the authenticity of the responses, the researcher scheduled another date for a virtual session and read to the participants the transcribed copy of their responses.

After the storytelling, the participants were requested to answer the 2 sets of Wellness Questionnaire. The questionnaire covered three dimensions, namely, mental, physical, and social-emotional wellness in form of a rating scale. Each dimension has 15 items where participants were asked the extent of being bothered by the pandemic phenomenon on a scale of 3 where 0 as *not at all bothered* and 3 *nearly everyday*. Hence, the lower the score the better is the state of wellness.

The 2 sets of questionnaires contain the same items to provide a comparison of their state of wellness before and after vaccination. They were coded BLUE for the pre-vaccination and GREEN for the post-vaccination. The Wellness Questionnaire was sent via Google Form or

email to the participants with the researcher giving appropriate and clear instructions how to answer and retrieval was done by the researcher in the same manner. After the retrieval of the questionnaire, the researcher went through it to check that all items were answered. If there were skipped items, the questionnaire was returned to the participant and guided properly to be completed.

Statistical Analysis

Data for analysis were the textual lived experiences of the elderly participants and the responses to the Wellness Questionnaire. Responses of the participants in the interview were translated to English and encoded in NVivo 12 Plus software to identify emergent themes during the pre- and post-vaccination experiences. Likewise, data in the Wellness Questionnaire were encoded in NVivo 12 Plus and means were obtained for Mental Wellness (MW) Physical Wellness (PW), and Social-Emotional Wellness (SEW) during pre- and post vaccination. Both descriptive and inferential statistics were used to interpret the responses to the Wellness Questionnaire. The means for each were descriptively categorized as *Optimal* (M=0-4), *Good* (M=5-8), *Fair* (M=9-12), and *Poor* (M=13-15). Overall means of the 3 dimensions were descriptively categorized as *Optimal* (M=0-11), *Good* (M=12-22), *Fair* (M=23-33) and *Poor* (M=34-45).

To further determine whether the changes in the means during the pre- and post vaccination were significantly different, the obtained means were submitted to Wilcoxon Signed-Rank Test (Elston & Johnson, 1995). The obtained results were interpreted at the 0.05 level of significance at a one-tailed test.

Conclusion

Analysis of the pre-COVID-19 vaccination lived stories of the elderly participants revealed three emergent main themes, (1) health protocols, (2) face mask and face shield, and (3) home chores. These themes were reflections of the participants' understanding of what COVID-19 as scary, infectious, and associated with death and health protocols. Their stories were expressed in very negative tone such as using the words COVID, infected, scared, sickness, afraid and dangerous were repeated in the responses 12 times while moderately positive words like might, good and careful were repeated in only 3 responses.

The theme of wearing face masks and face shield emerged as the conflict or struggle the participants during the pre-Covid-19 vaccination. They struggle breathing when wearing the mask and shield aside from feeling hot and sweating. They claimed that the face shield obstructs their vision aside from an added expense. However, they have to follow wearing them since it is a mandate during the pandemic despite the discomfort they are experiencing.

The emergent theme on home chores included household chores like cooking, cleaning or laundry and home routine activities such as praying, entertainment routines like watching television or listening to the radio, or exercising. The home chores were the coping resolutions of the participants to reduce fear and boredom of staying at home and not permitted to go out.

Post-vaccination stories of the participants revealed four main themes, namely, (1) big changes, (2) negative and bad effects of vaccine, (3) wellness, and (4) health protocols. The big changes were expressed in the way they understood the pandemic and the improvement in

their wellness especially on the emotional aspect. They also shared that their understanding of the disease was made clearer due to the availability and benefits of the vaccine.

The participants' conflict and struggle stemmed from their ambivalent perception of COVID-19 vaccine. Foremost was their perception on the negative and bad effect of the vaccine on their health and age. Their apprehensions were bolstered by neighborhood rumors about the negative side effects of vaccine that augmented further their resistance. The vaccine hesitancy according to Vergara (2021) could be a social trauma attributed to the Dengvaxia vaccine in 2016. However, they shared that their vaccine confidence was brought about primarily by their children and grandchildren and secondarily by their doctor and local officials. To cope with the pandemic situation, the participants continued to observe the Department of Health protocols. They expressed that their fear of the pandemic was reduced if not gone since, as they claimed, "they have something to fight against the virus."

Wellness as an emergent theme included the self-evaluation of the participants in their stories regarding their mental, physical and emotional wellness after getting the vaccine. This theme, likewise, revealed family support, doctor's advise and the acceptance of COVID vaccine. The stories about their wellness mostly supported the change in their physical and emotional reactions of being free from fear and the threat of being infected with the virus after being vaccinated. NVivo 12 analysis showed several positive words were used to describe their opinions and feelings regarding this theme such as vaccinated, health, children, convinced, follow, happy like, and many other positive descriptions. It can be implied that the improved vaccine confidence accounted for the experience of peace of mind, calmness, and confidence of a greater chance not to be infected by coronavirus.

The obtained mean of the participants' self-evaluation of their Mental Wellness before getting the vaccine was 9.47 suggesting a *Fair* state of being. The obtained mean for Physical Wellness was 7.38 described as *Good* and 9.41 for Social-Emotional Wellness which is described *Fair*. When the responses for the mental, physical, and social-emotional wellness were taken altogether, the obtained mean was 7.81 suggesting a *fair* state of being. After getting the vaccine he obtained mean of the participants' evaluation of their Mental Wellness was 7.29 described as *Good*. For Physical Wellness the obtained mean was 6.26 and Social-Emotional Wellness had a mean of 6.65. Both means fell into the *Good* category. The obtained mean for the overall wellness was 5.76 which is the borderline between *Good* and *Optimal*.

The Wilcoxon Signed-Rank Test of the participants pre- and post-vaccination wellness, $MW=2.75$, $p=.006$, $PW=-2.62$, $p=.009$, $SEW= -3.308$, $p = .001$, demonstrated significantly significant differences in state of wellness between the pre- and post-vaccination experiences. Interfacing these statistics with the themes derived from the stories suggests the big changes in the experiences of the participants before and after they received the vaccine.

Some limitations of this study might be acknowledged. Firstly, the nature of the research design uses purposive small samples so the results might not be generalized for the total population; secondly, the Wellness Questionnaire was submitted for face and content validity but has not undergone test of reliability; and thirdly, while care was strictly observed in the translation of responses from Filipino to English for purposes of NVivo analysis some English expression may not reflect the authentic context since there are Filipino words with no English equivalent.

The findings, however, opened interesting questions regarding the quality of life of elderly persons at-risk in times of a pandemic. What extent does the elderly population from low-income group receive health services, both medical and psychological, on a fair basis? Questions on the quality of family care-giving could, likewise, be enabling. Future researchers might think of looking into a longitudinal study on the journey of elderly persons at-risk in times of a pandemic to obtain a comprehensive picture how elderly Filipinos manage their lives. Another recommendation could be addressed to the field of Geriatrics with regards policies and practices toward a more responsive health care to ensure the aged population a healthier life as life expectancy is increasing.

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Mobile Phone Use Among Indonesian Elderly People and Its Obstacles

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Abstract

Background: Mobile phone users among Indonesian elderly people experienced the highest increase in the last 5 years. This increase was 3.6% from 43.08% in 2019. Mobile phone is useful for the elderly. We explored the way the Indonesian elderly people use mobile phone and its obstacles.

Methods: This descriptive research included fifty elderly people in Bantul (Yogyakarta) and Sragen (Central Java), aged ≥ 60 years, without severe visual impairment, hearing loss or cognitive impairment.

Results: The mean age was 68.92 ± 5.4 years. Fifty-two percent of them are female and 48% others are male. They are mostly traders (48%) and retirees (40%). Most of them are high school graduates (48%). Their most common reason for using mobile phone is to communicate with their family (80%), to access health information (50%) and to prevent stress (38%). Their favorite activities include voice call (46%), social media (30%), browsing the internet/YouTube (18%) and video call (6%). The most preferred social media is WhatsApp (90%). They use their phones almost every day (96%) and less than 30 minutes per session (54%). The obstacles are too complicated machines (48%), expensive prices (24%), unclear images (16%) and easily damaged device (12%). They solve the problems by asking their family members for help (44%), seeking information on their own (42%), and asking their friends for help (14%).

Conclusion: Mobile phone provide benefits for the elderly, especially for communicating with family and accessing health information. Support and training can help them overcome their obstacles to using mobile phones.

Keywords: Mobile Phone, Elderly, Obstacle

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Introduction

Successful aging depends on the availability of supporting physical, social, and economic elements in the infrastructure of living areas and communities. The availability of a wide range of supports, services and opportunities to participate in community life, including means of communication, safe transportation, health services, support services, healthy foodstuffs, and opportunities for flexible work, volunteering, recreation and socialization are important elements to support successful aging (Albert and Gans, 2017).

It is estimated that by 2050, 80% of elderly people will live in low and middle income countries where the speed of aging of the population in these countries is much faster than in the past. Between 2015 and 2050, the proportion of the world's population aged over 60 will nearly double from 12% to 22%. Globalization, technological developments (e.g. transportation and communications), urbanization, migration and changes in gender norms affect the lives of older people (WHO, 2022).

Currently the elderly are still underestimated in the world of technology and are often seen as "non-technological" person, but there is no evidence that the entire elderly population rejects technology. Elderly people, like adults in general, accept and adopt technology when it meets their needs and expectations which is accompanied by a different approach to technological progress than adults in general. Aging which impacts sensory, motor and cognitive changes causes older people to require more time to learn, be more prone to errors, require motivation, support, more steps to operate the system (Conci and Pianesi, 2009).

Mobile phones users among Indonesian elderly people experienced the highest increase in the last 5 years. In 2021, mobile phones user increased slightly from 2020 (average 46.68%). The use of mobile phones among the elderly in 2021 tends to be stable when compared to the previous year. Approximately 46.79% of the elderly were recorded as using mobile phones last year. However, mobile phones user had never reached half of the elderly population. The majority of the elderly use mobile phone to keep in touch with family and relatives (Pahlevi, 2022).

A study in 2017 of 2071 respondents aged 65 years and over showed that there was a significant positive effect of using a mobile phone on life satisfaction compared to a group that did not have a mobile phone with depression as a mediating role (Sagong and Yoon, 2022). Mobile phones are also useful for finding information quickly, important tools in emergency and life-threatening situations, and as personal assistants for elderly users when needed, but the complexity of the various buttons on mobile phones is a burden for the elderly with cognitive impairment (Chen *et al*, 2013).

Some elderly people don't have the motivation to use mobile phone or don't use them anymore because they are not comfortable with the devices (hardware or software) and service providers which are mostly designed for young people only, and they are used to using computers and feel more comfortable using computers than mobile phones. Physical limitations and cognitive disorders as well as the high price of mobile phone make them not motivated to own a mobile phone (McGaughey *et al*, 2013).

Research on the use of mobile phones in the elderly in Indonesia, especially in the Central Java and Yogyakarta regions and their barriers is still rare. It is hoped that from the results of this research we can learn how to use mobile phones for the elderly and their obstacles then

we can find an appropriate way to overcome these obstacles, so that the benefits can be taken to increase the independence and physical and mental health of the elderly.

Material and Methods

This was a descriptive research study.

Sample

This research included fifty elderly people in Bantul (Yogyakarta) and Sragen (Central Java), Indonesia. Elderly with age more than or equal to 60 years, not in acute illness and able to answer all questions were included in this study. This study excluded older people with severe visual impairment, hearing loss or cognitive impairment.

Data Collection and Analysis

A demographic questionnaire included age, sex, occupation, and level of education. The questionnaire was prepared based on several literatures and conducted open interviews with the research subjects. The data obtained were analyzed using SPSS-18. The mean and the median were calculated.

Results

According to the result, the mean age was 68.92 ± 5.4 years. Fifty-two percent of them are female and 48% others are male. They are mostly traders (48%) and retirees (40%). Most of them are high school graduates (48%). Their most common reason for using mobile phone is to communicate with their family (80%), to access health information (50%) and to prevent stress (38%). Their favorite activities include voice call (46%), social media (30%), browsing the internet/YouTube (18%) and video call (6%). The most preferred social media is WhatsApp (90%). They use their phones almost every day (96%) and less than 30 minutes per session (54%). The obstacles are too complicated machines (48%), expensive prices (24%), unclear images (16%) and easily damaged device (12%). They solve the problems by asking their family members for help (44%), seeking information on their own (42%), and asking their friends for help (14%).

Figure 1: Diagram showing the results of the study

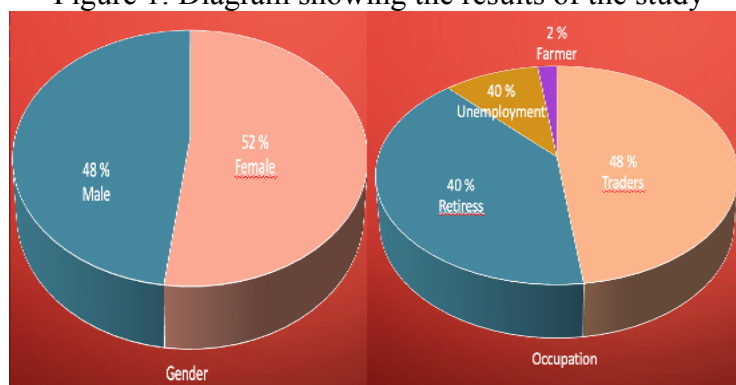


Figure 1 (continued): Diagram showing the results of the study

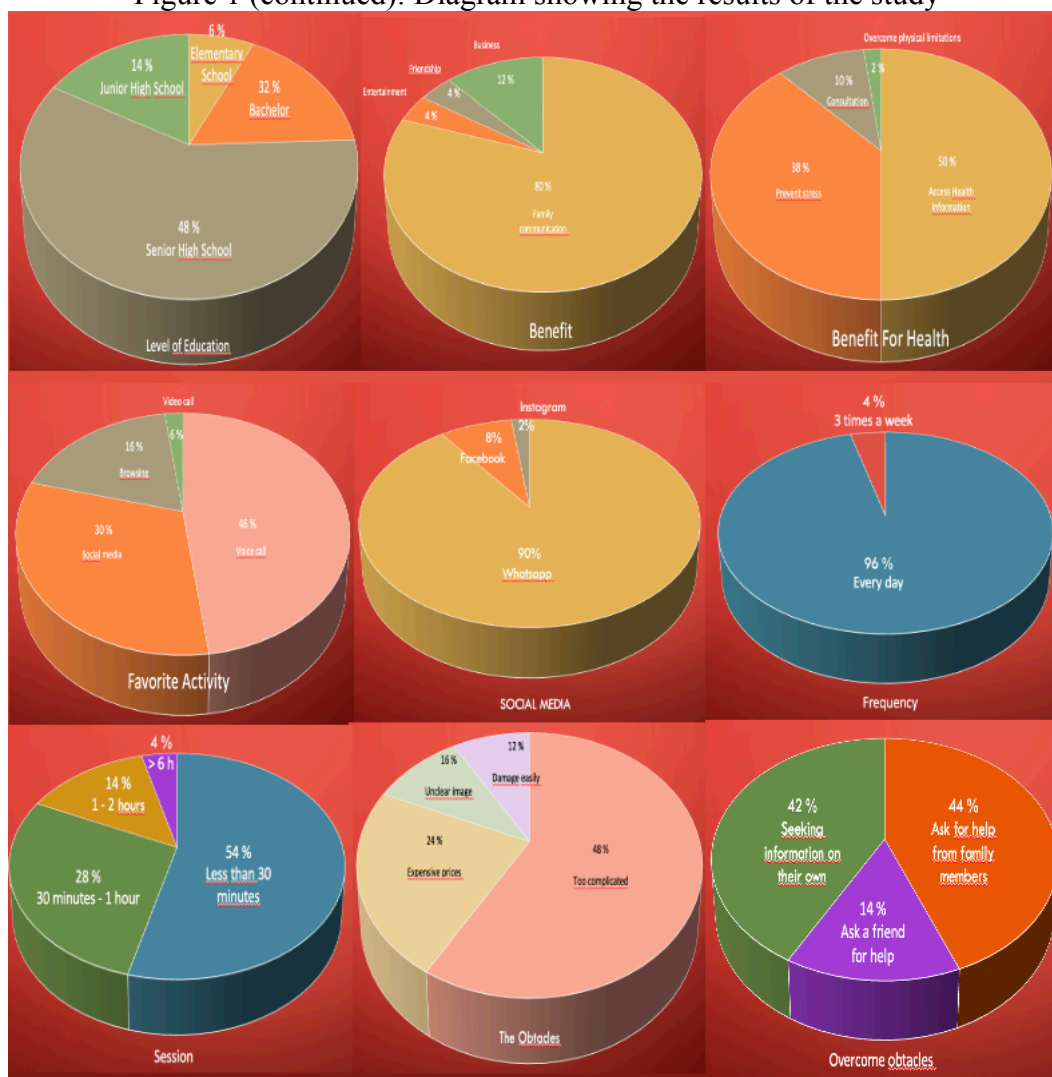


Figure 1: Diagram showing the results of the study

Discussion

This is the first study that examines the use of mobile phones by the elderly in Sragen (Central Java) and Jogjakarta. In 2022, there are eight provinces that are included in the aging population, West Sumatra, Lampung, Central Java, DI Yogyakarta, East Java, Bali, North Sulawesi and South Sulawesi. Yogyakarta is the province with the highest proportion of elderly (16.69%). According to age group, the older elderly in Indonesia, the less likely they are to be exposed to information and communication technology. The percentage of young elderly who use mobile phones (56.27%) is higher than middle elderly (39.87%) and old elderly (23.84%) (Badan Pusat Statistik, 2022).

In our study, their most common reason for using mobile phone is to communicate with their family (80%), to access health information (50%) and to prevent stress (38%). Their favorite activities include voice call (46%), social media (30%), browsing the internet/YouTube (18%) and video call (6%). The most preferred social media is WhatsApp (90%). They use their phones almost every day (96%) and less than 30 minutes per session (54%).

This is similar to a cross-sectional study conducted by Busch *et al.*, (2021) on 154 mobile phone users aged over 60 years, where they use mobile phones for social and non-social reasons. Mobile phone use for social purposes (including social media, audio/video calls, and instant messaging) reached 45.2% of total mobile phone use among the elderly, while 54.8% of this was for non-social use. Social media and reading news via mobile phone is the most activity carried out. Social media is the most used activity with an average of 39.8 minutes per day. The sample population spends an average of 159,4 minutes per day using a mobile phone. As a means of social interaction, mobile phones can prevent loneliness, problematic smartphone usage and cognitive decline.

A Study by Reid *et al.*, (2017) shows several priorities underlying elderly people using mobile phones. The first priority is ease of use (easy to use, easy to understand, can be started quickly). The second priority is the existence of use value (good quality for the price, warranty, service). The third priority is a good set of functional features (light and bright screen, buttons that are easy to perform an activity, and buttons that feel solid).

A study by Chen *et al.*, (2013) on 100 respondents aged 60 years and over, revealed that basic mobile phones functions are very important for elderly users. The eight features that respondents use most frequently are the calling feature, address book, alarm, date and time display, panic button for emergencies, incoming calls with a picture of the caller, and camera. Calling was the highest ranking because they are considered the easiest. The feeling of safety and security for the elderly and makes them keep in touch with their family and friends made the function of calling also increased.

From our study, we found that the obstacles are too complicated machines (48%), expensive prices (24%), unclear images (16%) and easily damaged device (12%). They solve the problems by asking their family members for help (44%), seeking information on their own (42%), and asking their friends for help (14%). Many mobile phones are not designed specifically for the elderly. Nowadays, mobile phones are mostly designed for young users with a variety of high-tech applications, playing games and surfing the web. The small size of the device, navigation controls with small buttons, often make the elderly not interested in using a mobile phone, and those who have a mobile phone find it difficult and even frustrating (McLeod, 2009).

Elderly mobile phone users find it difficult to understand and operate overly complex cross hardware interfaces and matrix software interfaces so they would prefer to use easily, simply, and intelligibly interface designs such as duplet hardware interfaces and page software interfaces. Reduced motor skills and finger dexterity, impairment of vision and cognitive abilities of older people such as remembering information followed by decline of processing and reaction time cause them to take longer to use mobile phones and encounter more difficulties related to mobile phone interface design compared to younger people (Lin *et al.*, 2009).

Common conditions in old age such as hearing loss, vision problems, joint pain, diabetes, depression and dementia which can appear together or what is commonly referred to as geriatric syndrome plus physical and social environmental conditions can affect the health and independence of older people directly and indirectly. (WHO, 2022). Furthermore, household economic capacity also influences access to information and communication technology and the use of mobile phones, computers and internet access (Badan Pusat Statistik, 2022). This needs to be taken into consideration by family, friends and the

community to help elderly people use mobile phones. Support from the government and the mobile phone industry and service providers is needed to help with this problem.

Research on the use of mobile phones in the elderly in Indonesia, especially in the Central Java and Yogyakarta regions and their barriers is still rare. This study explores how the use of mobile phones in the elderly, what are the obstacles and how do they overcome these obstacles. It is hoped that as health workers we can help the elderly to promote the benefits of using mobile phones and mobile phone manufacturers can take advantage of this opportunity to create a new breakthrough mobile phone that is friendly for the elderly, easy to use for the elderly but has a big impact on improving the health of the elderly. The limitations of this study were the small number of subjects and did not assess the multiple comorbid and other functional status of the subjects. further study is needed with more research subjects and a wider area.

Conclusion

This study revealed that mobile phone provide benefits for the elderly, especially for communicating with family and accessing health information. The obstacles are too complicated machines, prices, unclear images and easily damaged device. Support and training can help them overcome their obstacles to using mobile phones.

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***Mitigating Social Engineering Attacks on the Elderly:
Personalized Countermeasures to Enhance Cyber Situational Awareness***

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Abstract

The elderly population has experienced a significant financial and psychological impact from cyber abuse, particularly during and after COVID-19. This heightened vulnerability is primarily due to the rapid shift of essential services - such as Internet banking, telemedicine, and online shopping - to digital platforms, leaving many older adults unprepared and reluctant users of these technologies. To understand this phenomenon, we conducted an inductive analysis of literature reviews across multiple technical and socio-behavioral disciplines related to cyber abuse among older adults. Our findings revealed that social engineering attacks often exploit vulnerabilities associated with socio-behavioral traits unique to this demographic. Furthermore, we utilized reflexive thematic analysis to examine and interpret victims' accounts of cybercrime incidents, identifying patterns, relationships, and the influence of situational variables on their cyber situational awareness. This research informs the development of personalized countermeasures based on *cyber phenomics* to enhance cyber situational awareness and mitigate social engineering threats for the elderly population.

Keywords: Cyber Security, Cyberethics, Cybersecurity Education, Older or Senior Cyber Users, Cyber Abuse, Software Vulnerability Discovery, Cyber Situational Awareness, Cyber Threat Countermeasures, Assistive Technologies, Intelligent Systems, Personalized Countermeasures, Phenomics, Personalized Medicine

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Introduction

The growing dependence on cyberspace has left the elderly population more vulnerable to cyber threats, particularly social engineering (SE) attacks. Traditional countermeasures such as cyber threat awareness training are often inadequate for the elderly due to their lifestyle, unique socio-behavioral traits, and cognitive state.

This study applies a constructivist philosophy to understand the challenges older adults face in the digital landscape. The study explores SE attack patterns and vulnerable socio-behavioral traits by analyzing descriptive crime incident reports during the COVID-19 peak, providing a framework for personalized, information-driven countermeasures that adapt to evolving threats.

Grounded in social constructivism, this research assesses the current state of countermeasures, advocates for enhanced cyber situational awareness (cyberSA), and examines the potential of the N-of-1 approach for personalized countermeasures. By investigating the feasibility of an N-of-1 approach and leveraging discriminate data, this study offers valuable insights and a promising direction for future research in personalized cybersecurity countermeasures.

This study employed inductive reasoning and analysis of a vast array of peer-reviewed and grey literature across multiple domains and organizations related to older adults' cybersecurity, identifying emerging themes concerning cyber threats and vulnerabilities faced by this user group. A summary of the literature review is provided below.

An Aging Populace

Internet threat actors use social engineering attacks to exploit age-related vulnerabilities like emotional insecurities and difficulties adapting to fast-changing technology. **Figures 1 and 2** illustrate the projected doubling of the US population aged 60 and older by 2045, constituting over a fifth of the population.

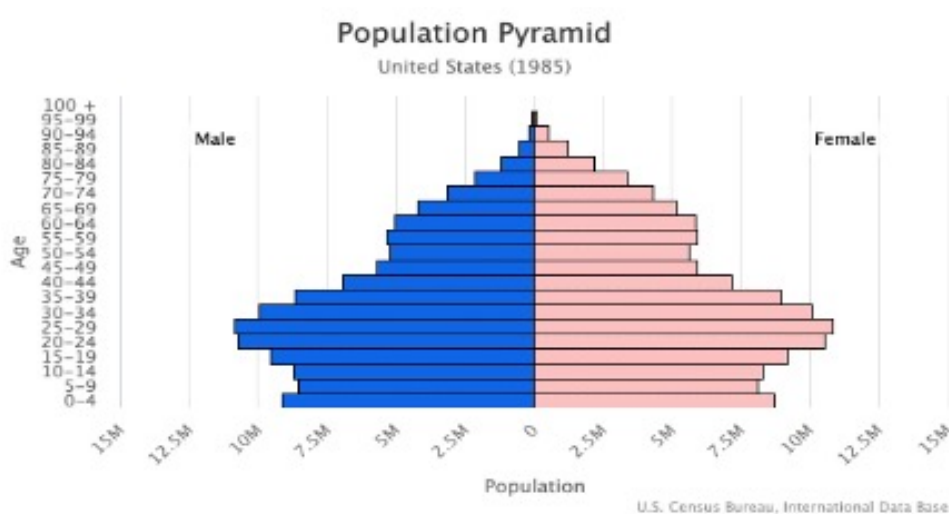


Figure 1: Population pyramid of 60+ for 1985

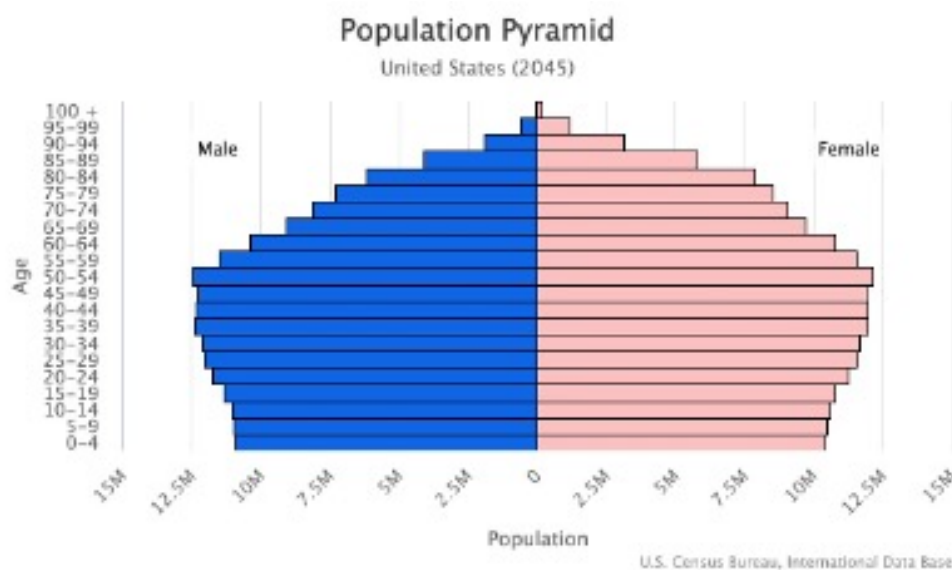


Figure 2: Population pyramid of 60+ for 2045

Social Engineering (SE) Attack Vectors

SE attack techniques aggregate and analyze large volumes of information about individuals to target them with highly personalized, adaptable, and effective attack vectors (Rößling & Müller, 2009), exploiting the inherent behavioral vulnerabilities of their victims. Attackers use advanced persistent threats such as sophisticated SE tactics that exploit social insecurities and behavior-induced vulnerabilities to dupe unsuspecting individuals into “giving” them access to social network accounts (Vargis & Schaeffer, 2022a).

Behavior-Induced Vulnerabilities

Hardin and Khan-Hudson (2005) state that aging and cognitively impaired citizens have been especially vulnerable to cyber exploits. A 2018 Federal Bureau of Investigation (FBI) report indicates that the elderly are going online in record numbers, opening social media accounts, and spending more time online (FBI, 2018), further exacerbating cyber exploits in this community.

COVID-19: Impact of the Rush to a New Computing Paradigm

The rapid shift to COVID-19-compliant operating models, prioritizing remote access to essential services, has led to hasty digitization, often compromising security and privacy (Vargis & Schaeffer, 2022b; Martinez-Alcala et al., 2021). The FBI's Internet Crime Report (FBI, 2023) highlights the exponential increase in cyberattacks targeting the elderly, with \$3.1 billion in losses in 2022, doubling annually since 2019.

Current State of Countermeasures

Current countermeasures against SE attacks mainly focus on general cyber threat awareness training, which is inadequate for the elderly facing sophisticated AI-driven attacks (Puig, 2023). Assistive countermeasures are needed to combat these advanced threats. Mbaziira and Murphy (2018) highlight the limitations of existing deterrence techniques and explore AI

networks utilizing natural language processing and deception-detection discourse for detecting cybercrimes.

Understanding Cyber Situational Awareness (CyberSA)

Cybercriminals mainly use SE tactics targeting behavior-induced vulnerabilities in older adults, compromising their cyberSA. Understanding situational awareness (Endsley, 1998) is crucial for creating effective countermeasures (Gutzwiller et al., 2020). Albladi and Weir (2020) examined behavior, perceptions, and socio-emotions to identify factors predicting vulnerability to SE threats, aiming to develop targeted awareness-raising countermeasures that may vary within individuals over time due to misinformation and social manipulation.

Personalized or N-of-1 Countermeasures

SE attacks are often tailored to their intended targets' specific vulnerabilities and behaviors. Accordingly, countermeasures must be customized to everyone's unique characteristics, including socio-behavioral traits and technical artifacts. These countermeasures can enhance an individual's cyberSA of an impending SE threat by providing individualized awareness prompts to help improve an individual's understanding of imminent cybersecurity risks or threats.

Leveraging Parallels From Other Disciplines

You et al. (2022) explore "harnessing digital platforms to scale the deployment of personalized medicine." In his discussion on "the phenomics revolution," Duncan (2023) quotes Leroy Hood, "The science and technology to help us predict and prevent diseases is arriving," referring to a "new healthcare paradigm" that uses big data and predictive analytics to assess and establish a "person's state of health at any given moment as influenced by their genes and from changes in other molecules," for personalized "wellness care."

This study seeks to encourage a similar approach introducing "cyber phenome," referring to technological, procedural, and behavioral characteristics (and any other relevant situational artifacts) associated with an individual's threat ecosystem. And the study posits that "cyber phenomics," the study of these artifacts, their interplay in a threat scenario, and their decomposition, can aid in devising n-of-1 countermeasures - personalized to an individual's state of situational awareness.

Methodology

This study aimed to identify patterns and vulnerabilities in elderly individuals' SE attacks by conducting an exploratory analysis of crime incident reports from victims aged 60 and older submitted to the American Association of Retired Persons (AARP). The analysis sought to interpret themes, patterns, and relationships between situational variables and threat outcomes. Following a methodical approach, the study used literature review findings to guide deductive reasoning, analyze reports, and decompose data into situational artifacts. These artifacts were classified as thematic states and situational variables, providing a framework for exploring real-time, information-driven countermeasures.

Data Analysis

The immersive recursive thematic analysis adopted a constructivist approach, interpreting correlations between SE threats and exploitable vulnerabilities across multiple disciplines. Cyber threats were decomposed, codified, and distilled into artifacts representing thematic states, situational variables, attack tactics, and behavior-induced vulnerabilities that influence the victim's cyberSA and threat outcomes.

This grounded theory methodology sought to answer the following research questions:

1. What themes emerge from analyzing cyber incident reports?
2. Can situational artifacts associated with these themes be identified?
3. Do these artifacts facilitate exploring personalized countermeasures to SE attacks?

Data Sourcing and Collection

This study's primary data source was the AARP Fraud Watch system, comprising over 2000 cybercrime incidents reported by victims aged 60 and older within a 200-mile radius of zip code 20000 (Washington, D.C., U.S.A) between January 1, 2020, and December 31, 2021. This period was selected due to high crime rates targeting the elderly during the COVID-19 pandemic peak.

Reflexive Thematic Analysis (RTA)

This study employed reflexive thematic analysis (RTA), a flexible method for non-positivist qualitative research for an inductive data-driven methodology to transcribe explicit expressions and interpret latent information. This immersive recursive analysis produced a thematic map of situational artifacts, states, and variables influencing SE attack outcomes, aiding in developing personalized countermeasures and real-time assistive solutions.

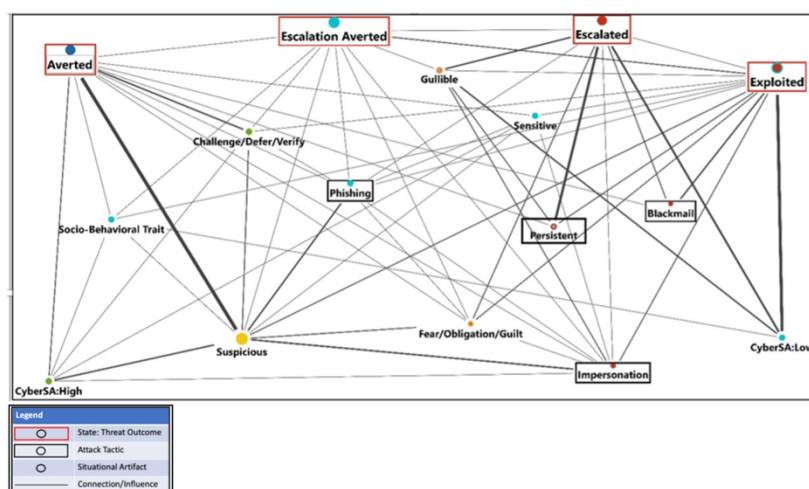


Figure 3: Revised thematic map with refined situational artifacts

Insights From the Analysis of the Research Instrument

The following is a summary of the analysis of the research instrument, decomposing each interpreted state of threat outcomes and the associated situational artifacts into tactics and situational variables that influence cyberSA.

Analysis of Patterns: Investigating patterns in situational artifacts of SE threats revealed valuable insights into tactics, strategies, and common attack patterns, vulnerabilities, and targets. Examples of insightful patterns include the timing of phishing emails, language and tone used in these emails, and target demographics and associated (sensitive and personal) information exploited in SE attacks.

Mapping of Relationships: Identifying the interconnectivity and dependencies between various factors in SE threats allowed a deeper understanding of the relationships between different situational artifacts. Examples include mapping relationships between gullibility, fear of authority, susceptibility to phishing emails, and the persistence of attackers when targeting more gullible individuals.

Analysis of Influences: Assessing the underlying factors contributing to vulnerability in SE threats helped reveal potential areas for intervention. For example, the influence of social isolation on susceptibility to impersonation scams was significant, as well as the impact of persistent attackers that exploited trust and used fear tactics.

Interplay Between the Above: The complex interplay between the *patterns analyzed, relationships mapped, and influences analyzed* led to a more comprehensive understanding of SE threats and informed the development of more effective (situational aware) countermeasures.

Table 1 is only a representative sample of tactics and socio-behavioral traits - to demonstrate the viability of the RTA process to address the research questions.

| Thematic States | Relationship to CyberSA | Influencers on CyberSA | |
|--------------------|--|--|--|
| | | Tactics | Socio-behavioral traits |
| Averted | Indicates a high level of cyberSA and effective response to potential cyber threats. | <ul style="list-style-type: none"> • Phishing and email scams • Lottery and sweepstakes scams • Grandparent scams | <ul style="list-style-type: none"> • Fear of authority • Obligation to family members • Guilt can lead to an impulsive response |
| Exploited | Indicates a potential weakness in cyberSA and a need for improved cybersecurity measures. | <ul style="list-style-type: none"> • Tech support scams • Identity theft and financial exploitation | <ul style="list-style-type: none"> • Gullibility • Delays can prevent exploitation • Sensitivity of information |
| Escalated | Indicates a need for ongoing monitoring and adaptation of cyberSA to keep pace with evolving threats. | <ul style="list-style-type: none"> • Spear phishing, SE • Remote access scams • Fraudulent investments • Blackmail | <ul style="list-style-type: none"> • Fear of authority • Verify to deter a threat • Undue trust (related to gullibility) |
| Escalation Averted | Indicates acquisition of cyberSA that effectively responded to evolving cyber tactics, often after experiencing prior exploitation. | <ul style="list-style-type: none"> • Impersonation • Romance scams, healthcare • Medical fraud | <ul style="list-style-type: none"> • Assess all spurious claims |

Table 1: Results from the final analysis

The study's results demonstrate the complex interplay between socio-behavioral traits, SE attack tactics, and cyberSA in the elderly population. Secondary variables such as age-related cognitive decline, social isolation, trust in authority figures, and financial vulnerabilities can impact the state of cyberSA, increasing the likelihood of successful attacks.

Interpretation of the Findings

The reflexive thematic analysis enabled the researchers to deeply understand the dataset, identify meaningful themes, and uncover patterns related to cyber threats targeting older adults. This immersive method generated valuable insights for the design of practical, information-driven countermeasures.

In conclusion, this analysis effectively examined complex cyber threats, providing a nuanced understanding of situational factors, and informing targeted interventions. Future research can explore additional variables influencing older adults' susceptibility to SE attacks and test countermeasures' effectiveness, refining interventions to protect vulnerable populations. Continued qualitative research can contribute valuable insights to addressing cybercrime and its impact on older adults.

Limitations of Study

This study may be limited by the reviewed literature, emerging cyber threat themes, and the researcher's ability to extract meaningful information from the limited dataset. Incident reports were analyzed in raw form to maintain trustworthiness, with only incomplete reports filtered out. As SE attacks evolve alongside growing awareness and technology, additional literature and new threat dimensions will emerge, requiring countermeasure frameworks to adapt accordingly. Despite these limitations, the study contributes to developing situational information-driven countermeasures.

Recommendations

This feasibility study aims to create improved SE threat countermeasures using intelligent, information-driven systems inspired by AI systems trained on phenomics to devise personalized treatments in biosciences. The following recommendations aim to achieve a tailored countermeasure system based on individual situational circumstances.

Orchestrating N-of-1 Countermeasures

An N-of-1 countermeasure system must focus on personalized and dynamic security approaches, prioritizing individual needs and vulnerabilities. It requires collaboration, data-driven insights, and a multi-faceted risk mitigation approach. These systems can incorporate personalized gaming elements into threat awareness training programs to create a more engaging and realistic user experience, improving situational awareness. More elaborate systems can monitor the threat ecosystem and orchestrate a combination of strategies to mitigate threats. A notional model for monitoring and moderating cyberSA is illustrated in Figure 4.

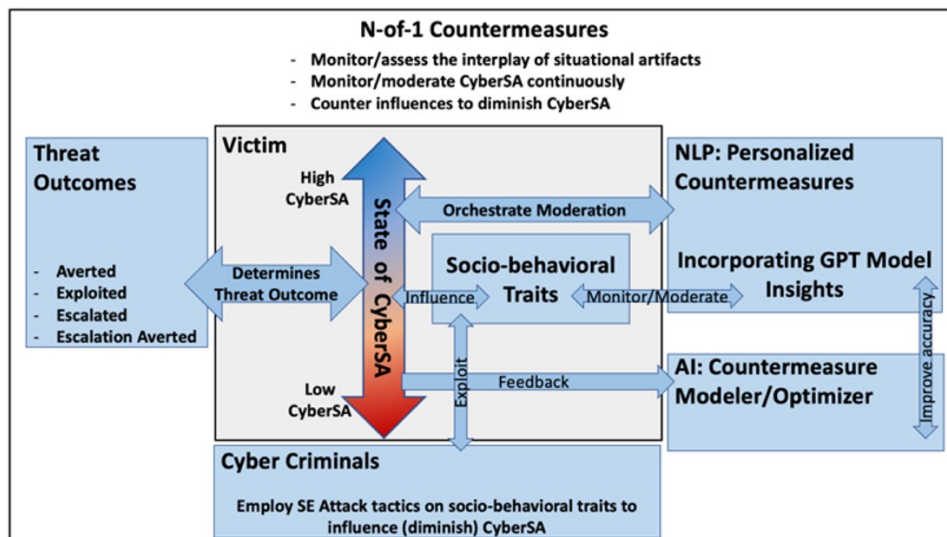


Figure 4: Orchestrating countermeasures to moderate cyberSA

Conceptual Framework for an N-of-1 Countermeasure System

A conceptual framework for an N-of-1 countermeasure system should include functional components such as data collection, data preprocessing, extraction and coding, pattern recognition and analysis, model development, and integration and deployment of application logic. The AL3RT™ framework (see Figure 5), an effort to instantiate this conceptual framework, was borne of this study, inspired by insights gleaned from the findings of the recursive thematic analysis. The 3RT in the AL3RT framework represents the *three recursive transformers* (that are the critical workhorses for the decomposition and interplay of *patterns, relationships, and influences*) to inform the development of N-of-1 countermeasures. Recursive transformers can be trained on a large dataset of SE attacks and their associated countermeasures. Recursive transformers can learn to identify patterns and features indicative of a potential SE attack by analyzing the language and social cues used in these attacks. And based on this analysis, these transformers can generate personalized countermeasures tailored to the individual's specific vulnerabilities and risk profile. Progress on the exploration and realization of this patent-pending framework will be shared at www.al3rt.ai

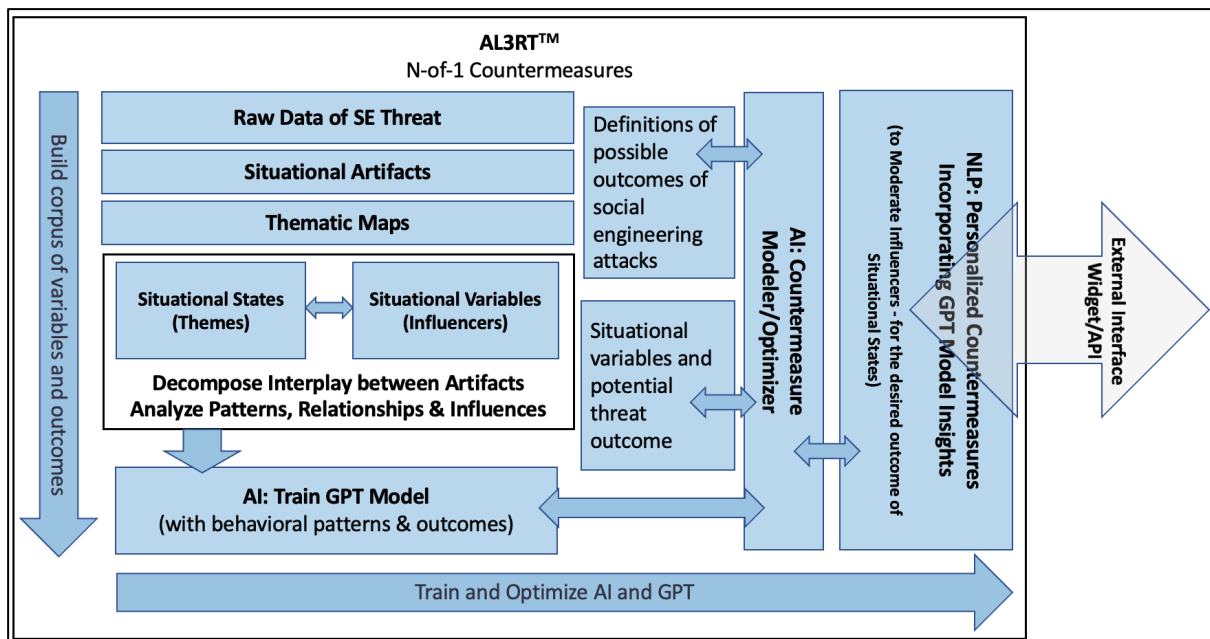


Figure 5: AL3RT™ Framework: Expanding the model from the study

Explore Cyber Phenomics as a Discipline to Enable N-of-1 Solutions

This study presents cyber phenomics as a multidisciplinary study for a data-driven approach to analyzing digital artifacts, socio-behavioral traits, and cyber interactions for insights into SE threats. An evolving corpus of cyber phenoms is essential for an AI-based, adaptive countermeasure framework. Continued research into intelligent strategies is needed to establish cyber phenomics as a discipline, enabling tailored countermeasures and fostering a resilient, inclusive digital ecosystem with user trust and confidence.

Conclusion

Older adults are increasingly vulnerable to costly, life-altering SE attacks due to age-related cognitive changes, trust in traditional communication, and continuous digital advancements. Cybercriminals will develop more sophisticated tactics as technology evolves, exploiting sensory interfaces and AI technologies. To combat this powerful threat vectors, it is essential to AI-driven “co-pilots” that monitor and enhance the cyber situational awareness of older adult cyber users with real-time alerts and guidance.

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The Elderly as a Technological E-excluded

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Abstract

Communication and Information Technologies (ICT) are part of people's daily lives, and indeed of older adults, whose inclusion often causes trauma and, as Casamayou et al. (2017) point out, is a challenge in contemporary societies. The insertion of the elderly means a significant slowness in the process, which leads them to a tacit and explicit digital exclusion related to the complexity of the equipment itself and to the characteristics inherent to adulthood, such as visual limitations, reduced motor skills, the paradigm of being "too old to learn," insecurity, fear of being ridiculed by the "slowness to assimilate and respond," lack of knowledge of the usefulness of technology and economic capacity that affects access to the different options. This paper looks at the technological needs and difficulties that older adults have in using technological devices and understanding their language.

Keywords: Older Adults, Technology, Exclusion, Barriers

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Introduction

A technological gap is closely linked to the generational gap, which implies differences in aptitudes and attitudes towards technology that are associated with the age of each individual (Brandán, 2007). For older adults, these aptitudes and attitudes are related to the physical and psychological characteristics of their adulthood, which leads them to show a certain reluctance to enter a world that is complex for them, both in terms of technological devices and in the acquisition, use, and management of information.

Those who have autonomously entered the world of new technologies at a late age are aware of the benefits this world brings, such as the expansion of social relationships since the use of mobile phones and tools such as e-mail and instant messaging facilitate communication with others, quick access to information through resources that can support them in their daily lives, and keeping them mentally active and therefore healthy.

Nevertheless, older adults are excluded from the supply of technology products since their designs, programs, and packages are aimed at the young people's market. In this sense, products representing versatility, innovation, progress, and variety for young people are complex and challenging for the elderly. Additionally, there is the self-exclusion of the elderly, generated by insecurity and fear of electronic devices and their language, and the fear of making a fool of themselves due to their limitations of understanding, assimilation, and response.

This is the situation described by Cerda (2005): "It is not easy to imagine how complex this situation is for an individual who wants to participate in the development of society, but who does not know where he is, where he belongs, since the world in which he has lived peacefully today begins to break down and fall apart under his feet, since he cannot visualize the institutional order he once knew, the representation he had of the world is not the same, he does not know himself, he does not know who he is."

Literature Review

Population aging is a reality worldwide, with the necessary distinction being made between normal aging and pathological aging according to the relevant biological, psychological, and social factors. The United Nations estimates that by 2050, one-quarter of Latin America's total population will be older adults.

According to Villa and Rivadeneira (1999), advanced age or old age has distinctive characteristics that are present in all personal aspects, as well as in physical conditions, economic and functional independence, changes in roles within the family, participation in the labor market, use of free or leisure time, self-perception and the perception that others have of older adults, among others. Del Popolo (2001) says that the health, economic, social, and family situations and their impact on the well-being of older people vary significantly according to socioeconomic class, gender, ethnicity, and place of residence.

For their part, Berriel et.,al (2011) point out that the shift to a new paradigm of greater freedom, the importance of subjective disposition for ways of aging, allow a better relationship with activity and social ties, providing older adults a different place in society and the appropriation of digital technologies. However, Sunkel and Ullmann (2019) point out

that although the use of ICT has increased globally, the level of use in the elderly is still relatively low compared to people aged 15 to 59.

Older age is the perfect time to learn and enjoy because the older you get, the more free time you have. Most older adults tend to desire to learn new things to stay active over time. Despite this, older adults tend to increase their fear of the unknown, considering age-related limitations such as decreased visual and auditory acuity, manual dexterity, etc. (Cabanés, 2005; Ribera & Casado, 2002). One of their limitations is related to the fear of new technologies, which is aggravated by cultural and social factors that place older adults in a disadvantaged position concerning younger adults, widening the technological gap between them (Cabanés, 2005).

Factors influencing the acceptance or rejection of assistive technology include fear of the new, motivation to use, advice, training, encouragement, and ease of use. The latter reduces the difficulties that people often perceive (Mollenkopf, 2002).

For older people, this ever-changing technological world with its new devices is an obstacle to accessing information, contributing to the technological gap. The lack of knowledge and support and the physical or cognitive limitations that some people develop as they age make using technological tools almost impossible (León-Ayala, 2011).

Bergada and Hebabdi (2001) point out that cyberspace and virtual practices are good indicators of the lifestyles of older people. According to Alava and Moktar (2012), the presence of the elderly in social networks and learning communities is increasing (they are participating with specific content to offer to their audience and thus contributing to the emergence of new content targeted to their specific needs). However, the majority of them are still "e-excluded."

Querol (2012) points out that family or friendship relationships have a value that cannot be given to virtual relationships because of their different nature; consequently, new technologies to facilitate communication must become more human (Cruz et al., 2015). The use of information technologies by older people is increasing, but it differs from that of younger people, who use them with greater intensity and for different purposes.

It is expected that in a few years, we will move from the "media generation" of today's older people, characterized by having known the importance of television as the primary means of communication, to the "digital generation" of seniors of the future, accustomed since their youth to the use of new technologies (Cruz et al., 2015).

It is important to note that as society ages (Tikkanen & Nyhan, 2009), incorporating technological learning tools for the elderly becomes essential. The development of these tools becomes an international issue of business competitiveness. The ternary model "training-work-retirement" has a social change process in which older adults have gone from needing leisure activities to training activities in information and communication technologies. The centers and associations that offer activities for the elderly include formal (seminars, courses, university programs) and informal (clubs, communities, social networks) training offers to improve the technological skills of older adults (Boutrand, 2009).

Methodology

This research seeks to typify older adults based on their needs and limitations concerning technological tools in Cartagena. This is a descriptive study with a qualitative-quantitative approach and is part of a macro project about the needs and difficulties, tastes, and preferences of the elderly with the products and services the market offers them.

Ten focus groups were conducted for the research, and then a structured form with open-ended objectives was applied to a probability sample of 208 people aged 60 and over. A five-point Likert scale was used, validated with Cronbach's alpha coefficient (0.86), and a univariate and bivariate analysis was performed using Snedecor's F-test to find significant differences between the groups. Finally, a cluster analysis was performed with four partitions to obtain two extreme and two intermediate groups.

The sample comprises 48.2% men and 51.8% women aged 60 and over—46.0% of the sample work, followed by 28.8% who do housework. In terms of education (all levels were included), most people have technical (35.10%) and professional (37.17%) studies.

Results and Discussion

Some cultural and economic factors often lead the elderly of Cartagena to avoid contact with technological platforms, and there is also a gap between the speed of learning and the speed of changes in the design and updating of technological devices that are not adapted to the needs of the population under study. The following are some factors that affect the ability of older adults to use new technologies:

Understanding the Technical Language of Technological Devices

The changes in ICT language and the need to learn and use it are among the main barriers for older adults, as it means "starting from scratch." These new terms are increasingly used in people's daily lives without the need to practice a specific field or profession, especially by the younger population who grow up in tune with technology. In the case of older adults, this language is unfamiliar, which makes it challenging to use the new devices that are coming on the market:

"I do not understand the technical language of the cell phone. I repeat what my grandson says but still do not understand."

"I know it is StandBy because, at work, my husband had a radio phone."

"By repetition, I am learning the basics."

"My grandchildren laugh because even though I understand some terms, I do not know how to pronounce them."

The research findings (Table 1) show that, according to the values, the level of understanding of the technical language is low (1.71 to 3.6). When the values are analyzed by gender, they are also low. The understanding of the technical language of the mobile phone is highlighted, taking into account that the value given by men (3.8) places them at a medium-high level and

that of women at a medium-low level (3.41). This difference is significant at the 5% level, according to Snedecor's F-test.

The level of understanding of the language of the other devices could be better, especially for the tablet, where the differences are also significant at the 5% level. There are no significant differences in the understanding of the technical language of both personal and laptop computers, which confirms that the difficulties in understanding the language of these devices do not depend on gender.

| N° variable | Designation | Total sample | Gender | | Snedecor's F |
|-------------|-------------------|-------------------|-------------------|-------------------|--|
| | | | Male | Female | |
| 27 | Cellphone | 3,5962 n = 208 | 3,7843 n = 102 | 3,4151 n = 106 | F(1,206) = 6,3747 p = 0,0123 |
| 28 | Laptop | 2,6635 n = 208 | 2,5098 n = 102 | 2,8113 n = 106 | F(1,206) = 1,6909 p = 0,1949 |
| 29 | Personal Computer | 3,0048 n = 208 | 2,9412 n = 102 | 3,0660 n = 106 | F(1,206) = 0,2692 p = 0,6044 |
| 30 | Tablet | 1,7163 n = 208 | 1,5196 n = 102 | 1,9057 n = 106 | F(1,206) = 4,2612 p = 0,0402 |

Source: update and expansion of Cuenca and Hoyos's (2016) database.

Table 1: Understanding of the technical language

Use of Technological Devices

The complexity of technological devices and their rapid and constant change tends to create a time lag for older adults forced to be in a "new beginning." This is where the limitations in learning capacity, the fear of making a fool of oneself, making a mistake, or losing all the information on the device become relevant.

Skills in the Use of Cellphones

The mobile phone is the device that older people are most comfortable with. It is important to note that most do not use mid- to high-end or state-of-the-art devices:

"I use the cell phone for what I know how to do: make calls, take pictures, and send messages. The rest my daughter can do and tell me."

"I want to keep my old phone; when they change it, I am as lost as when I had my first cell phone. They keep putting more and more things on it that I don't understand or know how to use."

"New phones have so many things on them that mess me up. I always have to ask my grandson for help."

"Calling by WhatsApp was hard for me, but since I get it for free..."

"You can do everything with new phones, but I get tangled."

"The keyboard is a mess. It was easier for me with the button keypad."

"I prefer my old phone. I do not see the gray letters."

The values given by older adults indicate that they have the most excellent skill and confidence in using mobile phones, especially in making and receiving calls. This is mainly explained by the simplicity of the procedure and the frequency of use (4.25). This item shows a similar behavior according to gender, with a higher rating by men (4.4) than by women (4.1). However, according to Snedecor's F-test, the differences are not significant as the p-value is above 5%.

Although the other actions are rated above three, they do not reach the maximum of four, which shows that mobile phone use still needs to be better managed. Except for the use of the keyboard, there are no significant differences between the groups (p-value above 5%), which confirms that the skill of using the mobile phone does not depend on gender (see Table 2).

| N° variable | Designation | Total sample | Gender | | Snedecor's F |
|-------------|--------------------------------|-------------------|-------------------|-------------------|--|
| | | | Male | Female | |
| 31 | Make and receive calls | 4,2596 n = 208 | 4,4020 n = 102 | 4,1226 n = 106 | F(1,206) = 3,4821 p = 0,0635 |
| 32 | Send and receive text messages | 3,6202 n = 208 | 3,6569 n = 102 | 3,5849 n = 106 | F(1,206) = 0,1441 p = 0,7046 |
| 33 | Download and app use | 3,3942 n = 208 | 3,3824 n = 102 | 3,4057 n = 106 | F(1,206) = 0,0157 p = 0,9006 |
| 34 | Surf de internet | 3,7356 n = 208 | 3,7353 n = 102 | 3,7358 n = 106 | F(1,206) = 0,0000 p = 0,9978 |
| 35 | Take pictures | 3,4760 n = 208 | 3,5294 n = 102 | 3,4245 n = 106 | F(1,206) = 0,3513 p = 0,5540 |
| 36 | Find and use the keyboard | 3,6779 n = 208 | 3,8824 n = 102 | 3,4811 n = 106 | F(1,206) = 5,3691 p = 0,0215 |

Source: update and expansion of Cuenca and Hoyos's (2016) database.

Table 2: Cellphone handling skills

Computer and Tablet Skills

The use of desktop and laptop computers, as well as tablet, is more complex for older adults because of the different steps that must be taken to perform different actions. The frequency of use is low, in contrast to mobile phones. The population studied shows a low level of dexterity in using these devices due to age-related characteristics such as slower learning speed and visual impairment. In addition, there is discomfort or fatigue when sitting for long periods. Finally, the insecurity and intolerance of the people in contact (children, adolescents, young people, and adults) for the explanations and instructions necessary for using such devices are an obstacle to improving the use of these devices.

"I have almost forced myself to use the Internet to communicate with my children who are away."

"I like the tablet because I can see better, but everything is still messy, and I always have to ask for help."

"I think all devices are good, but the problem is understanding and remembering what they explain."

"I prefer the phone with buttons for the keypad because it is easy for me to dial, and they are in plain sight."

"I use the computer, but I always feel insecure."

"Every time they update the computer, they must explain, and I feel less capable or stupid."

If I ask for help, I risk being laughed at, ignored, or told:

"Again! I have explained it to you already."

"Now everything is gray, and it is hard for me to find what I need."

The values show that all other actions are below four except for turning the personal computer on and off. Downloading files, pictures, and music on the laptop is very complex for the elderly (2.82). On the other hand, all actions related to the tablet are considered complex for the target population, as the values reach a maximum of 1.94. Table 3.

When analyzing the variables according to gender, similar behavior is observed using electronic devices, as the results are close to the overall mean. However, using Snedecor's F test, significant differences were found between men and women at the 5% level in turning on and off, using the laptop mouse, and taking photos with the tablet.

Regarding the skill in performing the other actions with both computers (personal and laptop) and the tablet, the significance level is above 5%, so it is confirmed that gender does not explain the difficulty/skill that the older adult has in using these electronic devices.

| N° variable | Designation | Total sample | Gender | | Snedecor's F |
|---------------|------------------------|-------------------|-------------------|-------------------|---|
| | | | Male | Female | |
| Laptop | | | | | |
| 37 | Turn on/off | 3,5529 n = 208 | 3,2059 n = 102 | 3,8868 n = 106 | F(1,206) = 4,6342 p = 0,0325 |
| 38 | Use of the touch mouse | 3,4519 n = 208 | 3,0882 n = 102 | 3,8019 n = 106 | F(1,206) = 5,6047 p = 0,0188 |
| 39 | Surf the Internet | 3,2933 n = 208 | 3,0196 n = 102 | 3,5566 n = 106 | F(1,206) = 3,2499 p = 0,0729 |

| N° variable | Designation | Total sample | Gender | | Snedecor's F |
|--------------------------|-----------------------------------|-------------------|-------------------|-------------------|--|
| | | | Male | Female | |
| Laptop | | | | | |
| 40 | Download files, images, and music | 2,8173 n = 208 | 2,6765 n = 102 | 2,9528 n = 106 | F(1,206) = 1,1248 p = 0,2901 |
| Personal computer | | | | | |
| 41 | Turn on/off | 4,0337 n = 208 | 4,0392 n = 102 | 4,0283 n = 106 | F(1,206) = 0,0013 p = 0,9717 |
| 42 | Surf the Internet | 3,7452 n = 208 | 3,8039 n = 102 | 3,6887 n = 106 | F(1,206) = 0,1496 p = 0,6993 |
| 43 | Download files, images, and music | 3,3462 n = 208 | 3,4902 n = 102 | 3,2075 n = 106 | F(1,206) = 1,0549 p = 0,3056 |
| Tablet | | | | | |
| 44 | Download and use the app | 1,8413 n = 208 | 1,6765 n = 102 | 2,0000 n = 106 | F(1,206) = 2,1377 p = 0,1452 |
| 45 | Surf the Internet | 1,9423 n = 208 | 1,7353 n = 102 | 2,1415 n = 106 | F(1,206) = 2,8283 p = 0,0941 |
| 46 | Take pictures | 1,9183 n = 208 | 1,6176 n = 102 | 2,2075 n = 106 | F(1,206) = 6,3422 p = 0,0126 |
| 47 | Find and use a keyboard | 1,9135 n = 208 | 1,7157 n = 102 | 2,1038 n = 106 | F(1,206) = 2,6586 p = 0,1045 |

Source: update and expansion of Cuenca and Hoyos's (2016) database.

Table 3: Personal computer, laptop, and tablet skills

Typification of Older Adults

In order to identify the different groups of older adults in terms of skills in the use of new technologies, the statistical technique of cluster analysis was used. This technique is applied to determine internally homogeneous but distinct groups by grouping smaller units or more significant segments (Santesmases, 2009). The top-down model was used, based on the Howard-Harris algorithm, considering the large sample size. Four groups were formed to obtain a sufficiently large segment size and homogeneous comparisons, as well as having two extremes and two intermediate groups.

Twenty-one variables were selected, related to older adults' level of understanding of the technical language of the technological devices and their ability to use specific functions of each device—Table 4.

The third grouping alternative was selected (with an explained variance of 58.48%), from which four groups were obtained. Considering the mean scores, groups 1 and 4 were identified as extreme groups, whereas groups 2 and 3 were intermediate groups.

| | | |
|----------|--|-------------------|
| LT-CEL | How well do you understand technical language? | Cell phone |
| LT-PC | How well do you understand technical language? | Laptop Computer |
| LT-PCM | How well do you understand technical language? | Personal Computer |
| LT-TAB | How well do you understand technical language? | Tablet |
| MAN-CEL1 | How well do you use the device to make/receive calls? | Cell phone |
| MAN-CEL2 | How well do you use the device to send/receive text messages? | Cell Phone |
| MAN-CEL3 | How well it uses the device to download/use applications? | Cell Phone |
| MAN-CEL4 | How well does the device use the device for surfing the Internet? | Cell phone |
| MAN-CEL5 | How well does the device use the device when taking pictures with the camera? | Cell phone |
| MAN-CEL6 | How well the device uses the device, find/use the keyboard? | Cell phone |
| MAN-PC2 | How well does the device use the mouse when using the touch mouse? | Laptop Computer |
| MAN-PC3 | How well does the device use the device for surfing the Internet? | Laptop Computer |
| MAN-PC4 | How well does the device use the device to download content from the Internet? | Laptop Computer |
| MAN-PCM2 | How well does the device use the device to browse the Internet? | Personal Computer |
| MAN-PCM3 | How well does the device use the device to download content from the Internet? | Personal Computer |
| MAN-TAB1 | How well does the device use the device to download/use applications? | Tablet |
| MAN-TAB2 | How well does the device use the device to browse the Internet? | Tablet |
| MAN-TAB3 | How well do you use the device to take pictures with the camera? | Tablet |
| MAN-TAB4 | How well does the device use the device to find/use the keyboard? | Tablet |

Source: own elaboration

Table 4: Variables related to technical language and the use of the functions of technological devices

Group 1. "Technically Skilled" Composed of 33% of older adults, this is the group with the highest number of positive variables. Members of this group show a good understanding of the technical language of the laptop, personal computer, and tablet. They can take pictures with a mobile phone camera and surf the Internet with a laptop. They find it easy to browse and download content from the Internet with their personal computer. When using the tablet, they have no difficulty downloading/using applications, browsing the Internet, taking pictures with the camera, and finding/using the keyboard.

Group 2. "Laggards" Consists of 25% of people. They need help downloading files, pictures, and music on the laptop. On the other hand, they find it easy to turn on/off the personal computer.

Group 3. "Semi-skilled" Consists of 17% of the elderly. They have a high understanding of the technical language of the mobile phone but need help understanding the technical language of the personal computer. They are proficient in using mobile phones to make/receive calls, send/receive text messages, download/use applications, browse the Internet, and find/use the keyboard. They are also comfortable using the laptop to download files, pictures, and music. They have no problems turning it on/off or using the touch mouse. However, they have difficulty turning their personal computer on/off, surfing the Internet, and downloading files, pictures, and music.

Group 4: "Outdated" Consists of 25% of older adults. This is the group with the most negative variables. They need help understanding the technical language of mobile phones, laptops, and tablets. They need help with the mobile phone in making and receiving calls, sending/receiving text messages, downloading/using applications, browsing the Internet, taking photos with the device (mobile phone) camera, and finding/using the keyboard. With the laptop, they have difficulty turning it on/off, using the touch mouse, and browsing the web. With the tablet, they have difficulty downloading/using applications, browsing the web, taking photos with the device (tablet) camera, and finding/using the keyboard.

Conclusion

Although older adults in the city of Cartagena are aware of the importance of information and communication technologies and their contribution to improving their quality of life by facilitating contact with different groups of people, having fun, keeping up to date, making different types of transactions, etc., they are lagging in the use of smartphones, computers, and tablets.

Due to the characteristics of their age, the learning process could be faster, as evidenced by the number of people who say they have little or no understanding of the technical language of computers and tablets. Their primary medium is the mobile phone, which they use mainly for telephone communication (making and receiving calls).

The difficulties are exacerbated by the design of the screens of the new devices, which present the icons in grayscale. These new screens force older adults to make a more significant effort to see or try to guess what is going on.

This opens up lines of future research in the use of each device.

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Study of the Level of Solitude in the Elderly at the Yogyakarta Nursing Home

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Abstract

Aging and loneliness has been established widely. Loneliness has been studied from many different points of view and there is no unified definition (Muhumed, K & Cervinkova, M, 2011) Mainly, loneliness is thought as being stranged from others. (Killeen 1998, 763-764.) Feeling of loneliness most vulnerable seems to be adolescents and elderly people. Loneliness among elderly population has been examined, in quantitative studies, according to demographic factors, education, socio-economic status or health. In average, onethird of elderly population suffers from loneliness at least sometimes (Victor etal. 2005, 364; Savikko 2008, 40; Theeke 2009, 392). Illness, death of a spouse and lack of friends were the most common causes of loneliness (Savikko 2008, 42). The level of loneliness itself can be assessed in a scoring system that is often used in the form of University Carolina (UCLA) loneliness scale. This validated score consist of 20 questionnaire that can assess one's subjective feelings of loneliness as well as feeling social isolation (Fetzer.org) Participants rate each item as either O ("I often feel this way"), S ("I sometimes feel this way"), R ("I rarely feel this way"), N ("I never feel this way"). The score system devided whether it is low (20-49), medium (50-69) or high (60-80).

Keywords: Loneliness, Solitude, Nursing Home, Elderly

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Introduction

Older adults are at increased risk for loneliness and social isolation because they are more likely to face factors such as living alone, the loss of family or friends, chronic illness, and hearing loss. A report from the National Academies of Sciences, Engineering, and Medicine (NASEM) points out that more than one-third of adults aged 45 and older feel lonely, and nearly one-fourth of adults aged 65 and older are considered to be socially isolated. Loneliness is the feeling of being alone, regardless of the amount of social contact. Social isolation is a lack of social connections. Social isolation can lead to loneliness in some people, while others can feel lonely without being socially isolated. Social isolation was associated with about a 50% increased risk of dementia and other serious medical conditions. Although it's hard to measure social isolation and loneliness precisely, there is strong evidence that many adults aged 50 and older are socially isolated or lonely in ways that put their health at risk. Recent studies found that:

- Social isolation significantly increased a person's risk of premature death from all causes, a risk that may rival those of smoking, obesity, and physical inactivity.¹
- Social isolation was associated with about a 50% increased risk of dementia.¹
- Poor social relationships (characterized by social isolation or loneliness) was associated with a 29% increased risk of heart disease and a 32% increased risk of stroke.¹
- Loneliness was associated with higher rates of depression, anxiety, and suicide.
- Loneliness among heart failure patients was associated with a nearly 4 times increased risk of death, 68% increased risk of hospitalization, and 57% increased risk of emergency department visits.

In China, about one-third of older adults feel lonely (Luo and Waite, 2014). Loneliness increases the risk of dementia, depression, and mortality risk among the Chinese elderly (Luo and Waite, 2014; Zhou et al., 2018; Bao et al., 2021). Many empirical studies have shown that social isolation and loneliness are closely related (Alcaraz et al., 2019). In the past decades, aging and social transition have been taking place simultaneously in China, which makes a large number of the elderly in China face unprecedented social isolation. In 2020, China has more than 264 million people aged 65 and above, accounting for 18.70% of the total population (National Bureau of Statistics, 2020). Simultaneously, urbanization has accelerated the miniaturization of families, by 2020, the proportion of the elderly living alone and with their spouses reached 21.38 and 23.45%, respectively, (Xu et al., 2014; National Bureau of Statistics, 2020). Unlike western countries, Chinese culture is rooted in Confucian values, Chinese older adults are highly dependent on family members, especially on their children (Zheng and Chen, 2020), thus these changes may result in reduced social contact for older adults (Luo and Waite, 2014). Coupled with the fact that social networks of the elderly are intrinsically more likely to be in a reduced state due to stressful events may experience in old age, such as widowhood, retirement, and so on (Bao et al., 2021), aging people in China are at high risk of social isolation. It is worth exploring whether the increased social isolation of the elderly in China has also led to more loneliness.

In Malaysia nearly onethird of older adults reported a lot of loneliness (Momtaz, et al. 2012). "However, rapid social change, including changes in employment, and the time pressures and travel distances have changed the pattern of many people's daily life" (Adriani, et al.2018). "As a result, loneliness is an increasing problem for all age groups, and it is a source of stress that a majority of Indonesians are unequipped to deal with" (Momtaz, et al. 2012, Adriani, et al.2018). The prevalence of loneliness was highest in the age groups 15–24 years, followed

by the oldest old (80 years or more) and the 70–74 years age group, while the lowest feelings of loneliness were reported among the 75–70 year-olds and the 55–59 year-olds.

Methods

Participants and Procedure

We conducted mini research based on elderly population in two nursing home Yogyakarta on January 2023. Those are our inclusion criteria like > 60 years old woman and man, independent Activity Daily Living (ADL) until mild dependency, and mild cognitive impairment. Elderly whom moderate until severe cognitive impairment, visual and hearing disturbances, patients at ward, and mentally disorder are our exclusion criteria. We also conduct informed consent to all participants before we took our data and some interviews, that informed consent consist of research aim and objectives. After we took some interviews, we readback the results in front of respondents.

Measures

The older adults responded to structured questionnaire items to bring out personal information on selected demographic characteristics of chronological age, gender, marital status, academic level, and their job before. Single scores on the selected demographic characteristic for each participant were processed and computed into groups of descriptive statistical data. The group data was used to find out how each of selected demographic characteristic effect loneliness among older adults.

Level of loneliness was measured as UCLA Loneliness Scale developed by psychologist Daniel Russell (1966), the UCLA Loneliness Scale (Version 3) is a 20 item measure that assesses how often a person feels disconnected from others. Using a 4 point rating scale (1=never; 4 = always), participants answer 20 questions, such as “How often do you feel left out?” and “How often do you feel part of group of friends?” Researchers later reverse-code the positively worded items so that high values mean more loneliness, and then calculate a score for each respondent by averaging their ratings. Study show that people who have high scores on the UCLA Loneliness Scale tend to have trouble in other areas related to social mobility. For instance, people with higher loneliness scores have worse friendships and romantic relationships than do people with lower scores (Russell et al, 1994). Other studies suggest that poor relationship can be both a cause and effect of poverty (Conger, Conger & Martin, 2010).

Results

Descriptive Analyses : We got 38 respondents , the majority of older adults were in the young old (65-74 years old) (53%; n= 19), middle old (75-84 years old) (33%; n =12) and older old (> 85 years old) (14%; n =7) , female (61%; n = 22) and male (39% ; n = 16). About 33%; n= 12 elementary school ; and none of the participants had attained university level of education. On employment status 30% ; n = 11 was private sector employee and half 30% n = 11 respondents were not employed. Based on UCLA Loneliness scale, 92%; n= 35 was low, and only 3% ;n = 1 was high.

Discussion

The present study examined the effect of selected demographic characteristics on loneliness level among older adults. The demographic characteristics of age, sex, status employment, level of education show significant influence of level loneliness among older adults. Previous study showed that aging itself increased risk for loneliness and social isolation because they are more likely to face factors such as living alone, the loss of family or friends, chronic illness, and hearing loss. Facilities for older people in nursing home is adequate; the older people get clean clothes, beds, and health food. Nursing homes are facilities for older people who need care, the primary goal of an institution for older people should be to maintain interest in life, not just maintaining life (Kimondo, 2012). Several residents expected that living in the nursing home would be the last journey of reviews their life, so they were willing to discuss reviews their deaths, such as symptom management, emotional, psychological, and spiritual support, and counseling services, especially with reviews their significant others (Ch-uang et al, 2015). On the other hand, many residents told that they felt they were cared for, but that at the same time the standard of reviews their care would have been even better if there had been more nursing personnel (Slettebø, 2008). Kimondo (2012) research shows that residents in nursing homes can establish a feeling of being at home with support from staff and relatives. Another research said that some residents wanted more support and opportunity for religion to be part of reviews their lives and need to engage in meaningful interpersonal reviews their social interactions with families and friends or with other residents in nursing home (Chuang et al, 2015).

Conclusions

Loneliness is one of social problem in elderly, that have to evaluate and the level of solitude at Yogyakarta nursing home was low.

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***Matchmaking Algorithm as a Tool to Tackle the Aging-Related Social Network Shrink:
Results and Recommendations From the Transdisciplinary
HannaH Technology Development***

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Abstract

This paper argues for the transdisciplinary conduct in the development of innovations in smart aging solutions based on the research results from the development of a matchmaking algorithm that tackles the aging-related social network shrink. The HannaH research team focused on developing the matchmaking algorithm that would support the exploration of new social contacts in the nearby of the place of residence of a user. The algorithm was designed so it can be used either in the smart speaker or as the smart phone app. The paper presents the research results from the concept development based on the research within end users as well as relevant experts. The series of focus groups, follow-up interviews and the MEESTAR study that focused on the iterative co-creation and the reflections of potential risks of the technology, resulted into three areas of research outcomes that are presented in the paper: (1) general concepts and looks, (2) data safety and research architecture and (3) ethical principles and legal processes. Further, we demonstrate how the smart aging solutions development and implementation can be effectively empowered by the transdisciplinary conduct. We show how personal assistance supports intragenerational ties and local community development, we suggest that providing feedback effectively contributes to participative development and digital competences raise, and we discuss the interrelation of digital safety and economic measures of the innovation development. We conclude with the argumentation for transdisciplinary perspective on compensation of the sensitive ethical aspects of the technology and bring suggestions for respective possible measures.

Keywords: Aging, Iterative Co-creation, Matchmaking Algorithm, MEESTAR, Social Network Shrink, Transdisciplinarity

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Introduction

The Institute for Applied Research on Aging at Carinthia University of Applied Sciences (IARA, CUAS) develops transdisciplinary solutions for active assisted living, with a special focus on aging and regional structural context (IARA, 2023; Oberzaucher et al., 2021). We specialize on life situation of older people, technical support and possibilities of aging, as well as the economic and demographic conditions of aging. Our mission is to achieve and utilize scientific findings about aging society, and to improve the social, health and economic situation of older people. We do this in a transdisciplinary manner; that means that we combine the focus on demographic change and regional development, socio-technological innovations and the social inclusion and participation until old age. In this paper we demonstrate how we proceed in a transdisciplinary manner on the case of the HannaH project in the stage of an innovation development and bring results on three levels (general concepts and looks, data safety and research architecture and ethical principles and legal processes).

The Development of the Matchmaking Algorithm HannaH

The project Hannah, a small collaborative innovation development project that place in 2022 with the support of the Active Assisted Living funding (AAL) and the consortium consisted of Norwegian, Dutch and Austrian partners. The business partner and the consortium coordinator was the research and the development company SPRIGS from the Netherlands (SPRIGS, 2023), on the user side there was the Dutch Senior Association (NOF, 2023) and the municipality of Raelingen in Norway (Raelingen commune, 2023), and the research part was taken by IARA, CUAS (IARA, 2023).

The problem that HannaH project focused on can be demonstrated by a short quotation of a senior person: “It became so silent around me.” According to the research, the social networks tend to shrink during aging in terms of size, diversity and frequency of social contacts, whereby the circle of friends tend to be reduced more significantly than family ties. (Wrzus et al. 2013). The existent research shows that the peak of the social network development in the human life is situated between mid-twenties and early thirties. Afterwards, it tends to slowly but surely drop and it significantly drops in the senior age, whereas this trend tends to appear more on the friendship dimension of the social networking than on the family side. The average size of the friends network of people over 55 years is then between four and five friends.

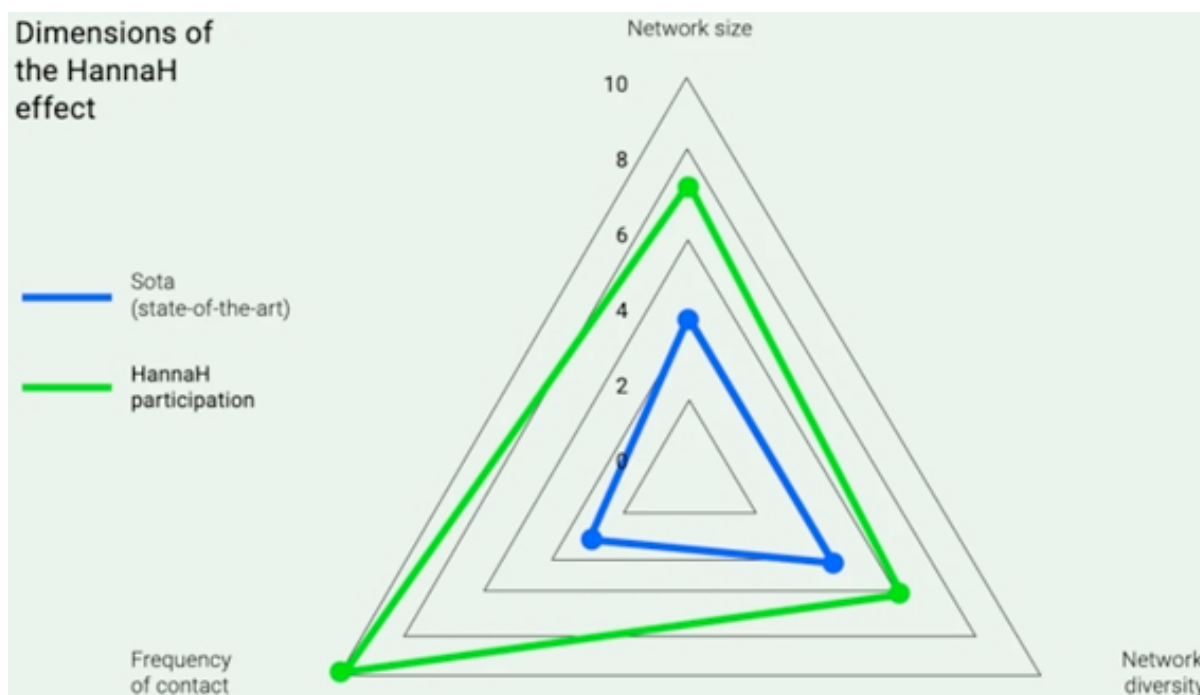


Figure 1: Social network shrink. Resource: HannaH project

We focused on the social network shrink on all three dimensions: size, the frequency of the social contacts, and the diversity. The idea is that user would be prompted to trying new social contacts on more basic level and gives themselves new opportunities to develop new social relationships with people they do not know from previous life, despite relatively limited mobility and diversity of social contacts in comparison to previous life stages.

The HannaH technology tackles shrinking of a social network in a following way: After the introduction, basic schooling and installation, the matchmaking algorithm, either in the smart speaker or as the smart phone app, invites user to make short contact with somebody they do not know, but may share the interests with via short audio incentive. Based on the approval in the form of short conversation the algorithm picks someone from shared database and suggests the other person short conversation with someone new. All users input basic data into the HannaH database by themselves, so the algorithm has a reservoir of interests and other relevant data to search through. The suggestion for new social contact would be formulated in the short sentence like “Would you like to chat with somebody?” Shall both, first and the second user reply positively, HannaH organizes online chat session through audio speaker between the two of them. Of course, if those two users enjoy the chat, they may chat again on their own initiative, or even at some point also meet each other and develop their social contact into the more complex relationship that is no longer dependent on HannaH facilitation. On the contrary, in case any of the users wishes to withdraw from the contact during the audio-facilitated matchmaking, HannaH should navigate them into the smooth and easy withdrawal. During our research, the HannaH technology was explained to the end users and experts with the help of short comic showing how the matchmaking algorithm (incorporated into the smart speaker) may facilitate the social network expansion.

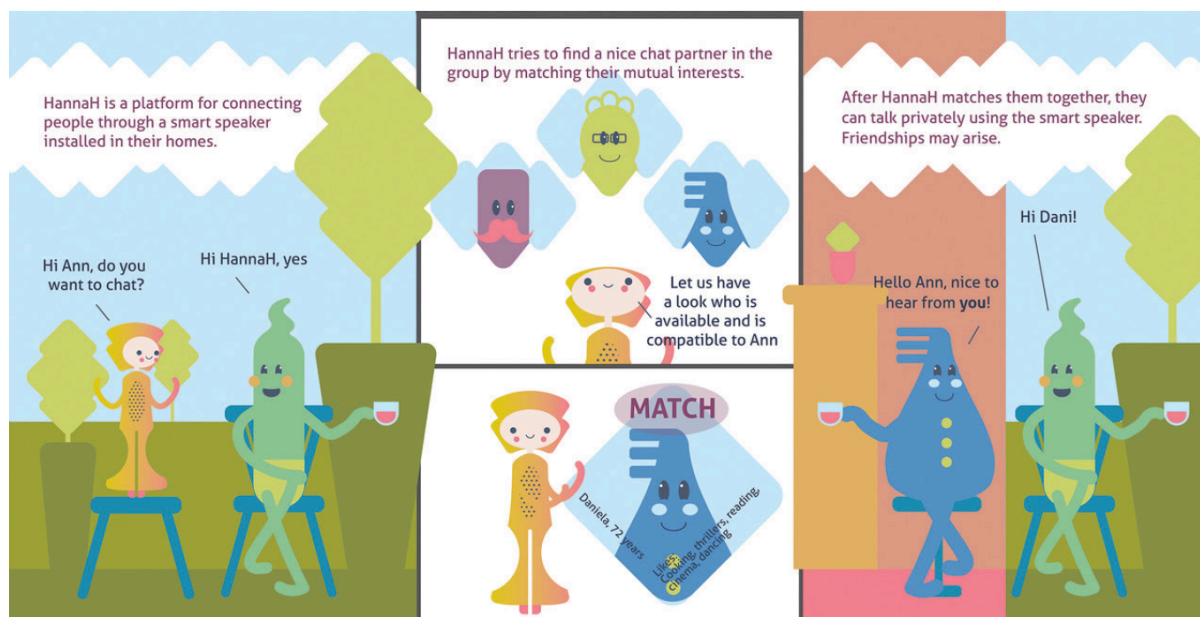


Figure 2: Comic approaching HannaH technology to end users. Resource: HannaH project

Methodology

Our research task at IARA was to contribute to the development of concept of HannaH by the iterative co-creation of the matchmaking algorithm. We focused on the formulations of the end users needs and the reflections of the potential risks of the technology. This entire research design was focused on developing on the first stage of the aging innovations development. That means we focused on the idea and the concept development, not the implementation and the evaluation, or productization and anchoring.

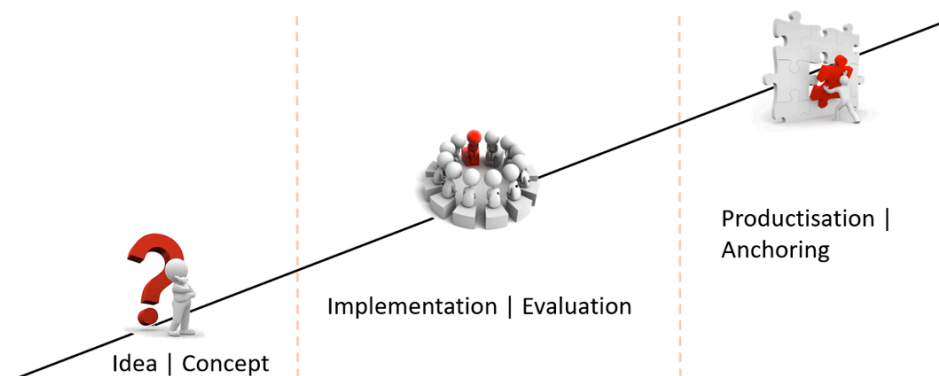


Figure 3: Smart aging – filling the innovation gaps. Resource: Oberzaucher, 2023

The research design was the following: On the side of primary and end users (that means seniors), we conducted several focus groups in all the participating countries, together with 33 participants, and individual follow-up interviews with 12 people from Netherlands and Austria. On the side of experts, we spoke with experts from active assisted living, care, and other interdisciplinary experts in the later stage of the research. First we conducted a set of focus groups together with five experts from care and active assisted living and finally we conducted the MEESTAR study (Menzeschke et al. 2013), the Model for the Ethical Evaluation of Socio-Technical ARrangements. All together, we spoke with 7 people with the

following fields of expertise: user design and software development, information technology, industrial engineering, disability and diversity studies, psychology, applied social sciences and sociology. With our study we answered the following research question: **What are the user needs and the potential risks of the matchmaking algorithm that is supposed to tackle the social network shrink in an older age?** The research results can be clustered in three topics. One is the general concept and looks of HannaH, second is the architecture and data safety of HannaH, and the third is the ethical principles and the legal processes, while developing and introducing HannaH into the market and society.

Research Results I. General Concepts and Looks of HannaH

Looking at general concepts and looks of HannaH; both, end users and experts agreed on the importance of personal assistance of the matchmaking algorithm implementation. Both groups said that it is really important, that the entire philosophy, how to use it, and also the selection of well-fitting potential participants should be communicated in a face to face dialogue. We assumed that this suggestion has great potential for the local community participation and that this can also strengthen the intergenerational social ties, for example, by creating a voluntary group in the local community of youngsters that may help the technical support of the technology, and so forth.

An important outcome that came from end users was that HannaH should not be mismatched with a human assistant, and that it should be clear that HannaH is a technology, not human. The need of such emphasis may have been triggered by an outlook of the introductory comic (see Figure 2), as HannaH is in a way humanized there. Research participants emphasized that it should be clear that HannaH is not a human assistant from the very beginning. Further, both groups, end users and experts came with an idea that it would be good either during the usage, or at the point of exiting or entering to give the opportunity to give the feedback to the developers and then the algorithm can be developed further. Experts also suggested that it would be good if there is a support hotline in case technical issues appear while using HannaH.

Especially experts pinpointed at the importance of the critical mass of users that should be in the reservoir of contact at the point of introducing HannaH, because in their perspective this raises the possibility of quick and suitable matches; and the experts agreed that if the algorithm would not quickly give well-fitting match then the user will not be motivated to use it further. So the critical mass of users from the very beginning resonated as an important point when it comes to general concept of the developed algorithm. In association to this point, the experts also emphasized that the trust and meaningfulness of using HannaH has to be built very fast and that there are social media platforms, concurring applications, and software, so somehow the end users have to be motivated to use HannaH; and this goes back to the first point of general concept and looks results, since the motivation to continuously use HannaH may be supported by the cooperation with local authorities, be it care workers, the network of volunteers or civic associations.

Research Results II. Architecture and Data Safety of HannaH

Both, end users and experts delivered valuable inputs regarding the architecture of the matchmaking algorithm safety and its data security. In terms of HannaH form, the suggestion was given that it would probably be the best, if HannaH is both stationary and portable, because then the matchmaking algorithm would be able to meet the diversity in the mobility

conditions and habits of end users, and that it could also be flexible and follow one primary user's mobility habits diversity, so it can be used both at home and on the way by one primary user. Another valuable input was that no matter if HannaH is in the smart speaker or as the smart phone app, it should have incorporated very transparent on-off button, in order to secure privacy and to ensure users that they are not constantly being listened to.

Something, that was definitely not welcomed by the research participants, was the possibility of automated detection of emotions by HannaH. The idea behind this suggestion was, that the automated detection of emotions may ease the user to withdraw from discomforting interaction, or strengthen tackling the loneliness, if HannaH indicates that a person feels lonely and suggests new interaction. But, all sorts of possible automated detection of emotions were simply not evaluated positively and considered desirable.

Regarding the data storage and sharing, the suggestion was that this service should be independent, it should not be served by any third part, so there is no data sharing issue with any third party, like external company. Similarly, regarding the data storage, the suggestion was that data should be stored as locally as possible for similar reasons.

There was suggestion that the data sharing setting could be flexible, so some users can share only the minimal amount of data and then later if they trust the system more or from the beginning if they feel like it, they can choose to share more data in a more complex way, because this could give them better fitting matchmaking services. Such flexibility of data sharing setting could support developing trust to the system and the user comfort.

Regarding the discussion of cost for services, the debate was quite diverse, but more participants were at the end of the day in favour of public funding and free of charge of service of HannaH. Finally, the research brought idea that HannaH could have and added function as emergency alarm and this could also be considered an added value of the technology.

Research Results III. Ethical Principles and Legal Processes

Last but not least, we discussed the ethical principles and the legal processes with the research participants. During the interdisciplinary expert discussion according to the MEESTAR study (Menzeschke et al. 2013), the high ethic risks were pinpointed in the dimensions of care, safety, justice and privacy. And average risks were defined in the dimensions of autonomy, participation and self-conception. Overall, the HannaH technology was evaluated as ethically sensitive, but in a way that can be compensated for.

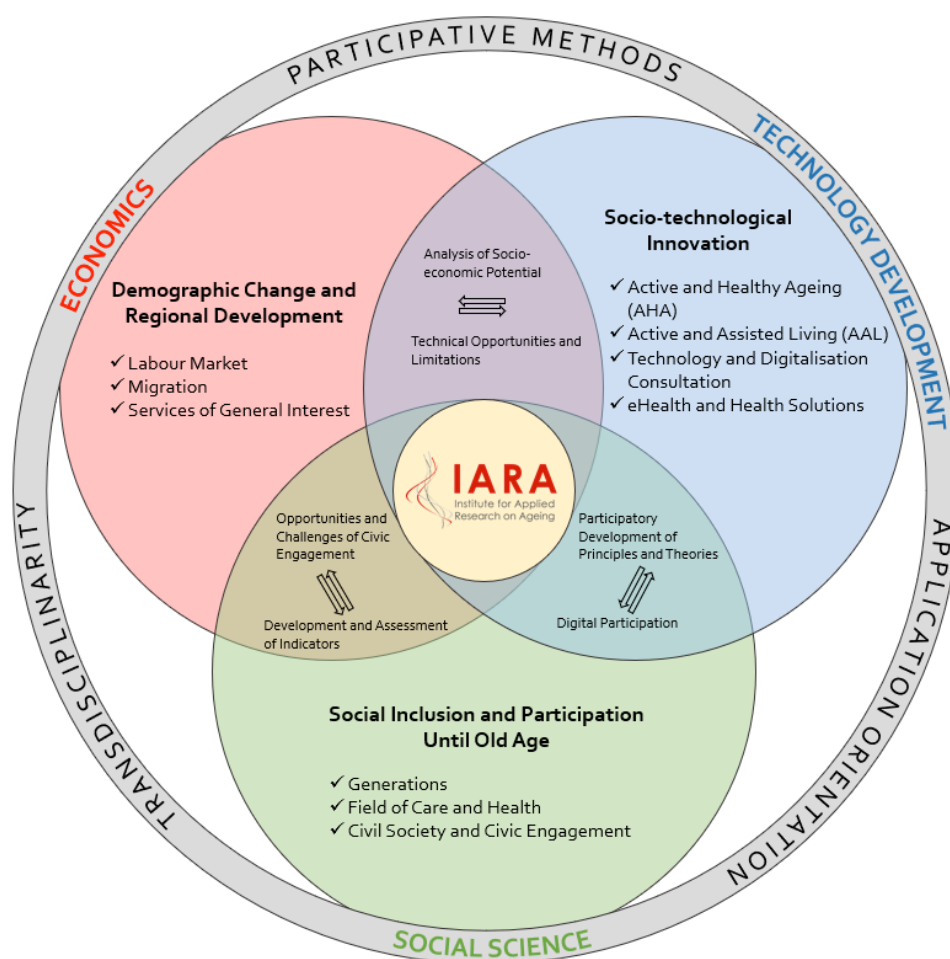
During the MEESTAR study debate, the experts concluded that support in stress resilience and self-control skills would be highly recommended and this would be a great preventive measure while introducing HannaH. That means, that some of the risks or ethically sensitive issues that may come with the technology, would be resolved with supporting human skills of dealing with loneliness, stressing communication, pressure on decision if I am, as a user, going to proceed with slowly developed new friendship or not. The experts also strongly recommended to introduce some technical support of the system abuse prevention. For example, for commercial purposes of third parties and so forth.

We also discussed the issue of intercultural friendships, multicultural societies that are aging, and the experts concluded that perhaps it would be a good preventive measure if the

matchmaking algorithm does not address cultural differences during the matchmaking at all. There was also one critical topic of tackling loneliness, featuring technological support of such process; the experts agreed that there is a slight jeopardy of substituting the outgoing routine with audio home-to-home contacts through the speaker or application, so that here also the support of local community services may be a good prevention of such an unfortunate development, so the technology does not at the end of the day support loneliness, not tackle it.

The Potential of the Transdisciplinary Conduct

We would like to conclude with showing how we treat transdisciplinarity and transdisciplinary approach in our Institute for Applied Research on Aging, based on the data from the HannaH research. Smart aging solutions can be effectively empowered by the transdisciplinary conduct. Transdisciplinarity is not just combining different forms of knowledge, it is as a matter of fact creating new forms of not only knowledge, but also solutions.



Resource: IARA

Figure 4: The transdisciplinary approach of IARA

In order to demonstrate it, let us get back to some of the concluding remarks from HannaH research outcomes, and discuss the transdisciplinary approach to them, in terms of further development of the technology, or any other research and development in the field of smart aging.

In the general concept and looks of the HannaH technology, there was stated the importance of personal assistance of matchmaking algorithm in implementation. This would have potential for local community participation and for the strengthening the intergenerational social ties with local community, care providers or teenage participants who would voluntarily give technical support to end users. That means, that personal assistance in implementing the matchmaking algorithm would present not only the opportunity to develop local civic engagement, but it could also present an economic input for local economies to blossom.

The second exemplary outcome that demonstrates well the transdisciplinary approach is the suggestion to incorporate the possibility of providing the feedback by end users in order to continue in development of an algorithm. This not only helps the technology development, but it also supports development of the digital competences and participative approaches in the research and development. This means that such measure can also support closing the digital gap in a society where HannaH would be introduced.

Sometimes the transdisciplinary approach uncovers the dilemmas that need to be resolved. This can be demonstrated on an example from the research outcomes on architecture, safety and data security. The suggestion that the data should be stored as locally as possible, de facto raises the costs of the technology if we consider contemporary European economic framework. So to an extent, this conflicts with the suggestion, that the service should be free of charge. The technological solutions that are being developed in the aging research, should be parallelly piloted economically, we need to think if and how can public financing support the solution, how low threshold it can be in terms of accessibility of end users, etc. Such discussions and simulations should be piloted well before the productization phase and this can in terms of impact help developing smart aging solutions with more significant social impact.

Conclusion

Based on the research results examples given above, we can conclude that the transdisciplinary conduct in the aging research brings more opportunities than challenges. The statement from the HannaH MEESTAR study was that this technology is ethically sensitive, but in a way that it can be compensated for. Once a research team introduces transdisciplinary perspective on research topics, it also widens the reservoir of the solutions and shortage compensations in more than one disciplinary field.

For example, when we were talking about the technological support of HannaH with experts, and the fact that it may bring people into dilemmas, how to deal with being overwhelmed with too many new social contacts, or technical difficulties of handling the device, this could be approached as positive challenge and the introduction of the technology can be combined with the education of being more resilient, more digitally competent, so at the end of the day, the seniors could benefit from introducing new technology, if it is followed by the right social solutions; and if it is economically harmonized with the local and global economical and demographical framework.

In the smart aging, the technology does not only play an assistance role. In the case of HannaH matchmaking algorithm, it brings added value in terms of neutrality of service given and supporting user's autonomy by providing matchmaking exclusively according to the inputs that user inserts to it. The user should be as much as possible in charge of creating

their own social networks and the matchmaking algorithm is supposed to operate with sensitive approach, not engaging them into unwanted contacts. Thus, HannaH operates in a decently personalized manner, while supporting and empowering user's autonomy. Such outcome could be formulated thanks to the transdisciplinary approach, that IARA team introduced while developing the HannaH matchmaking algorithm.

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***Implementation of ‘My Guardian Angel’ – A Smart Wearable Device –
in a Sheltered Home in Singapore***

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Abstract

Singapore is one of the fastest ageing countries in the world, with the proportion of citizens aged 65 and above increasing from about 11% in 2012 to an estimated 25% by 2030. To tackle this ‘silver tsunami’, the 2023 Action Plan for Successful Ageing aims to empower older persons to lead healthy lives while ageing-in-place. As falls are a leading cause of injury-related hospitalisation, this is a major concern in Singapore. This paper will describe the implementation of ‘My Guardian Angel’ (MGA) – a smart wearable device – in a Singaporean Sheltered Home (SH) for ambulant older persons. The device is novel in that it not only uses wearable sensors to detect and respond expediently to falls, but also encompasses other features which seek to improve the quality of life of older persons living in the SH. The features of the MGA include: (a) ‘Mealtime Attendance Taking’ that alerts staff if residents miss a meal; (b) ‘Laundry Management System’ where laundered clothes are tagged and tracked; (c) ‘Access Control System’ that serves as an ‘pass’ to residents’ rooms and enhances their privacy; and (d) ‘Fall Detection System’ in which falls detected by the MGA would push the location of the fall to a staff’s tablet who is then able to respond immediately. The paper will provide an overview of the MGA, and offer insights into the benefits, challenges as well as feasibility of implementing its components in an institutionalised setting for older persons in Singapore.

Keywords: Gerontology, Healthy Ageing, Health Technology, Institutionalized Living, Quality of Life

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1. Introduction

Singapore is one of the fastest ageing countries in the world. The proportion of Singapore citizens aged 65 and above had increased from 11.1% in 2012 to 18.4% in 2022, and will rise to almost 25% by 2030 (National Population and Talent Division et al., 2022). To tackle this ‘silver tsunami,’ the government launched the 2023 Action Plan for Successful Ageing to address these issues, which aimed to strengthen support networks and to empower older persons to lead healthy lives while ageing-in-place (Ministry of Health, 2023).

Older adults who are physically active are less likely to experience falls and fall-related injuries (Lee et al., 2022), and improve the probability of maintaining physical, mental and social health as well as enabling healthy ageing (World Health Organization, 2018). However, one in three community-dwelling older persons aged 65 years and above will still be expected to have at least one fall within a year (Ang et al., 2020), and falls are a leading cause of injury-related hospitalisation among this population in Singapore (Health Promotion Board, 2015).

1.1 St. John’s Home for Elderly Persons

In the Singapore context, Sheltered Homes (SHs) provide accommodation to older persons who are Activity of Daily Living (ADL)-independent (i.e. are able to move about and care for themselves on their own), but who do not have family members or caregivers to look after them (Agency for Integrated Care, n.d.). ADL-independent is measured by the Resident Assessment Form (RAF) which assesses the functional status of residents on nine indicators with a scoring system rating them from one to four (Lim & Ng, 2015). For SHs, a resident needs to obtain a score of 15 and below (i.e. Category 2) to be eligible for admission.

St. John's Home for Elderly Persons (SJH) was established in 1958 and is an SH for ambulant older persons aged 60 and over; it is also a registered charity in Singapore. SJH used to be located in an old converted military barrack which occupied a single-storey over a large piece of land. SJH moved into a new, modern, award-winning¹ five-storey building in 2021, whose design sought to maximise cross-ventilation of rooms, important in a hot and humid tropical country such as Singapore, so as to enhance the comfort of residents.

The new building increased SJH’s capacity from 86 to 144 residents, and incorporated elderly-friendly design features, such as slip-free tiles, wider corridors and doorways, and larger bathrooms to accommodate wheelchairs. The improved facilities of SJH also included an open-plan physiotherapy space with state-of-the-art equipment, a hydrotherapy pool, as well as a roof-top garden for communal gardening and living.

1.2 ‘My Guardian Angel’

One of the thrusts to improve the quality of life of SJH residents is to leverage on technology for optimum healthcare, and the introduction of ‘My Guardian Angel’ is a giant leap in that direction.

¹ The SJH building design won an award at the Asia Pacific Property Awards 2021-2022, and was shortlisted for the World Architecture Festival 2018 Health – Future Project award.

‘My Guardian Angel’ (MGA) – a wearable device – was funded by the Techbooster Fund of National Council of Social Services (NCSS) in Singapore. The MGA utilizes a sensor monitoring and analytics programme in addition to Bluetooth technology to provide safer and more efficient care for residents vis-à-vis traditional methods of reactive care and routine checks. It monitors a resident’s ADL and proactively alerts staff for anomalies that indicate an intervention is required.

One of the main features of MGA is its fall detection capability. Older persons who have experienced falls or near falls can develop a fear of falling, which may lead them to reduce their activities, thereby negatively impacting their quality of life (Ang et al., 2020). A fall detection type device, such as the MGA, monitors for falls and sends help to minimize the consequences of falls (Usmani et al., 2021).

At SJH, if a resident falls (e.g. in the bathroom), the fall is detected by the MGA they are wearing and the location of the fall will be pushed to the staff’s tablet who is then able to respond immediately. There is also an emergency call button on the MGA for the resident to activate manually should the need arise.

The MGA is also able to detect other anomalies. For example, the failure to maintain personal hygiene or adhere to daily routines may be an indication of self-neglect (Day et al., 2017). Hence, the MGA will alert staff if residents do not attend a meal (i.e. ‘Mealtime Attendance Taking’) or had not sent their clothes to be laundered after a period of time (i.e. ‘Laundry Management System’). Another feature is the ‘real time location system’ which includes virtual geofencing that is able to detect when a resident ventures into an unsafe location, or enters a restricted area during a certain time period (e.g. at night when visibility is poor).

Last, the MGA also serves as an ‘access card’ to residents’ rooms (i.e. ‘Access Control System’), which enhances their privacy as access to their rooms is restricted to only those authorized to enter. The MGA was originally available in two forms – as a ‘watch’ to be worn on one’s wrist, or as a ‘necklace’ that is hung around one’s neck.

Figure 1: MGA worn on a resident’s ‘wrist’



1.2.1 Purpose

The purpose of this study was to examine the challenges and benefits of implementing the ‘My Guardian Angel’ intervention at a Sheltered Home for ambulant older persons in Singapore, as well as to assess the feasibility of such an initiative. The study also aimed to provide practical next steps to improve the implementation of the MGA, as well as to provide

other organisations that are implementing similar technologies with helpful information to avoid the issues and challenges faced in the implementation of MGA. Three central questions guided this study:

- a. What challenges did staff of SJH face in the implementation of MGA?
- b. What benefits did the implementation of MGA bring to the residents (and staff) of SJH?
- c. How feasible is the MGA in detecting falls experienced by SJH residents?

2. Methodology

This research adopted an exploratory case study design which sought to better understand the implementation of the ‘My Guardian Angel’ intervention at St John’s Home for Elderly Persons. Specifically, the research sought to review information pertaining to the challenges and benefits of the MGA, as well as its perceived impact in improving the quality of residents’ lives.

Although a case study design tends to be qualitative in nature, it could also measure or review quantitative data (Privitera, 2022). Hence, this research adopted a convergent mixed methods approach where “the researcher converges or merges quantitative and qualitative data...at roughly the same time and then integrates the information in the interpretation of the overall results” (Creswell & Creswell, 2018, p. 15).

The research involved a review of existing documents that recorded incidents of falls by residents at SJH. The researcher extracted quantitative data that were assessed to be relevant, for example, the number of falls per month, the number of residents who fell in the same month (to account for repeated falls by the same resident), as well as the number of “unwitnessed falls.”

The qualitative documentation of fall incidents also allowed the researcher to observe the “language and words” of staff in an unobtrusive manner (Creswell & Creswell, 2018, p. 188), and also provided ‘curiosities’ that were further explored during the follow-up informal interviews with staff.

The research would provide an account of SJH and the MGA followed by the analysis of data that led to the themes and issues surfaced. To improve trustworthiness and credibility, the data collected from the various sources were used to triangulate and build a “coherent justification” of the findings presented in this paper (Creswell & Creswell, 2018, p. 200).

3. Findings

3.1 ‘Access Control System’

The ‘Access Control System’ is another simple and helpful feature that benefitted both staff and residents. In the past, residents were free to move between rooms even though they were not its occupants. Moreover, there was no means to restrict their movements to certain areas unless it was physically locked.

Now, residents wearing the MGA device would be able to access their rooms without the need to carry an additional item like a fob or card. This also enhances their privacy as access to their rooms would only be permitted to those who stay there. The geo-fencing feature also

means that access to certain areas such as the rooftop garden can be limited at specified times such as at night where visibility is low and fall risks increases.

A learning point related to the implementation of the ‘Access Control System’ was on the sensitivity of the MGA device which impacts the time taken for the door to the rooms to be opened. To elaborate on this, the system involves an independent contractor / vendor who authenticates the identity of the ‘user’ before granting access to the facility such as the room. Hence, the time taken for the system to grant access to the resident may take an inordinate amount of time that is perceived as “taking too long”. However, the calibration of sensitivity also has an impact on other areas such as the battery life of the MGA.

3.2 ‘Mealtime Attendance Tracking’

The ‘Mealtime Attendance Tracking’ was a simple yet helpful feature that benefitted both staff and residents. In the past, this was not feasible as staff could not take the attendance of staff manually; they would rely on either their observations of residents or reports from residents’ fellow roommates.

Now, their attendance is automatically logged in the system when residents who are wearing their MGA devices collect their meals at the cafeteria. An alert is sent to staff when a resident fails to show up for their meal within the pre-set duration. One interviewee recounted an incident where a resident had not shown up for breakfast, and a staff member was alerted to this. Upon arriving at the resident’s room to check on them, the staff found them with an abnormally low heart rate which required immediate medical attention – this allowed them to intervene and preserve the resident’s life.

A learning point related to the implementation of the ‘Mealtime attendance tracking’ was the duration for the meal set into the system. Previously, a longer duration was set in the system which triggered the alert only at the end of the mealtime. However, this caused issues when the cafeteria had closed and food was no longer available after the staff had checked on the resident and they came down to consume their meal.

Moreover, the intention was for staff to check on residents who may be in distress or require help (as evident in the anecdote above). Hence, the Home experimented with different meal timings, and eventually settled for a shorter but reasonable time frame for the trigger to be set. This new mealtime duration balanced the flexibility residents may appreciate in not rushing them to have their meals early, while giving staff sufficient time to check on residents and intervene for those who may require help.

3.3 ‘Laundry Management System’

The ‘Laundry Management System’ was a clear benefit from the implementation of the MGA for both staff and residents. This system involved the residents’ clothes having an RFID tag which allowed for them to be tracked from the time they are deposited at the laundry room, to the point where they were returned to residents. The previous process was entirely manual, and in addition to being laborious, also resulted in missing or misplaced laundry. It was also not possible previously to track which residents had their clothes washed, or the frequency with which they did so.

Despite its success, there were two issues that surfaced during implementation which staff highlighted, although these had been resolved. The first involved the scanner that tracked the residents' laundry – the staff in charge of implementing this recounted that s/he faced numerous challenges in the placement of the scanner as the placement impacted the sensitivity required to accurately detect and log the residents' laundry. There were instances where duplicate logs were captured for the same load of laundry, whereas others lacked sensitivity and required the staff handling the laundry to manually move the load in order for it to be detected and logged. It appeared that this process involved a fair bit of trial and error, although once the ideal position for the scanner was found, no further issues were encountered.

The second issue that surfaced pertained to the RDIF tags that had to be sewn into the residents' clothes for tracking purposes. Although an industrial machine was purchased for this purpose, the RFID tags were dislodged after a few washes and had to be manually hand-sewn onto the residents' clothes. Fortunately, although this was a massive undertaking in the first instance, subsequently this was only required to be done for new residents or residents' who replaced their clothes.

3.4 Decrease in “Unwitnessed Falls”

The decrease in the number of “unwitnessed falls” is one of the key findings in this study. “Unwitnessed falls” are defined broadly by staff as falls that were not witnessed by any party other than the resident who fell, and implies that help could not be immediately rendered or was not reported to SJH staff.

There are generally two scenarios related to “unwitnessed falls” – the first being one in which the resident fell and could not continue, and help could only be rendered when they were discovered by staff or other residents who then provided or activated help. This is illustrated by the following entry in the ‘fall incident log’:

“...the other residents of [room] D6 were all sleeping when [healthcare aide] saw [resident who fell] sitting on the floor during dorm patrol.”

The second scenario were incidents in which the resident fell but was able to continue what they were doing, and did not report the incident. This is illustrated with the following entry into the ‘fall incident log’:

“[Healthcare assistant] noticed [resident's] 4th toe on right foot and left forearm had slight hematoma. Then she asked what happened. The [resident] then said she fell today earlier in the morning inside the bathroom when she showering around 6am, but she didn't inform anybody.” Or

“When I was going to give [resident] her pre-breakfast medication, she told me last night around 2 am she fell down inside the toilet... but she didn't informed me at that time.”

Although the status of the resident in the above quote was stable, there could be situations whereby residents fell, did not report it, and subsequently experienced a deterioration in their condition. The notion of ‘silent fallers’ who do not report their fall or seek medical assistance unless they are injured is not uncommon among older persons (Ang et al., 2020). Hence, the

implementation of the MGA allowed for all falls to be investigated, and for healthcare professionals to make an independent assessment of the fallen resident's condition instead of relying on the residents' self-assessments.

It is noteworthy that the MGA did not eliminate "unwitnessed falls." Interviews with staff to understand these incidents revealed that residents may not have been wearing their MGA when they fell. The research literature has found that wearing a fall detection device all the time can be frustrating or annoying, and the older person may also need to remember to wear the device (Hassan et al., 2023). This is consistent with what was found in this study.

3.5 Feasibility of the 'Fall Detection' Feature of MGA

The 'fall detection' feature of the MGA was the last component to be tested, and had not been fully implemented for all residents as of 15 May 2023. The initial phase of the implementation of this feature commenced in February 2023 with 15 residents who were assessed to be of 'high fall risk'; 12 additional residents joined the trial in March 2023.

3.5.1 False Positives

Staff recalled false positives (i.e., system sent alert for a fall when no fall actually occurred) were a significant issue at the start of implementation (6 Feb 2023), with one staff stating that there were "multiple triggers through the [first] night" of implementation. The sensitivity settings were adjusted which eliminated the false alerts. However, a review of the records revealed that two falls (by the same resident) were not detected on 19 and 22 February. The sensitivity settings were refined further and the system had stabilised and though there are occasional false positives, usually due to mechanical issues, the staff interviewed no longer cited this as a pressing issue.

Records also indicated that there were issues with some devices which led to false positives. For example, one resident had nine incidents of false positives (falls) over a six day period and is likely indicative of a mechanical fault. As of July 2023, false positives had been minimized to about 2 occurrences a week.

3.6 Issues Impacting Feasibility of MGA

3.6.1 Trade-Off Between Battery Life and Sensitivity (of Features of MGA)

One of the key issues identified in this study pertained to the battery life of the MGA, and ultimately its impact on the feasibility and sustainability of this initiative. Battery power issues or 'battery life' had been highlighted in the literature as one of the challenges that pervade wearable technologies that support independent living among older persons (Baig et al., 2019; Gettel et al., 2021).

Similarly for the MGA, which utilized non-rechargeable (disposable) batteries, the actual shelf life of the battery varied considerably from the estimate provided by the manufacturer of the MGA – from the two years stated in the contract, to two weeks at one point when the settings on the MGA were tuned to significantly increase its sensitivity. At the time of writing, the average battery lifespan was about three months.

The reasons provided by staff involved in the implementation revolved around the initial estimate being premised on the “minimum” settings being set in the MGA. However, during implementation, this was assessed to be insufficient and had to be increased. For example, at the start, the sensitivity of the ‘Access Control System’ was insufficient to detect the residents’ MGA and resulted in delays in the opening of doors or even in the doors not opening. Therefore, the sensitivity of the MGA had to be increased from baseline to ensure residents gain timely access to their rooms.

The trade-off explicit in this and other similar scenarios posed by the MGA is that the increase in sensitivity setting for the MGA results in a decline in its battery life. Staff also discovered an additional impact on the MGA device’s lifespan – when the device was opened for its battery to be changed, the seal that ensured the device was waterproof may not work as well; in some instances, this led to water seepage and damage (Figure 2). All these significantly increased the costs for implementation, and potentially impacts the durability of the MGA device and its long-term feasibility. A second iteration of the wristband is being trialed, and will hopefully increase the durability of the device.

Figure 2: Water seepage (circled) in the MGA ‘watch’



3.6.2 Residents’ Compliance With Wearing MGA

The feasibility of the MGA device, especially in detecting falls, is reliant on residents’ compliance with wearing MGA. However, this research found that some residents may forget to wear the MGA device, especially when they wake up at night and have to use the bathroom. Moreover, there are other residents who may not “see the need” for the MGA device; this has also been found in other research where older persons did not see a need for fall detection devices or were embarrassed by them (Gettel et al., 2021). This usually means that they do not wear the device, and correspondingly does not reap its benefits, and remains the biggest challenge that will need to be overcome for the MGA device to be implemented successfully.

4. Conclusion

The MGA had several clear benefits for the older persons residing at SJH – the Access Control, Mealtime Attendance Taking and Laundry Management Systems appear to improve their Quality of Life such as through enhanced privacy and safety, prompt assistance that is provided when issues are detected and sent to staff, etc.

It appears that part of the reason for its utility lies in the fact that it encompasses several features instead of just being used for one purpose, e.g., fall detection. This means that residents had more reasons to use the MGA device as it would allow them access to their rooms or track their laundry.

One finding was that the long-term sustainability of the MGA device hinged on the ability to balance the sensitivity of settings for the various features of the MGA for them to perform effectively vis-à-vis the battery life span of the MGA device. It appears that these features may need to be calibrated individually when implemented and is not insurmountable.

However, it is acknowledged that the fall detection component is still ‘work-in-progress’ with the potential to further enhance quality of care of residents. As this study found that some residents still do not use the MGA which led to a few occurrences of “unwitnessed falls,” the first recommendation would be to conduct a follow-up study that seeks out the perspective of SJH residents in the use and application of the MGA, specifically exploring the barriers and facilitators of their wearing the MGA.

This could pinpoint factors that lead residents not to use the MGA, and implement tweaks that increase compliance with wearing the MGA while at SJH. Although this was not raised during the study, residents’ perspectives could also be sought on any feedback they may have on the MGA, including any privacy concerns they may have.

Although the focus of this study is the implementation of the MGA at SJH, the ultimate goal is for it to have a positive impact on the quality of life (QOL) of residents at SJH. Future studies can incorporate measures to ascertain the impact in this domain.

In conclusion, the key features of the MGA device appear to contribute towards improving the quality of care received by residents of the Home. This is congruent with other research which found that despite challenges faced, the general consensus was that such devices enhanced the independence of older persons using such devices (Gettel et al., 2021).

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Cost-Benefit Considerations of Post-clinical Telerehabilitation for Stroke Patients

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Abstract

The REHA2030-project aimed to implement telerehabilitation for stroke patients to be able to train at home. It included a robotic therapy device and support from therapists via the internet. The system was designed and installed on tablet computers for patients and therapists. Based on the field test a cost-benefit consideration was carried out to evaluate economic effects. After the identification of relevant cost and benefit parameters for telerehabilitation, data was collected and analyzed prior and after the field test. The focus was on the perspectives of patients, therapists, and relatives as well as the overall economic benefit. The main findings are: (1) Regarding the benefits, two out of three patients were very satisfied with their therapy; for therapists, the time needed for preparation was reduced; and for relatives, no transport services (and costs) were needed. (2) Cost savings per therapy amounted to 21.62 EUR per patient compared to conventional therapy. (3) Moreover, ten minutes more training time was reached compared to conventional therapy, which can be traced back to the increased level of motivation of the patients. It is critical to note that the costs can vary due to different conditions, e.g. many people already have a tablet and so costs might be lower. The generalizability of the results is limited by the small sample size (three patients and seven therapists), whereby the results have shown that this format encourages patients to exercise, which underlines results from other studies.

Keywords: Telemedicine, Cost-Benefit Considerations, Telerehabilitation, Stroke-Patients

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Introduction and Aim of the Study

“Move the information, not the patient” (Jankowski et al., 2015, p. 118)

Stroke is a leading cause of disability worldwide and often people are affected, who are middle-aged or of working age. Telemedicine applications are known so far in the area of acute stroke care, but also in the fields of various therapies for stroke patients or their post-inpatient care; often speech therapy is cited (cf. Audebert et al., 2009; Bellomo et al., 2020; Mörsdorf & Beushausen, 2021).

The REHA2030-project was an interregional project in cooperation with partners from Slovenia and Austria, with the aim to provide telerehabilitation for stroke patients. Telerehabilitation should support the patients in their homes; they should be treated or get adequate therapy after the stroke in their homes, which is especially for people living in rural areas of interest. After the development of the technical solution (with a focus on a user-friendly device and the development of a robotic device for telemedicine), a field trial was carried out. Moreover, a service model for telerehabilitation was developed and a cost-benefit analysis was conducted (cf. Krainer et al., 2022). Within this paper, the results of the cost-benefit consideration are introduced and discussed. After the results of the literature review the methodology follows. Afterwards, we present and discuss the results of the analysis.

State of Research

The literature review led to several studies on telerehabilitation for stroke patients, with a positive effect on the motivation for training, a high level of commitment, especially due to the use of the technical device, as well as higher compliance compared to the intervention group (cf. Choi & Paik, 2018; Cramer et al., 2019; Dodakian et al., 2017). Improvements in the motoric functions of the upper limbs were outcomes (measured with standardized tests) and in some cases, the grip strength improved (cf. Burdea et al., 2020; Chen et al., 2020; Choi & Paik, 2018; Dodakian et al., 2017; Keidel et al., 2017; Rozevink, 2021). Alongside physical training, telerehabilitation showed improvements in cognition, a reduction of stress or depression and the acceptance of the technology (cf. Burdea et al., 2020; Maddahi et al., 2021). Besides the positive results also some criticism is stated, such as a very small sample size or the limited therapy period (cf. Choi & Paik, 2018; Qiu et al., 2020; Rozevink, 2021). In addition, technical problems were stated as negative aspects (cf. Burdea et al., 2020).

Regarding cost-benefit considerations on teletherapy, hardly any study contains detailed information of cost-efficiency. Kidholm et al. (2016) calculated the costs for telerehabilitation for patients with heart diseases in a randomized controlled study. With the result of higher costs for the teleintervention, mainly due to higher costs for equipment (5,709 EUR for teletherapy versus 4,045 EUR for the control group, cf. Kidholm et al., 2016). Contrarily, Llorens et al. (2014) calculated the telerehabilitation in comparison to hospital costs for people after a stroke and calculated 835.61 US\$ per patient for telerehabilitation and 1,490.23 US\$ for in-clinic rehabilitation. Hence, it was of great interest to carry out a cost-benefit analysis for the field trail of the REHA2030-study.

Methodological Approach

From a methodological point of view, the field test was evaluated with a cost-benefit consideration. Based on a literature research, the relevant indicators for telemedical

applications and telerehabilitation were identified and coordinated with the project partners. After the operationalization of the cost and benefit parameters, the collection of data was in focus, including a qualitative survey with patients and relatives, focus groups with the therapists and interviews with the project partners. In general, the perspectives of patients, therapists, and relatives, as well as the overall economic aspects were included.

The indicators were divided into main indicators and sub-indicators. Considering benefits, the main indicators represent the expected benefits for the main stakeholders (patients, therapists, relatives, and overall economic view). As can be seen in the following Table 1, the main indicator for the benefits for patients includes three sub-indicators: continuity and faster progress in therapy, increased therapy/training quality, as well as relief for patients (including time and financial relief). For therapists and relatives, time and financial relief were included as well. The overall economic benefit covers the relief for the health (care) system, the faster integration into the labor market and ecological effects.

| Main indicator | Sub-indicator |
|------------------------------|---|
| Benefit for patients | Continuity and faster progress in therapy |
| | Increased therapy/training quality |
| | Time relief |
| | Financial relief |
| Benefit for therapists | Time relief |
| | Financial relief |
| Benefit for relatives | Time relief |
| | Financial relief |
| Economic Benefit | Relief for health (care) system |
| | Faster integration into the labor market |
| | Ecological effects |
| Technical intervention costs | Equipment and installation costs |
| | Operating costs |
| Costs for therapists/clinics | Costs for therapists |
| Development costs | |

Table 1: Benefit and cost parameters (own source)

The cost parameters contain the costs for the technical intervention and the costs for the therapists/clinics (see also Table 1). The technical costs include the whole equipment (e.g. tablets, medical-therapeutic equipment PABLO[®], SIM-card and tablet cases) and the installation as well as operation costs (e.g. electricity, internet, license fees, repair and maintenance, support costs). The costs for the therapists and clinics cover the personnel costs differentiated between teleworking and on-site working and insurance costs (professional liability insurance). Moreover, the development costs which were spent on the whole project were also calculated. Additionally, as seen in the literature (cf. Choi & Paik, 2018) the willingness to pay of the patients was asked in the questionnaire.

The qualitative survey was carried out with patients, therapists and relatives and additionally focus groups were organized to discuss several indicators. Starting in March 2022 and ending in June 2022, a total number of three patients (after stroke), seven therapists and one relative participated in the study. The period of telerehabilitation was between four and eleven weeks,

the therapists worked as freelancers or in clinics and covered the rehabilitation in the areas of physiotherapy, occupational therapy and speech therapy. Two of the three patients received all three therapy areas and one patient received only occupational therapy. In total, seven therapy processes were used for the evaluation. The average age of the patients was 52 years and 39 years within the therapists.

Results

The following paragraphs summarize the results of the analysis, distinguished between benefits and costs.

Benefit-Considerations

From the patients' point of view, the therapy progress was compared between the conventional therapy (on-site) and the teletherapy with REHA2030. The conventional form was rated twice as good and once as very good; comparatively, REHA2030 was rated twice as good and once as neutral. In detail, the patients reflected that their motor skills including balance, the quality of life, the speech abilities and the listening comprehension improved with the telerehabilitation. Nevertheless, patients rated the conventional therapy form better compared to telerehabilitation.

Moreover, the REHA2030 tool recorded the continuity of therapy with a total number of 558 therapy units done. This means that 173 more therapy units were done than originally planned. Specifically, one patient completed 296 occupational therapy sessions instead of the planned 110, while the other two patients completed the planned number or less (131 out of 131 and 120 out of 144).

To further assess training continuity, patients and therapists were asked about their subjective assessment of the number of training sessions. Two patients answered that they had trained more in their opinion and one patient said that it was the same with the standard therapy. The therapists stated that all patients exercised more in the different types of therapy. Increased motivation led to increased training performance in one of three cases.

Considering the therapy/training quality, two out of three participants were very satisfied with REHA2030, but two patients also stated that there should be more variety of exercises in order to not get bored by the training. Likewise, the therapists rated the telerehabilitation with the patients as very satisfied to satisfied (four times very satisfied, three times satisfied). The practicability of the system was assessed as positive by patients, since guidance and monitoring of the tasks completed were helpful and the system was easy to acquire. The same was stated by the therapists, plus the possibility of feedback sessions.

The relief for the patients was measured by time spent and financial expenses. In terms of time, the three patients required on average 40 minutes for conventional therapy, three times per week, which resulted in approx. two hours of therapy per week. The teletherapy lasted on average 79 minutes for the asynchrony sessions and around 51 minutes for synchronic sessions per week. This resulted in an average training duration of approx. 2.2 hours per week. It is important to note that asynchronous telerehabilitation includes exercises and synchronous includes video calls (and real-time exercises) with the therapists. This means that teletherapy lasted approx. ten minutes longer time per week than the standard therapy format. But besides training time, travel time for patients to the place of therapy have to be

considered. For example, a journey time of 30 minutes one way (25 kilometers) was calculated for one participant. Thus, one hour of travel time was saved on average three times per week compared to conventional therapy.

The financial relief for patients was calculated at around 65 EUR per week, as the driving (25 kilometers) will cost around 21 EUR per training (calculated with official kilometer allowance in Austria; $25 \times 2 \times 0.42$; for more information see Austrian Federal Ministry of Finance, 2022).

From the therapists' perspective, a time relief was calculated for each functional therapy form. The calculation was carried out with standard therapy versus teletherapy. Occupational therapists need around 132 minutes for standard therapy, speech therapists 70 minutes and physiotherapists 250 minutes per week. For teletherapy, an occupational therapist needed about 79 minutes per week, a speech therapist about 131 minutes per week and a physiotherapist about 166 minutes per week. This means that occupational therapists need around 52 minutes less time with teletherapy, speech therapists need on average 61 minutes more time for teletherapy and physiotherapists need around 84 minutes less time per week with the teletherapy format. Moreover, adding the preparation and the follow-up time for the teletherapy, around 19 minutes for preparing and follow-up the tasks for synchronous units are needed and around 26 minutes for asynchronous ones, if new exercises need to be implemented into the REHA2030-system, otherwise only 10 minutes are needed. It should be emphasized that the exercises installed can be transferred/applied to other patients or can serve as templates, but that some time must be invested, or a longer period of use is necessary in order to have a large pool of exercises. The therapists stated that the system was user-friendly and only problems with transferring or uploading videos occurred and could be solved.

Considering the perspective of relatives, the travel time and the costs were also considered. As sometimes dependents drive with the patients to the therapy their travel time has to be considered too. Travel time was approx. 30 minutes. Including the costs calculated on the basis of the travel costs charged for the patients, the relatives could also save about 65 EUR per week (see calculation for patients). Additionally, in the survey it was stated that a reduction of stress due to scheduled dates for driving to the therapy was helpful.

The overall economic benefits were primarily discussed in the focus groups. First the relief of the health (care) system was discussed and resulted in the view that follow-up therapies might be reduced, but cannot be quantified. Since lifelong training is necessary for patients after a stroke, telerehabilitation might be a constant support. In addition, the possibility of synchronous and asynchronous training with one therapist allows more patients to receive rehabilitation at the same time. In a broader sense, this could also bridge the waiting time for rehabilitation. Regarding the transport costs, it can be said that if rescue transport companies (such as the Red Cross) are necessary for patient transport, these can be saved by teletherapy in any case. In Austria, one kilometer costs approx. 0.99 EUR¹, which could then be saved. The faster integration into the labor market could not be underlined in the survey, because it depends on the clinical picture.

The last benefit parameter was the ecological effect of saving CO². With reference to the maximum calculated journey of 25 kilometers (example of a patient), approx. 0.0018 tons of

¹ Information according to the Austrian Red Cross via email on July, 26th 2022.

CO² can be saved if this distance does not have to be covered by car (fossil fuel; calculated based on Foundation myclimate, n.d.:online).

Cost-Considerations

The costs were calculated per patient per therapy. The technical intervention costs consist of equipment and installation costs, as already described. Above this, the cost parameter includes on the one hand the tablets at 13.83 EUR (rental costs), the medical-therapeutic device PABLO[®] at 194.22 EUR, accessories for the tablets such as protective cases, and on the other hand personnel costs for the training of the therapists at 12.75 EUR and for the installation at 4.36 EUR. In total, this results in costs of 225.97 EUR. The next sub-indicator includes the operation costs like costs for the internet (18.66 EUR), the electricity costs for the use of the tablet computer (0.0132 EUR) and the PABLO[®] (0.0004 EUR). Furthermore, maintenance costs including the insurance of the medical-therapeutic device PABLO[®] (7.65 EUR), material costs for support (purchase costs at 11.20 EUR; ongoing costs at 45.03 EUR) as well as costs for the second level support (personnel costs; 78.23 EUR) are of relevance. In total, this makes around 160.78 EUR per therapy. In general, royalties should also be considered when developing and implementing such an application, but in this project no fees for the software or PABLO[®] incurred. So, the technical intervention costs amounted to 386.75 EUR. The second main indicator includes the costs for the therapists or clinic consisting of personnel costs at 498.05 EUR, the first level support, which was provided by the therapists (6.67 EUR) and insurance costs, whereas no additional occupational insurance was necessary in the course of the project. Summing up, the costs for therapists were 504.72 EUR. The total costs for a period of the average five weeks of rehabilitation and assuming that six patients can use the REHA2030 system as telerehabilitation in one year, amount to 891.47 EUR.

Additionally, the development costs were also calculated and amounted to 14,652.75 EUR for in-house development of the system and 23,000.00 EUR to third parties for development.

Lastly, the willingness to pay was asked. The three patients would be willing to pay between 40 EUR and 200 EUR for further use of the telerehabilitation application. The therapists said that this option makes more sense for freelance therapists, who would be willing to pay between 50 EUR and 400 EUR. Another suggestion would be that the social security pays 25 EUR per teletherapy unit to the clinics to finance the telerehabilitation equipment and the therapists can choose for whom and when the telerehabilitation can be used.

Discussion and Conclusion

In summary, telerehabilitation takes about ten minutes more time from the patient's point of view, but costs 65 EUR less due to the elimination of transport costs for the private car. Cost savings can be achieved primarily by reducing the number of journeys to therapies and even personnel costs. The costs per patient per therapy were around 892 EUR. 519.70 EUR could be saved compared to conventional therapy. But it should also be noted that many people already have a tablet computer and would be able to install the app or system, which might then reduce the costs for the patients. In general, costs may vary due to changes in time or location.

In addition to cost savings, positive effects on motivation should be emphasized and are also supported by the literature. As Milani et al. (2021), Richter et al. (2021), Cramer et al. (2019)

or Dodakian et al. (2017) have already pointed out in their studies, telerehabilitation as a new format can strengthen training motivation and willingness to train. Moreover, in some cases, the number of patients per therapist could be higher, which would allow more patients to receive rehabilitation or to be treated more quickly. This point is underlined above all by the time saved by physiotherapists and occupational therapists.

Limitations can be seen on the one hand, that no standardized test procedures (e.g. Fugl-Meyer Upper Extremity-Test, EuroQoL-5) were carried out. On the other hand, the sample size was limited and further research and studies should be made as the presented studies cited also show limitations in their sample size (e.g. Rozevink et al., 2021).

In conclusion, teletherapy might not replace on-site therapy, because some patients need on-site therapies (hands-on therapy or help) due to their individual and clinical picture, but telerehabilitation might be a positive additional service.

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Predictors of Preferred Retirement Age Among Filipino Older Employees in the Academe

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Abstract

Sixty-five is the mandatory retirement age for civilian employees in the Philippines. Early this year, the optional retirement age was lowered from sixty to fifty-four years by the House of Representatives. This study aims to determine whether older Filipinos prefer early or late retirement based on identified predictors, i.e., individual attributes, family-related considerations, work environment, and socioeconomic context. Determining the reasons for employees to remain longer in the workforce will guide policymakers in retaining older employees and promoting age inclusion. The seventy participants from the academe represent the faculty, research extension and professional staff, and administrative staff aged fifty years and older as of 30 June 2020. Cross-tabulation was employed between the preferred retirement age and the predictors, with the Chi-square test of independence used to measure their association. The resulting p-value was tested at 5 percent and 10 percent levels of significance. The older employees' mean preferred retirement age is 63.8 years (ranging from fifty-seven to seventy-one years). Sixty-six percent prefer late retirement (at sixty-five years and older) while 34 percent prefer early retirement (or younger than sixty-five years). Career development programs and recognition practices significantly affect preferred retirement age. Late retirement is preferred when career development programs like training on written and spoken communication, research skills, and creative design, as well as longevity and loyalty awards as recognition practices are available. Investing in career development programs and recognition awards motivates older employees to retire later and provides them the opportunity to age healthily.

Keywords: Retirement, Academe, Philippines, Older Employees

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Introduction

Retirement, or when an employee exits the labor market, spikes at age 65. It is attributed to the influence of custom or accepted practice (Lumsdaine, Stock, & Wise, 1996) and to mandatory retirement in most countries. The Philippines has established the mandatory retirement age of civilian government employees at 65 years (The Government Insurance System, 1997). However, in January 2023, the House of Representatives approved House Bill No. 206 to lower the optional retirement age from sixty years to fifty-six years (House of Representatives, 2023). The bill is designed to protect the health and well-being of older employees, as well as to encourage them to retire early to be with their families for a longer period of time.

Yet over the years, the rising life expectancy has been increasing the participation rate of those aged fifty-five to seventy-four. Thus, member countries of the Organization for Economic Cooperation and Development are encouraged to increase their minimum and statutory age of retirement (Geppert, Guillemette, Morgavi, & Turner, 2019).

Data on Filipino employees' preferred retirement age is lacking. To help fill this gap, this study extends the current body of knowledge on the predictors of retirement. We examined the determinants of the preferred retirement age of employees in UP Manila, the first study of its kind conducted in the UP system. Predicting the employees' preferred retirement age will benefit the university in developing effective retirement planning programs as well as retention programs for those who still want to work.

This study provides insight into who would prefer early or late retirement relative to predictors such as individual attributes, family-related considerations, and work environment (Dwyer, 2001), as well as socioeconomic context. It may also assist the university and government in developing new strategies to improve issues related to the individual, their family and work environment, and their perception of preparing for retirement.

Specific Objectives

This study aims to determine how certain considerations predict preferred retirement age (Figure 1). These considerations are:

1. Individual attributes, such as:
 - a. health perceived by the individual
 - b. health diagnosed by a professional
 - c. retirement preparedness (age)
 - d. financial situation
 - e. skills development
2. Family-related considerations, such as:
 - a. household type and size
 - b. household chore responsibilities
 - c. support given to the household
 - d. support received from family
3. Work environment, such as:
 - a. career advancement
 - b. work-life balance
 - c. recognition practices

4. Socioeconomic context, such as:
 - a. organizational retirement preparation
 - b. government retirement preparation

Conceptual Framework

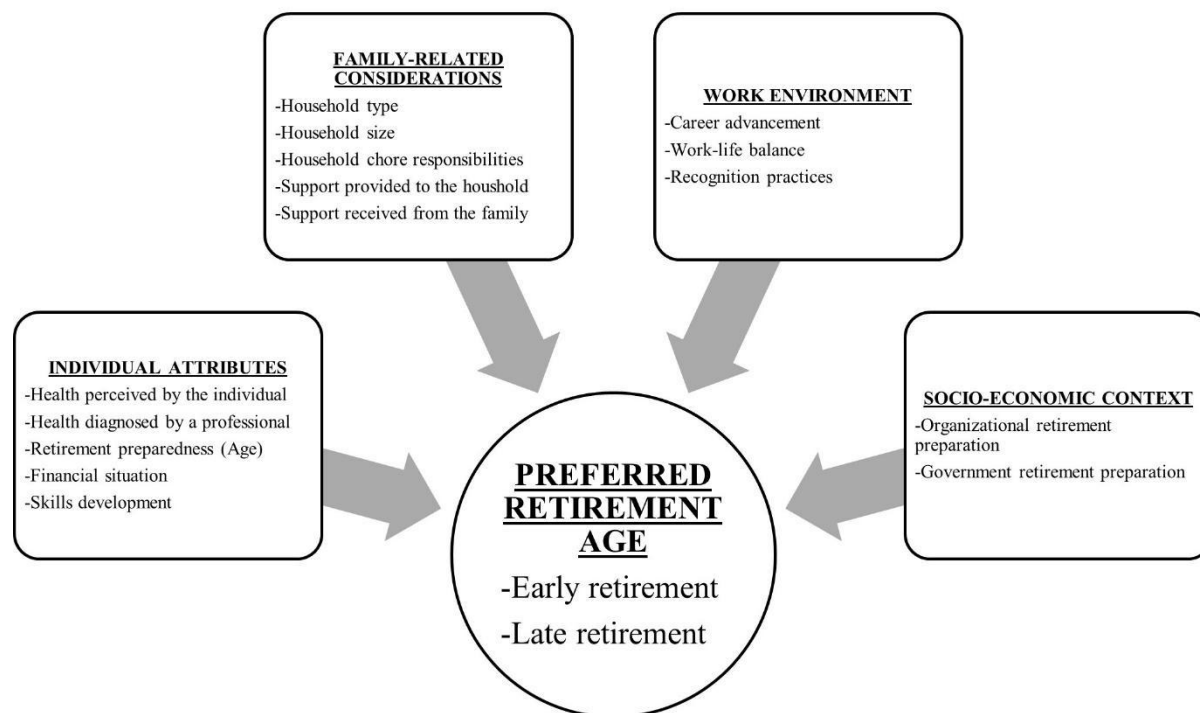


Figure 1: Predictors of preferred retirement age

Health has a significant effect on employees' retirement plans. Poor health is a driver to retiring earlier than expected (Dwyer, 2001; Taylor & Shore, 1995; Sousa-Ribeiro, Bernhard-Oettel, Sverke, & Westerlund, 2021). Pre-retirement planning (i.e., how much the employee has thought about retirement) also has a direct effect on financial preparedness (Noone, Alpass, & Stephens, 2010; Alessie, Van Rooij, & Lusardi, 2011). According to Hurd, Duckworth, Rohwedder, and Weir (2012, p. 7), "individuals with higher levels of conscientiousness are more likely to be economically prepared for retirement." Also, De Wind et al. (2014) proved that employees who reported a higher focus on skills and knowledge development were more likely to retire late.

The workplace and the state can also affect retirement preparation. Employees who receive benefits and have defined-benefit pension plans and retirement health insurance offered by the organization are more prepared for retirement (Cochran, Crowne, & Carpenter, 2012). Another source of influence on retirement preparation is positively related to government programs (Kim, Kwon, & Anderson, 2005). Perceived retirement support from institutions has significant importance in retirement preparation, so employees know what benefits they get from the government after retirement.

Family obligations and relationships also affect retirement age preference. For instance, it will be difficult for employees to retire early because of their financial responsibility to their

children (Szinovacz, DeViney, & Davey, 2001). The presence of dependents and other household members delays employee retirement transition (Szinovacz & Ekerdt, 1993).

A study by Adams on planned retirement age (i.e., the age at which the employee expects to retire), showed no significant correlation between job satisfaction and planned retirement age (Adams, 1999). However, the same study showed that career-related variables (career commitment, career growth opportunity, and occupational goal attainment) do significantly affect retirement plans. For instance, the more committed employees are to their careers, the less they plan to retire early.

Methodology

The data for this study is from the *University of the Philippines Manila Wellness Initiative for Seniors and Elders (UPMWISE) Project 1: Collaborations and Assessments of Health and Well-Being*.

Sample and Data Collection

From a list of 480 current employees aged fifty years and above as of 30 June 2020, two hundred and twelve employees were sampled through randomized stratification, using their employee category (i.e., faculty, administrative staff, and research extension and professional staff or REPS) as a stratifying variable. Of the two hundred and twelve respondents, seventy-one responded to an online survey conducted from 2 September 2022 to 14 October 2022. However, only seventy responses were considered because one participant did not respond to the preferred retirement age. Forty-one of the respondents are faculty, twenty-one are REPS, and nine are administrative staff (Table 1). Fifty-eight employees refused to participate due to reasons like busy schedules, personal reasons, or being on sabbatical leave. Some did not state their reasons for refusal.

| Designation | Population size | Randomly Sampled | Replacements | Number of completed online interviews |
|----------------------|-----------------|------------------|--------------|---------------------------------------|
| TOTAL | 480 | 212 | 63 | 71 |
| Faculty | 298 | 133 | 41 | 41 |
| Administrative Staff | 161 | 70 | 19 | 9 |
| REPS | 21 | 9 | 3 | 21 |

Table 1: UP Manila employees who satisfy the inclusion criteria of UPMWISE Project 1 based on the revised list (3 August 2022) from Human Resource Development Office (HRDO).

Data Processing and Analysis

Given the spike and mandatory retirement age at sixty-five years old, this study uses two categories of preferred retirement age: 1) early retirement (at younger than sixty-five years old), and 2) late retirement (at sixty-five years old and above) to determine whether employees would prefer to retire early or later because of the identified predictors.

The *UPMWISE Project 1* Statistician used the Statistical Package for the Social Sciences (SPSS) software for statistical analysis. The dependent variable, preferred retirement age, is

compared with the predictors (Table 2). Chi-square tests of independence are used to measure their association. The resulting p-value is tested at 5 percent and 10 percent levels of significance.

Results

The mean retirement age is 63.8 years (ranging from fifty-seven to seventy-one years). More employees (65.7 percent) prefer a late retirement than those who would rather retire early (34.3 percent).

| Predictors | Total | | Early retirement | | Late retirement | | p-value |
|--------------------------------------|-------|------|------------------|------|-----------------|------|---------|
| | n | % | n | % | n | % | |
| | 70 | 100 | 24 | 100 | 46 | 100 | |
| Health | | | | | | | |
| Healthy (individual perception) | 15 | 21.4 | 6 | 25.0 | 9 | 19.6 | 0.599 |
| Unhealthy (individual perception) | 55 | 78.6 | 18 | 75.0 | 37 | 80.4 | |
| Not sick (physician's diagnosis) | 53 | 75.7 | 16 | 66.7 | 37 | 80.4 | 0.202 |
| Sick (physician's diagnosis) | 17 | 24.3 | 8 | 33.3 | 9 | 19.6 | |
| Retirement preparedness (age) | | | | | | | |
| ≤50 | 32 | 56.1 | 10 | 58.8 | 22 | 55.0 | 0.790 |
| >50 | 25 | 43.9 | 7 | 41.2 | 18 | 45.0 | |
| Financial situation | | | | | | | |
| Saving | 53 | 75.7 | 18 | 75.0 | 35 | 76.1 | 0.920 |
| Not saving | 17 | 24.3 | 6 | 25.0 | 11 | 23.9 | |
| Skills development | | | | | | | |
| Yes | 38 | 54.3 | 11 | 45.8 | 26 | 58.7 | 0.305 |
| None | 32 | 45.7 | 13 | 54.2 | 19 | 41.3 | |
| HH type | | | | | | | |
| Nuclear family | 33 | 47.1 | 13 | 54.2 | 20 | 43.5 | 0.395 |
| All else | 37 | 52.9 | 11 | 45.8 | 26 | 56.5 | |
| HH size | | | | | | | |
| 1 to 5 | 50 | 71.4 | 19 | 79.2 | 31 | 67.4 | 0.301 |
| 6 or more | 20 | 28.6 | 5 | 20.8 | 15 | 32.6 | |
| HH chore responsibilities | | | | | | | |
| Exercise | 30 | 42.9 | 8 | 33.3 | 22 | 47.8 | 0.245 |
| No exercise | 40 | 57.1 | 16 | 66.7 | 24 | 52.2 | |
| Support provided | | | | | | | |
| Yes | 10 | 14.3 | 5 | 20.8 | 5 | 10.9 | 0.258 |
| None | 60 | 85.7 | 19 | 79.2 | 41 | 89.1 | |
| Support received | | | | | | | |
| Yes | 16 | 22.9 | 5 | 20.8 | 11 | 23.9 | 0.771 |
| No | 54 | 77.1 | 19 | 79.2 | 35 | 76.1 | |
| Career advancement | | | | | | | |
| Agree | 56 | 80.0 | 14 | 58.3 | 42 | 91.3 | 0.001 |

| | | | | | | | |
|--|----|------|----|------|----|------|-------|
| Disagree | 14 | 20.0 | 10 | 41.7 | 4 | 8.7 | |
| Work-life balance | | | | | | | |
| Agree | 46 | 65.7 | 14 | 58.3 | 32 | 69.6 | 0.347 |
| Disagree | 24 | 34.3 | 10 | 41.7 | 14 | 30.4 | |
| Recognition practices | | | | | | | |
| Agree | 52 | 75.4 | 15 | 62.5 | 37 | 82.2 | 0.070 |
| Disagree | 17 | 24.6 | 9 | 37.5 | 8 | 17.8 | |
| Retirement preparation (UP) | | | | | | | |
| Yes | 33 | 48.5 | 14 | 58.3 | 19 | 43.2 | 0.232 |
| No | 35 | 51.5 | 10 | 41.7 | 25 | 56.8 | |
| Retirement preparation (Government) | | | | | | | |
| Yes | 39 | 57.4 | 13 | 54.2 | 26 | 59.1 | 0.695 |
| No | 29 | 42.6 | 11 | 45.8 | 18 | 40.9 | |

Table 2: Predictors of preferred retirement age by early and late retirement.

Individual Attributes

Perceived and diagnosed health status have different results in terms of retirement age preference. Twenty-five percent of employees who perceive themselves healthy prefer to retire at an earlier date, while of those who perceive themselves unhealthy, 80.4 percent would prefer to retire later. In contrast, 33 percent of employees who are diagnosed as sick prefer early retirement, and 80.4 percent of those diagnosed as not sick prefer to retire later.

In terms of preparedness (age) and financial situation, employees who prefer an early or late retirement do not differ much. However, of those who are developing certain skills, 58.7 percent prefer late retirement, while of those not investing in skills development, 54.2 percent would prefer an early retirement.

The results between preferred retirement age and individual attributes are not statistically significant at 5 percent or 10 percent.

Family-Related Considerations

Of the employees living with their nuclear family, 54.2 percent prefer to retire early, while of those who are not in a nuclear family, 56.5 percent prefer to retire later. Seventy-nine percent of employees with a smaller family prefer to retire earlier, while of those with more household members, 32.6 percent prefer a late retirement.

Our study found that of the employees who financially support someone, 20.8 percent prefer early retirement, while of those who do not support anyone, 89.1 percent prefer a late retirement. Those who are either being supported or not are undifferentiated in preferential retirement.

The results between preferred retirement age and family-related considerations are not statistically significant at 5 percent or 10 percent.

Work Environment

Significant differences are found between the work environment and the preferred retirement age. Of those who agree that the university invests in career development, 91.3 percent prefer late retirement, while of those who do not agree, 42 percent prefer an earlier date. At the same time, of those who agree that the university provides recognition awards, 82.2 percent prefer to retire later, while of those who do not agree, 37.5 percent prefer an earlier retirement. The same pattern is seen in university work-life balance. Those who agree that the university has a positive work environment prefer a late retirement, while those who do not agree prefer an early retirement due to work conditions.

Career development and recognition practices are statistically significant in predicting preferred retirement age at a 5 percent and 10 percent level of significance, respectively. However, the work-life balance is not statistically significant.

Socioeconomic Context

Sixty-six percent of employees who agree that UP Manila is preparing them for retirement prefer to retire early rather than later, while of those who do not agree, 56.8 percent prefer to retire late. Retirement age preferences do not vary in terms of government retirement preparation.

Results between preferred retirement age and socio-economic context are not statistically significant at 5 percent.

Discussion

With a significant statistical result, career development and recognition practices have a significant influence on preferred retirement age. Consistent with Thorsen, Jensen, and Bjorner (2006), low possibilities for development and low recognition from management are significant predictors of early retirement. Older employees with high job satisfaction remained longer in the labor market. This indicates that sufficient investment in career development and employee recognition could make older employees postpone their retirement.

Attention to older employees' career development and incentivized awards will increase their motivation and productivity. Accordingly, the university HRDO offers core, foundation, technical, leadership, job-specific, and gender and development training to its employees (Human Resource Development Office University of the Philippines Manila, 2023). Data on employee-category-specific learning and development is not available, but training includes stress management workshops, written and spoken communication training, Google Workspace / Microsoft Office, a pre-retirement webinar, research skills training, and an anti-violence against women and their children webinar, among others. With regard to recognition awards, UPM offers the Longevity or Length of Service Award and the Loyalty Award to its employees. According to the UPM Office of the Vice-Chancellor for Administration, the Length of Service Award is granted to employees who have rendered at least three years of continuous and satisfactory service in a particular position, with one step increment provision (Office of the Vice-Chancellor for Administration University of the Philippines Manila, n.d.). And the Loyalty Award is given to employees who have completed at least 10 years of

continuous and satisfactory service in the university, with a cash bonus of ₱1,000 per year of service.

We also examined whether the other independent variables could predict early or late retirement. However, the results are not significant. But it is also important to consider their implications for retirement age preference because past research has proven the predictability of individual attributes, family-related considerations, and socioeconomic context in retirement.

Perceived and diagnosed health have different effects on predicting early and late retirement preferences. Contrary to the study of Noone, Alpass, and Stephens (2010), UP Manila employees with better health conditions do not prefer early retirement. However, employees who reported being diagnosed with diseases (or who are sick) showed that they would prefer an early retirement. A doctor's diagnosis is more legitimate and tangible evidence of their health condition than their subjective view. The employees (24.3%) reported that they have high blood pressure, diabetes, arthritis, neuralgia or rheumatism, digestive illness, and chronic back pain, among others. However, many of the employees (75.7%) are not diagnosed with any health condition and can continue to work. Therefore, it is important to invest in employee health benefits to have a healthier workforce for productivity.

As mentioned in the literature, financial responsibility to the household may make employees work longer (Szinovacz & Ekerdt, 1993). However, our study found that those who do not financially support anyone prefer to retire late. Seventy-seven percent of the respondents do not have someone to support them, so this may be a factor in why they prefer to retire late. They must work longer to save more for retirement.

Simultaneously, investing in marketable skills helps train older workers. However, the incidence of training opportunities decreases as employees age (OECD, 2002). Picchio (2021, p. 1) concluded that "older adults are slower, less effective, and more heterogeneous than younger people in learning new skills," but training older workers would slow or reverse the decline in their cognitive activities. Hence, it is necessary to provide training support for older workers to lengthen their time in the labor market.

Our study found that those who invest in personal skill development prefer to retire later. Marketable skills reported by the employees include office procedures, continuing education or academics, teaching, book writing, computer programming, and event management. Other non-marketable skills are arts, culinary, sports, and gardening, among others. There are still employees who do not invest in their marketable skills development. To encourage them to work longer, they should be offered skill development that could make them more productive.

In terms of family-related considerations, family-retirement linkages can be explained by interlinked lives, which means that the behaviors and attitudes of an individual are prominently influenced by family members who primarily need financial support (Szinovacz & Ekerdt, 1993). Filipinos are family-oriented and place high importance on their family's well-being, therefore, family relationships and obligations can affect their retirement plans. In our study, more employees who have a nuclear family and a smaller household size of 1 to 5 individuals would prefer to retire earlier. However, the financial obligations of employees within their household may delay their retirement transition in consideration of their

dependents. The employees provide financial support to their relatives, children, and spouses; hence, they choose to work longer for continued assistance.

It is also crucial to consider how many of the respondents' family members are employed and contribute to the household income. For instance, it can be assumed that the more workers in the household, the less the employees might be obligated to contribute financially. In this way, the employees might not be constrained financially and might retire earlier than expected.

If employees are satisfied with the organization's retirement planning, then they prefer early retirement. This is consistent with the study of Cochran, Crowne, and Carpenter (2012) that older worker-friendly policies lead to early retirement. This indicates that satisfactory retirement planning lies within the organization, therefore, it should invest in its employee retirement preparation, such as the Government Service Insurance System (GSIS) Retirement/Life Insurance Benefit, Pag-IBIG Provident Benefit Claim, and UP Provident Benefit Claim.

The results show that the Philippine government's retirement preparation has little to no effect on retirement age preference. This is already obvious because of the statutory conditions for retirement that employees should abide by. However, lowering the minimum age of retirement could not entirely benefit the older employee population. As claimed by the House Speaker, early retirement would enhance older workers' well-being because they would withdraw from work-related stress (House of Representatives, 2023). However, the GSIS (n.d.) asserts that the proposed bill does not recognize the demographic trend of an ageing population where the life expectancy is increasing and the fertility rate is declining in the Philippines. Given this trend, we can expect that there will be more older employees in the future hence we should not discourage them from continuing to be in the workforce.

The literature likewise suggests that active participation in society reduces the risk of dementia. Sutin, Aschwanden, Luchetti, Stephan, and Terracciano (2021, p. 6) concluded that "a sense of purpose in life was associated with reduced risk of dementia over a span of up to 17 years." Wang, Molassiotis, Guo, Leung, and Leung (2022) also analyzed the association between social integration and dementia and found that enhancing social engagement, social support, social network size, and social contact, as well as reducing loneliness will prevent or delay the onset of dementia.

As such, we can assume that employees who would prefer to retire later will have better well-being because of the sense of purpose in their work, making them proactive in contributing to society. Social isolation and loneliness are detrimental to older employees' cognitive capacity (Wang et al., 2022), so it is essential to legalize policies that will help committed older employees retain their jobs.

Limitation

The identified limitation of this study is the low participation rate of qualified respondents in the online survey.

Conclusion

Our study supports investment in career development programs (e.g., written and spoken communication training, creative design training, and research skills, among others) and employee recognition awards (e.g., longevity and loyalty) as important interventions to prolong the service and quality of lives of older employees. Although all other predictors are not significant for preferred retirement age, many ageing workers will continue to choose to work to support their families and relatives if they are healthy. The organization should revisit existing programs or policies focusing on improving employee health status and work conditions if it intends to retain older employees. It is recommended that the government consider total voluntary retirement for employees' well-being.

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Frailty Index Study: A Challenge Study to Quantify Fatigue

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Abstract

Background: Frailty indices have been assessed worldwide using Index by the Fried et al. (2001). The index consists of five indicators: (1) unintentional weight loss, (2) self-reported fatigue, (3) weakness (grip strength), (4) slow walking speed, and (5) low physical activity. Of these, the self-reported fatigue index is a subjective assessment and may differ from objective assessments of physical and mental fatigue. There is a need to investigate whether subjective fatigue can be replaced by an objective measure. *Purpose:* We examine the relationship between subjective fatigue and indicators of chronic fatigue syndrome and to investigate factors that influence subjective fatigue. *Methods:* We measured a measure of autonomic nervous system activity in 1258 people. *Result:* Results Study 1: TP, ccvTP, LF and HF decrease with age; LF/HF (stress index) is independent of age. Study2-1: Fatigue, muscle mass and lean body mass are strongly negatively correlated. In relation to age and body composition, age and body fat percentage and fat mass, total body muscle score, muscle mass, estimated bone mass, and body water content showed a non-significant negative correlation. Study 2-2: There was a non-significant negative correlation between subjective fatigue and HF, LF/HF, TP and ccvTP. Study 2-3: There were correlations between subjective fatigue and muscle mass, lean body mass, bone mass, and body water content. *Conclusions:* Autonomic nervous system indices may be associated with subjective fatigue in Japanese older adults. The results suggest that subjective fatigue may be associated with body composition.

Keywords: Frailty Index, Subjective Fatigue, Autonomic Nervous System, Body Composition, Older Adults

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Introduction

In our research projects, we have investigated the early detection of frailty and provide guidelines to improve health promotion and quality of life for individual older adults. The global assessment of frailty is based on the Fried Frailty Index with 5 indicators. The Japanese Geriatrics Society also proposes the J-CHS with 5 indicators to assess frailty in older adults (Satake & Arai, 2020). The index consists of five indicators, which are (1) unintentional weight loss, (2) self-reported fatigue, (3) weakness (grip strength), (4) slow walking speed, and (5) low physical activity.

In our previous study, we examined the relationship between expiratory pressure and grip strength in 232 community-dwelling older adults. The results showed a moderate positive correlation between grip strength and brachial muscle area, and a weak significant positive correlation between grip strength and expiratory pressure (Kariya, et al., 2019).

Subsequent studies have focused on indicators that are effective in the early detection of pre-frailty (Kariya, et al., 2021). Twenty-nine middle-aged and older community-dwelling adults participated in the study. Frailty was measured using the Revised Japanese Cardiovascular Health Study Standards (Revised J-CHS Standards), as well as expiratory pressure and brachial muscle circumference as indicators. Since there was a correlation between grip strength, arm circumference (AC), arm muscle circumference (AMC), and expiratory pressure, frailty was assessed using expiratory pressure measurements as an indicator for the older adults who could not measure grip strength. In particular, expiratory pressure has a high contribution to the upper body pre-frailty index and a high correlation with the level of assistance and care required.

The above review suggests that the use of expiratory pressure as an alternative index of grip strength is effective for older adults with dementia, rheumatism, and diseases of the bones and nerves in the fingers who have difficulty receiving instruction.

In the course of daily management and teaching of health promotion classes and various experiences, we were confronted with a new research question.

The problems are that the self-reported fatigue indicator is either yes or no. It is subjective and does not accurately capture the feeling of fatigue because it is a questionnaire that asks about the feeling of fatigue over the past two weeks, although the feeling of fatigue changes daily and has diurnal fluctuations.

Even when data are collected prospectively and the life backgrounds of older adults are understood, the question "I don't feel tired." and immediately after that we see cases where they have car accidents or fall and break bones.

The purpose of this study is to examine the relationship between subjective fatigue and (1) autonomic indices and (2) body composition, and to investigate whether physiological indices can be used to assess the relationship between subjective fatigue and (1) autonomic indices.

Literature Review

We reviewed the literature that focused on the measurement of fatigue, the relationship between fatigue and the autonomic nervous system.

A variety of fatigue measures existed. It is important to select an appropriate frailty scale depending on the type of fatigue of interest (Knoop, 2019). Fatigue is a multidimensional symptom and that individual dimensions of fatigue can be measured by validated clinical measures (Billones, 2021). Garis et al. reported that fatigue and heart rate variability (HRV) may have relationships and may be an indicator.

Vreijling, et al (2021) reported that lower HF HRV was found in patients with medically unexplained physical symptoms (MUPS) compared to healthy population. These results explain the potentiality of using HRV in the analysis of diagnosis and treatment of MUPS related symptoms. Differences in autonomic response between patients with CFS and healthy population (Van Cauwenbergh, et al. 2014).

Functional Somatic Syndromes (FSSs) and Somatic Symptom Disorders (SSDs) patients have significantly lower Heart Rate Variability (HRV) compared to healthy individuals (Ying-Chih, et al., 2020). Myalgic encephalomyelitis/chronic fatigue syndrome (ME/CFS) patients have altered autonomic cardiac regulation compared to healthy controls (Nelson, et al., 2019). Lower HF-HRV in patients with medically unexplained physical symptoms (MUPS) indicates autonomic nervous system dysregulation, particularly lower parasympathetic activity (Vreijling, et al. 2021).

Research Methods

Study Design: Observational study

Study period: December 2014 - June 2023

Research Index: the J-CHS index recommended by the Japan Geriatrics Society as our research index.

Study Location: Several cities in Shiga, Hiroshima, and Okayama prefectures in Japan

Study participants:

Study 1: 1258 participants in the research program (age $M=39.47$, $SD=17.37$).

Study 2: 12 participants (age $M=72.75$, $SD=5.53$) in the frailty prevention program were selected from Study 1.

The following measures were administered: (1) presence/absence of fatigue, (2) fatigue level (assessed on 6 levels: 0, 1, 2, 3, 4, and 5), (3) autonomic nervous system index, and (4) body composition.

This project is approved by the Institutional Review Board at the Prefectural University of Hiroshima.

Measurement

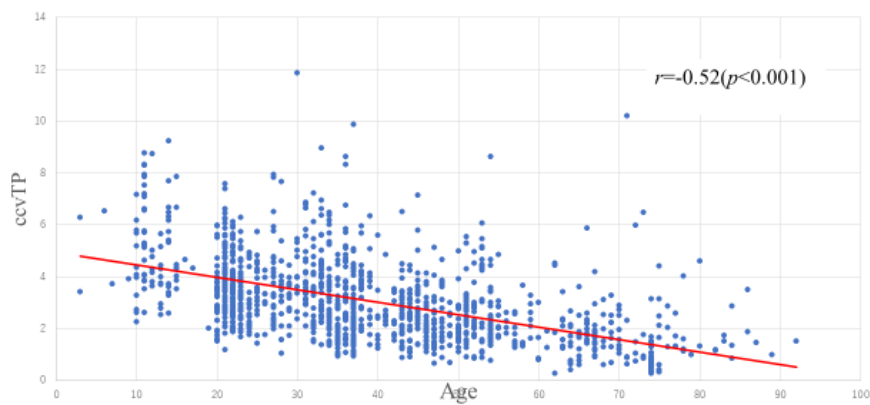
Gender, age, HRV (Murata Manufacturing Co., Ltd.), body composition analyzer (Tanita), blood pressure, SpO₂, fatigue, expiratory pressure, grip strength, height, weight.

Results

Study1: 1,258 Participants in the Research Program

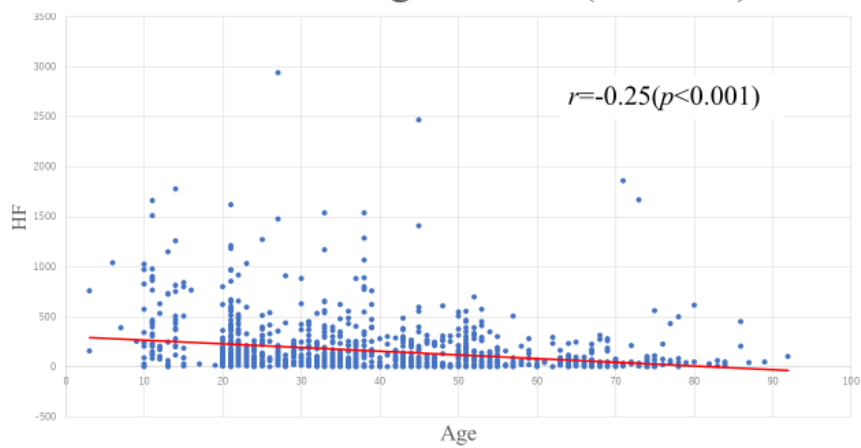
1) The higher the ccvTP, the lower the age (Figure 1)

Figure 1: Scatter Plot of Age and ccvTP($n=1258$)



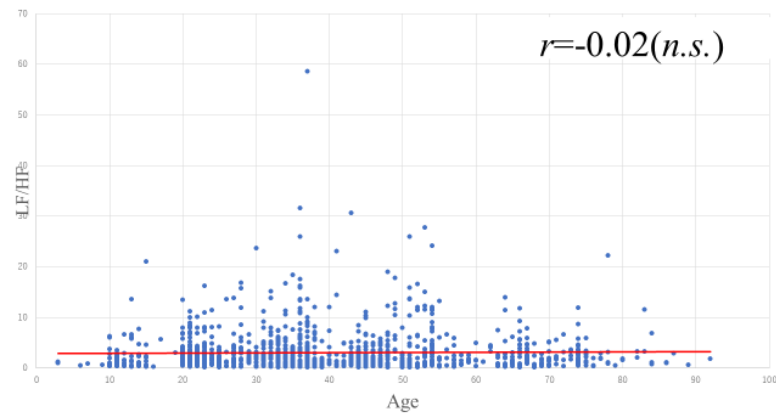
2) HF and age have a weak negative correlation ($r=-0.25$, $p<0.00$) (Figure 2)

Figure 2: Scatter Plot of Age and HF($n=1258$)



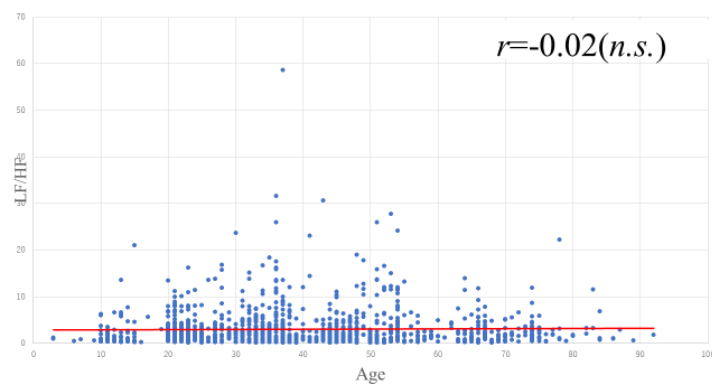
3) Weak negative correlation between LF and age ($r=-0.25, p<0.001$) (Figure 3)

Figure Scatter Plot of Age and LF/HF($n=1258$)



4) LF/HF as a stress index is independent. ($r=-0.02, n.s.$) (Figure4)

Figure Scatter Plot of Age and LF/HF($n=1258$)



Study 2-1: Age-Related Changes in Body Composition

1) Total body muscle mass decreases with age ($r=0.57, p=0.049$) (Figure 5)

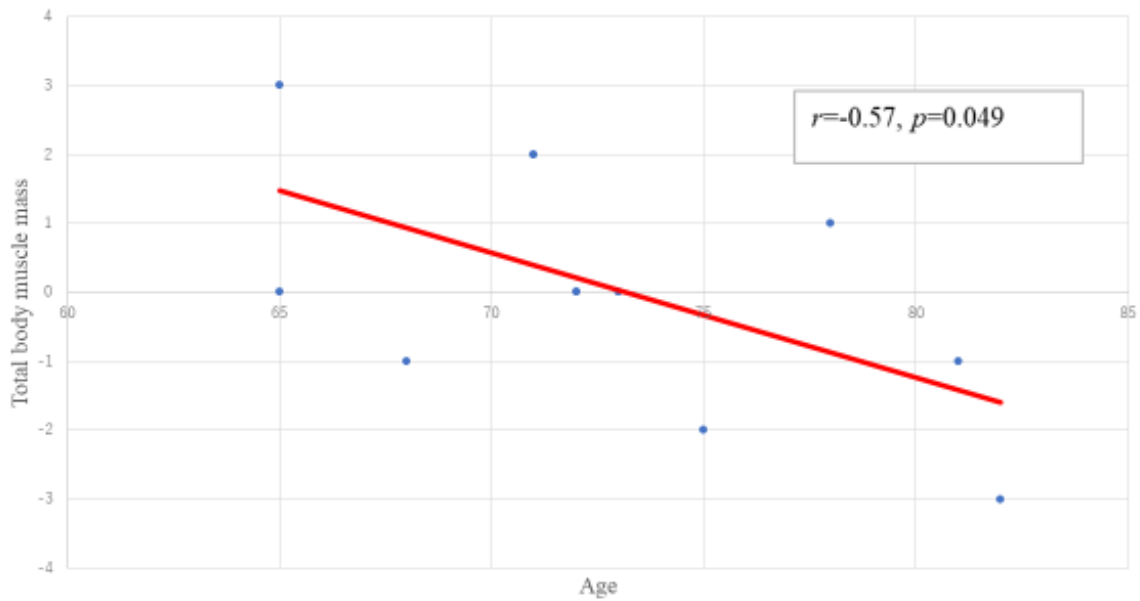


Figure 5 Scatter Plot of Age and Total Body Muscle Score($n=12$)

2) Fat mass decreased with age ($r=0.44, p=0.14$) (Figure 6)

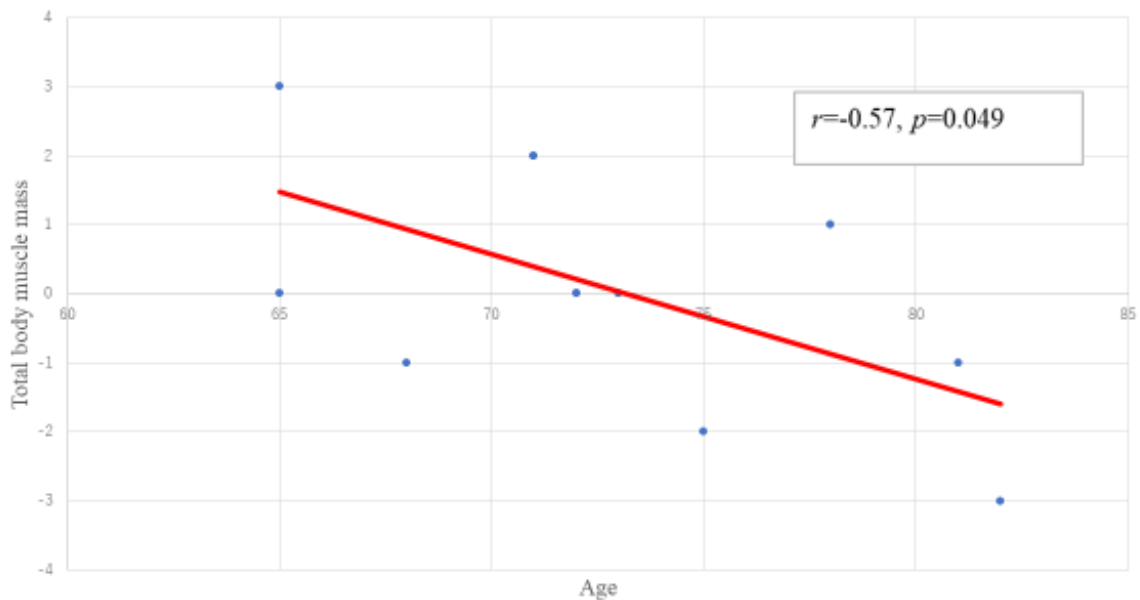


Figure 5 Scatter Plot of Age and Total Body Muscle Score($n=12$)

3) Body fat percentage decreased with age ($r=0.42, p=0.16$) (Figure 7)

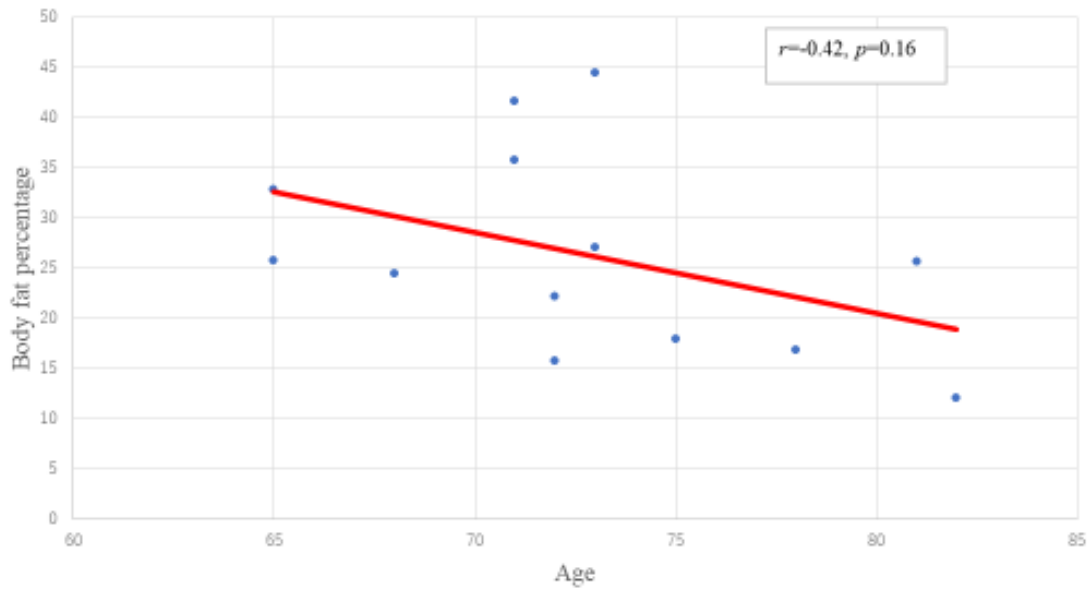


Figure 7 Scatter Plot of Age and Body fat percentage (n=12)

4) Bone mass decreased with age ($r=0.31, p=0.32$) (Figure 8)

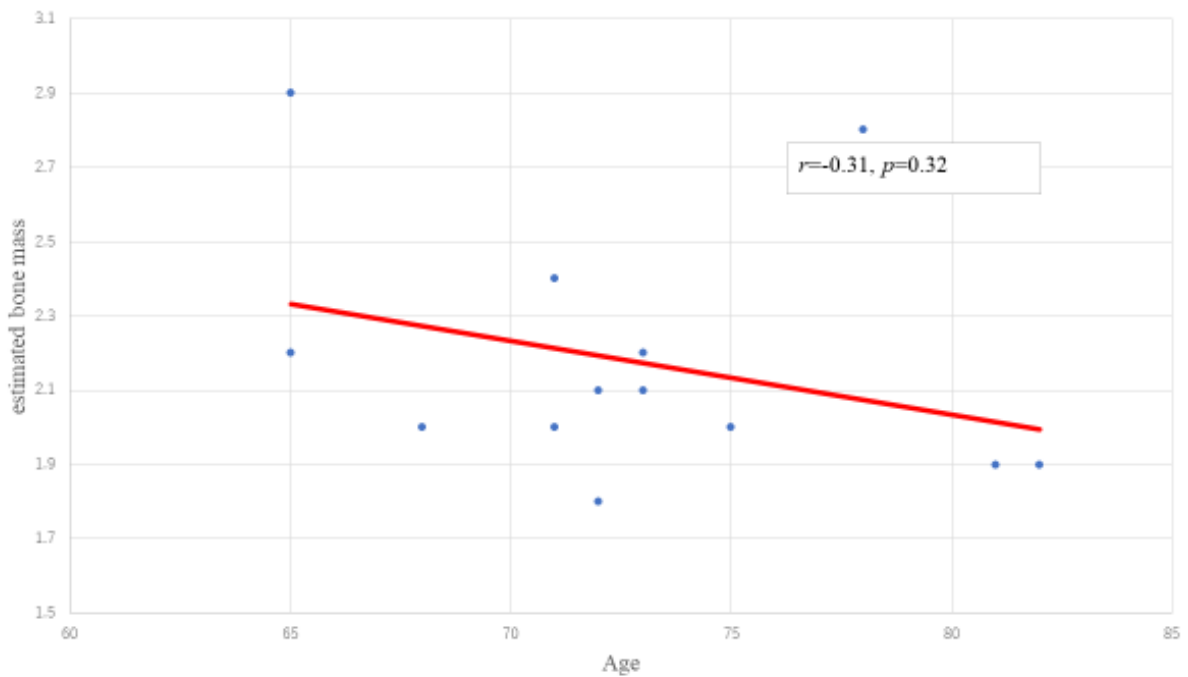


Figure 8 Scatter Plot of Age and estimated bone mass(n=12)

5) Body water content decreased with age ($r=0.30, p=0.34$) (Figure 9)

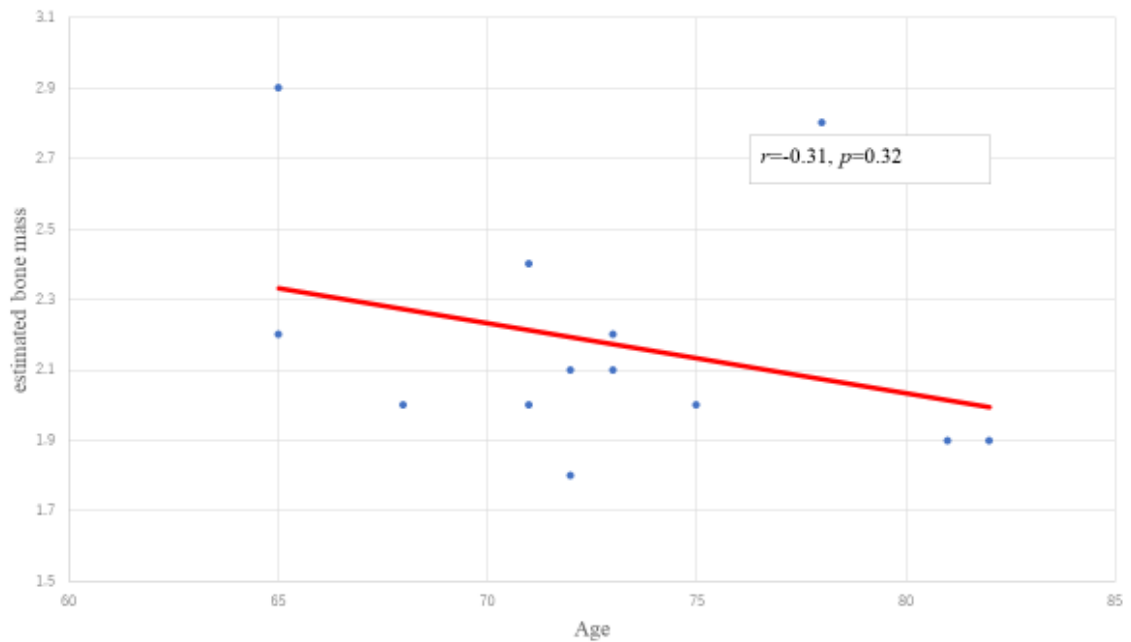


Figure 8 Scatter Plot of Age and estimated bone mass($n=12$)

6) Total Body Muscle Score decreases with age ($r=-0.57, p=0.049$) (Figure 10)

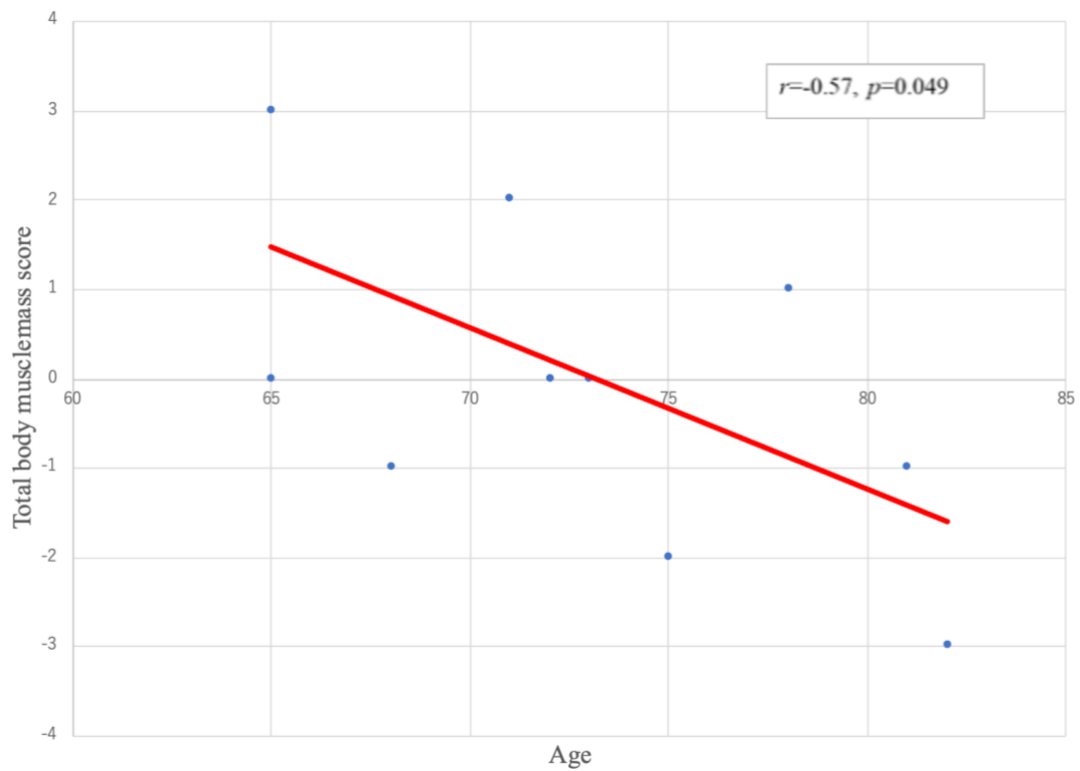


Figure 10 Scatter Plot of Age and Total body muscle mass score ($n=12$)

Study 2-2: Relationship Between Fatigue and Autonomic Nervous System (Figure6)

1) There was a positive correlation between fatigue level and age of autonomic function ($r=0.33, p=0.32$). (Figure11)

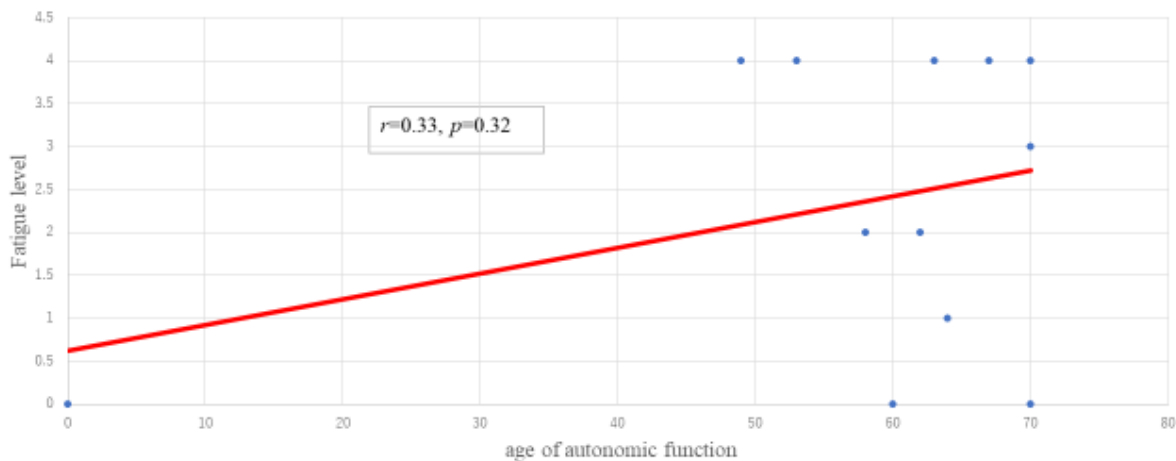


Figure 11 Scatter Plot of fatigue and age of autonomic function (n=11)

2) There was a negative correlation between fatigue level and HF (parasympathetic index) ($r=-0.23, p=0.47$) (Figure12)

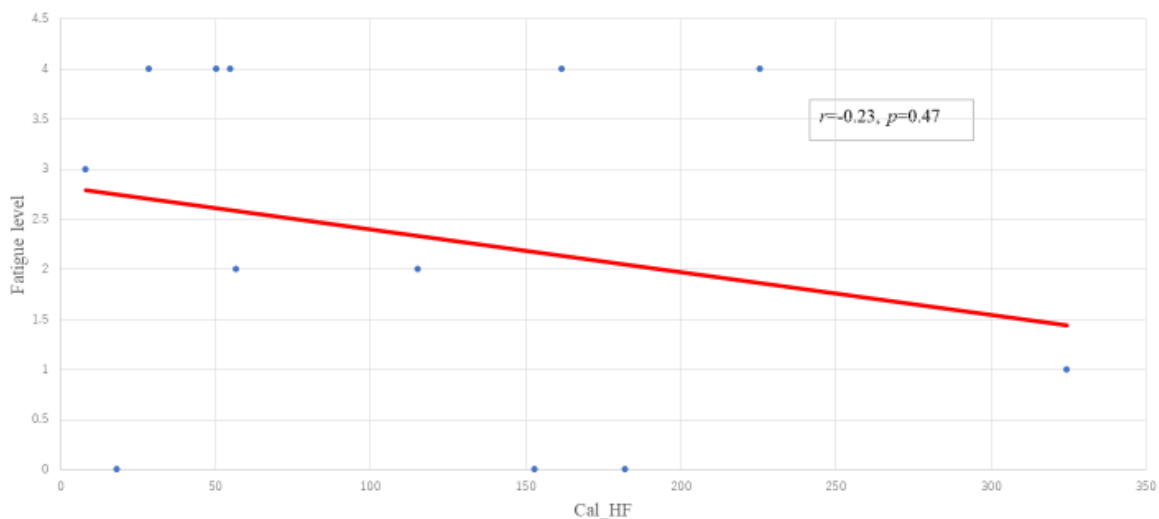


Figure 12 Scatter Plot of fatigue and Cal_HF(n=11)

Study 2-3 Relationship Between Subjective Fatigue (Assessed on 6 Levels: 0, 1, 2, 3, 4, and 5) and Body Composition

1) A t-test was performed with the degree of fatigue as the independent variable and the autonomic index and body composition as the dependent variables, all of which were not significant. (Table 1 and Table 2)

Table1:Result of t-test1; Binary subjective fatigue index and autonomic nervous index

| | Group* | n | M | SD | t | df | p |
|-------|--------|---|--------|--------|-------|----|------|
| LH/HF | 1 | 6 | 3.29 | 2.43 | -0.40 | 10 | 0.70 |
| | 2 | 6 | 4.05 | 4.05 | | | |
| TP | 1 | 6 | 416.53 | 480.45 | 0.34 | 10 | 0.74 |
| | 2 | 6 | 343.06 | 238.82 | | | |
| ccvTP | 1 | 6 | 2.17 | 1.16 | 0.52 | 10 | 0.62 |
| | 2 | 6 | 1.89 | 0.64 | | | |
| LF | 1 | 6 | 320.32 | 438.04 | 0.56 | 10 | 0.59 |
| | 2 | 6 | 209.58 | 198.52 | | | |
| HF | 1 | 6 | 96.21 | 78.67 | -0.65 | 10 | 0.53 |
| | 2 | 6 | 133.49 | 117.06 | | | |

Table2:Result of t-test2; Binary subjective fatigue index and body composition

| | Group* | n | M | SD | t | df | p |
|-----------------------------------|--------|---|---------|--------|-------|----|------|
| Autonomic Nurves Age | 1 | 6 | 60.67 | 8.12 | 0.61 | 10 | 0.55 |
| | 2 | 6 | 53.67 | 26.76 | | | |
| Body Fat rate | 1 | 6 | 26.13 | 7.25 | -0.06 | 10 | 0.96 |
| | 2 | 6 | 26.50 | 13.62 | | | |
| Fat Mass | 1 | 6 | 13.60 | 5.78 | -0.60 | 10 | 0.56 |
| | 2 | 6 | 16.50 | 10.25 | | | |
| Mass except Fat | 1 | 6 | 36.68 | 2.37 | -1.50 | 10 | 0.17 |
| | 2 | 6 | 42.37 | 8.98 | | | |
| Muscle Mass | 1 | 6 | 34.62 | 2.15 | -1.52 | 10 | 0.16 |
| | 2 | 6 | 40.08 | 8.54 | | | |
| Total Body Muscle Score | 1 | 6 | 0.00 | 1.10 | -0.16 | 10 | 0.88 |
| | 2 | 6 | 0.17 | 2.32 | | | |
| Estimated Bone Mass | 1 | 6 | 2.07 | 0.22 | -1.07 | 10 | 0.31 |
| | 2 | 6 | 2.28 | 0.45 | | | |
| Body Water Content | 1 | 6 | 27.15 | 2.84 | -1.44 | 10 | 0.18 |
| | 2 | 6 | 32.23 | 8.17 | | | |
| Standard Weight | 1 | 6 | 51.43 | 2.04 | -1.56 | 10 | 0.15 |
| | 2 | 6 | 54.25 | 3.91 | | | |
| Degree of Obesity | 1 | 6 | -2.32 | 13.80 | -0.94 | 10 | 0.37 |
| | 2 | 6 | 9.23 | 26.72 | | | |
| Visceral Fat Level | 1 | 6 | 4.50 | 2.17 | -1.84 | 10 | 0.10 |
| | 2 | 6 | 8.83 | 5.35 | | | |
| Footing Point | 1 | 6 | 95.33 | 4.63 | 1.55 | 10 | 0.15 |
| | 2 | 6 | 87.83 | 10.94 | | | |
| Basal Metabolism | 1 | 6 | 1038.17 | 88.93 | -1.45 | 10 | 0.18 |
| | 2 | 6 | 1182.83 | 227.01 | | | |
| Determination of Basal Metabolism | 1 | 6 | 12.50 | 3.56 | 0.67 | 10 | 0.52 |
| | 2 | 6 | 10.67 | 5.65 | | | |

*Group1: Fatigue, Group2: Not Fatigue

2) There is a negative correlation ($r=-0.63, p=0.04$) between subjective fatigue and muscle mass. (Figure13)

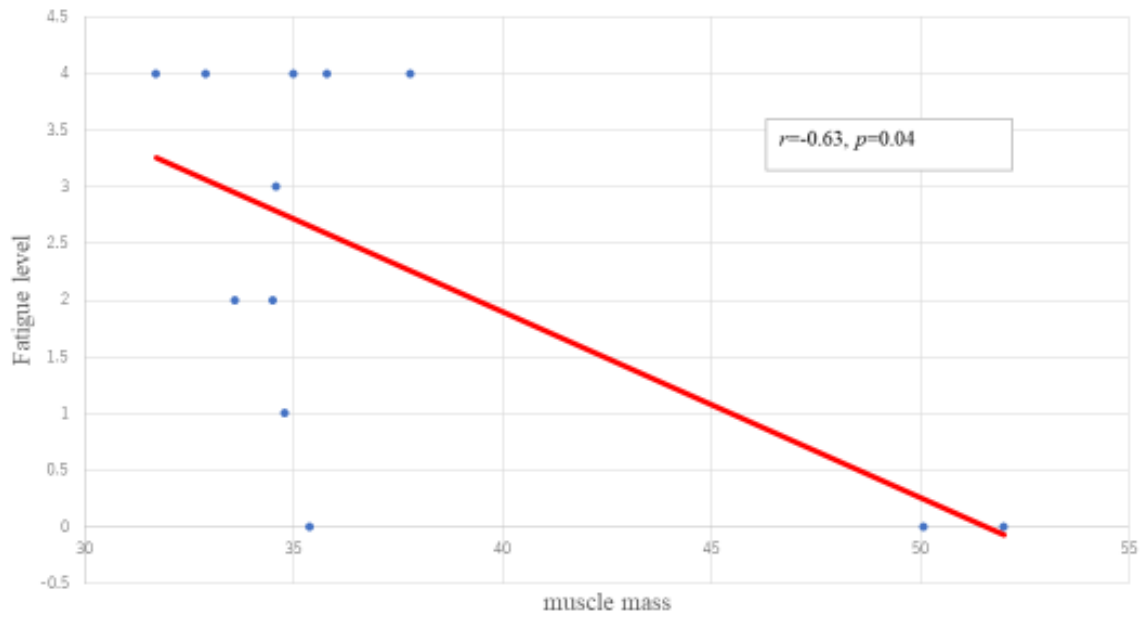


Figure 13 Scatter Plot of fatigue level and muscle mass($n=11$)

3) There was a negative correlation ($r=-0.62, p=0.04$) between subjective fatigue and lean body mass. (Figure14)

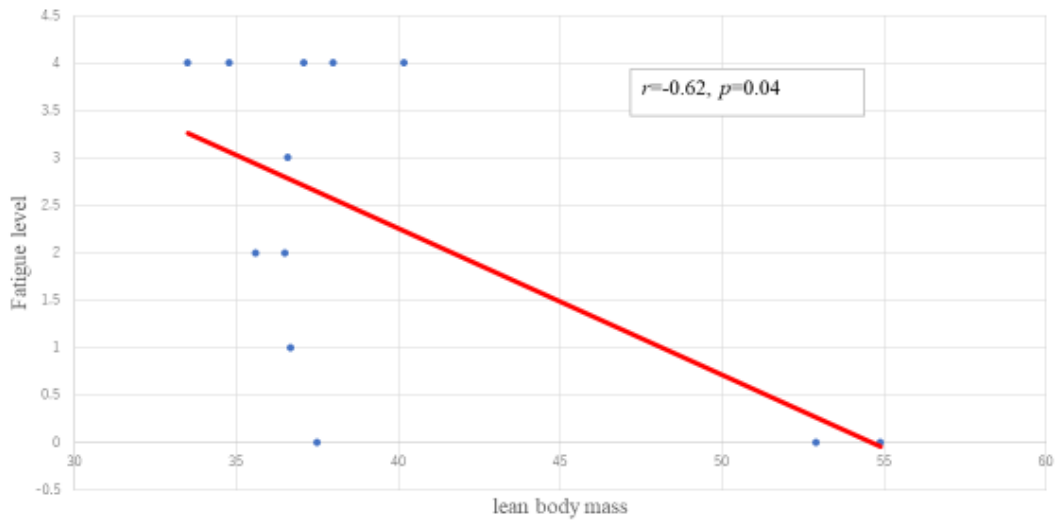


Figure 14 Scatter Plot of fatigue level and lean body mass ($n=11$)

4) Negative correlation ($r=-0.57$, $p=0.065$) between subjective fatigue level and body water content. (Figure15)

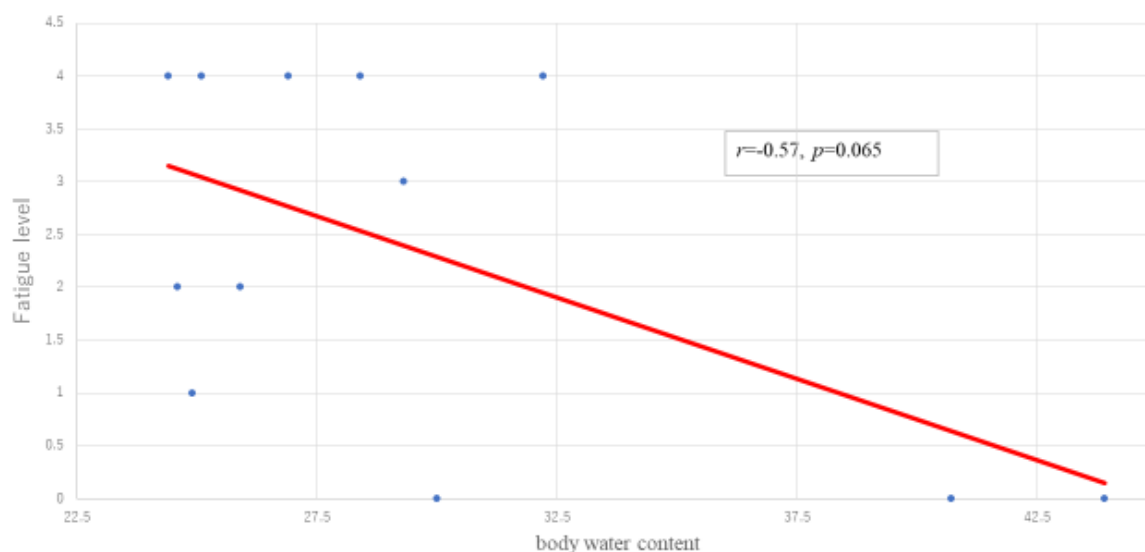


Figure 15 Scatter Plot of fatigue level and body water content ($n=11$)

Discussion

- The finding that fatigue can be assessed by objective measures of the autonomic nervous system supports previous studies.
- The relationship between fatigue and HF in the elderly needs to be investigated.
- In this study, body composition was investigated among the factors affecting subjective fatigue in the elderly, but psychological anxiety and activity should also be investigated.

Conclusions and Implication

- The results suggest that a two-choice "yes/no" fatigue index may not reflect an objective assessment.
- Autonomic nervous system indices may be associated with fatigue in the elderly in Japan. In particular, the association with HF (parasympathetic index) supported previous studies.
- The results suggest that body composition may be associated with fatigue. In particular, it may be related to muscle mass, bone mass, and body water content.

Further studies are needed to examine the relationship with psychological factors such as activity, sleep duration, and anxiety.

Notes

About Autonomic Nervous System Indicators (Fatigue Science Laboratory, n.d.) translated by authors:

- (1) LF: Power values obtained from spectral analysis of heart rate variability are integrated in the frequency band of 0.04 to 0.15 Hz. Power values obtained from spectral analysis of heart rate variability are called LF (Low Frequency) and mainly include sympathetic components.
- (2) HF: The power value integrated in the frequency band of 0.15 to 0.4 Hz is called HF (High Frequency) and mainly includes the sympathetic component.

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Computer Vision Based Video Game to Enhance Agility for Elderly Individuals

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Abstract

Staying physically and mentally healthy is important for the elderly individuals. In this paper, we propose a computer vision video game that allows the user to exercise their hands by raising their hands above their shoulders. The video game we designed uses a laptop with a webcam and employs computer vision to track the elderly wrist's to be above the shoulder and it has a counter that keep track of the number of times the user raises the hand. This type of game is suitable for elderly individuals with legs mobility issue and are home-bound. The users can sit down to play the game and that can help to improve the agility of the hands by making hand movements. This paper discusses the special specifications required by elderly individuals and that encompasses usability, accessibility, and engagement. A simple and easy to navigate interface is necessary. The font size and a high visual contrast page with recognisable objects should make it more accommodating for ageing eyesight. There should be clarity in the game audio. The game control options (such as mouse, keyboard) should be easy to use. The game content needs to be engaging and not too complicated for the elderly. For exercise game that requires spatial awareness keeps the agility in the elderly. By taking turns to play this game, the elderly individuals can better connect and socialise with their friends and family. Players can try to improve on their game scores and outperform one another.

Keywords: Computer Vision, Exercise Games, Gerontology

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Introduction

Markerless motion capture can perform movement analysis with reduced data collection and processing time. According to Wade et al (2022), the pose estimation algorithm error rates are like marker-based capture, but it still pales in comparison with the gold standard bi-planar video radiography in terms of accuracy. The current open-source estimation algorithm is not really designed to do biomechanical application. Nonetheless, many applications including games use open-source estimation algorithms such as human pose landmark, hand landmark and gesture recognition, because they are sufficiently accurate for their usage. Metkar et al (2022) had developed some human gesture-controlled gaming applications and some of the examples included a quiz game where player can use the tip of index and middle finger to select the MCQ answer, a racing car game can be controlled by the index finger, a bubbles game where bubbles appeared on the screen, and the player can use the tip of their finger to pop it. Metkar et al (2022) had use whole body tracking in a red light green light game. Faujdar et al (2023) use human pose estimation for their virtual gym tracker. The gym trainer tracker can assist in counting repetitions of any exercise done during weightlifting or CrossFit events. The pose estimation can be used to identify key points and measurements of angles between key points (such as elbows and shoulders) can be measured.

In our research, we seek to develop a computer vision exercise game for elderly people using human pose estimation algorithm. Before we look at the general guidelines on video game development and how we look at the suitability of the key guidelines for designing computer vision applications for elderly people. In this paper, applications of pose estimation and use of pose estimation models will be discussed. The development of our game prototype is presented and discussed.

Applications of Pose Estimation & Use of Pose Estimation Models

There are numerous applications we can use markerless human pose estimations to determine the human body posture by processing the images or videos. It tracks human body landmarks also known as keypoints which include the face (ears, eyes, mouth and nose), the upper body (hip, shoulder, elbow, wrist), lower body (knee, ankle), foot (heel, big toe, small toe) and hand (tip and 3 joints of each finger). Human activities estimation can be performed for surveillance, security, and monitoring purposes. These activities may range from walking, running, sitting, and sleeping.

In healthcare, pose estimation is used to monitor motor and non-motor development of infants, human performance optimization, injury prevention, and safety, and clinic motor assessment (Stenum et al, 2021). In sports, movements can be monitored to help athletics to achieve optimal performance and not relying on personal trainers and equipment which may be costly (Sharma et al, 2022). Bridgeman et al (2019) presented a full-body 3D pose estimation and allowed the tracking of multiple players in highly dynamic sports scenes such as table-tennis, boxing, karate, and soccer. For robotics, human pose estimation can be used to train the robot's joint movements. Wang et al (2019) performed human-robot retargeting which let a robot follow the movements of a human subject. In VR gaming, the pose is estimated by the camera and the game character can move in accordance with the human's pose. Anvari et Park (2022) conducted a survey on doing 3D human body pose estimation in virtual reality and they had discussed different methods for human motion estimation. In movie or game, 3D rendered graphics can be animated by human's movements. Tous (2023)

described Pictonaut, an approach to perform movie cartoonisation using 3D human pose estimation and GANs.

Design Considerations & Research Methodology

Our design considerations include identifying if there are any specific frameworks related to the design of video games for elderly people. Any guidelines to address unique needs and preferences of elderly people. What about the cognitive, physical and sensory abilities of elderly people. We also question what the guidelines for designing a computing application for elderly people are. Most importantly, we would like to know if there is any specific guideline on computer vision games for elderly.

The objectives of the research are as follow:

- (1) To design a computer vision exercise game for 2 groups of elderly people above 65 years old (wheelchair bound and non-wheelchair bound)
- (2) To develop computer vision game design guidelines for elderly people

The game is developed and tested to ensure that it is used computer vision to capture player's actions and responses to and from the game system. The game is tested to ensure the game specifications are met. Experimental and iterative methodology is used.

General Guidelines That Can Be Applicable to Video Game Design

In this section, we look at some general guidelines that can be applicable to our video game design and they include universal design principles, ISO 9241-210 Ergonomics of Human-System Interaction, Gerontology and Gamification frameworks. Universal Design aims to create products, systems and environments that can be usable by as many people as possible, despite their age, ability, or conditions (Steinfeld & Maisel, 2012). It encompasses key concepts which include equitable use, perceptible info, flexibility, simple and intuitive design, and tolerance for error. Adopting these principles makes the game more inclusive and accessible. While it may not be suitable for all video games because some games are targeted for a specific audience.

International standard ISO 9241-210 Ergonomics of Human-System Interaction provides guidelines for interactive systems which includes video games. It consists of accessibility, usability, and user experience. Though it may not be addressed specifically to elderly people, these key principles are incorporated since it should help to improve the design of games for elderly people.

Gerontology is the study of the different aspects of aging ranging from social, cultural, cognitive, biological, and psychological. A sub-field of gerontology focuses on the use of technology to address the needs of elderly people. The principles and frameworks in gerontology on user-centred design, age-appropriate design and suitable technology are beneficial in guiding design process to develop games for older demographics. Singh (2002) has presented recommendations of suitable exercise for elderly people. It is useful to understand how certain movements may benefit them so that we can incorporate them into our computer vision exercise game.

Gamification frameworks may provide some insights on game design elements that can improve player motivation and engagements. Chou Yu-Kai (2013) has proposed an

octanalysis framework that looks at 8 core aspects (such as epic meaning, empowerment, social influence, unpredictability, avoidance, scarcity, ownership, and accomplishment) that can provide intrinsic motivators and improve positive user experiences. Mora et al (2015) presented a review of the literature on gamification design frameworks, and the paper categorised existing approaches and showed an assessment of the main features which can be useful to developers of gamified solutions. Hunicke et al (2004) proposed the MDA framework (Mechanics, Dynamics and Aesthetics) as a formal approach to understanding games to build the gap between game design and development, game criticism and technical game research.

Key Guidelines for Designing Computer Vision Applications for Elderly People

We examine the needs of elderly people, their abilities, and their preferences when we design a computer vision game for them.

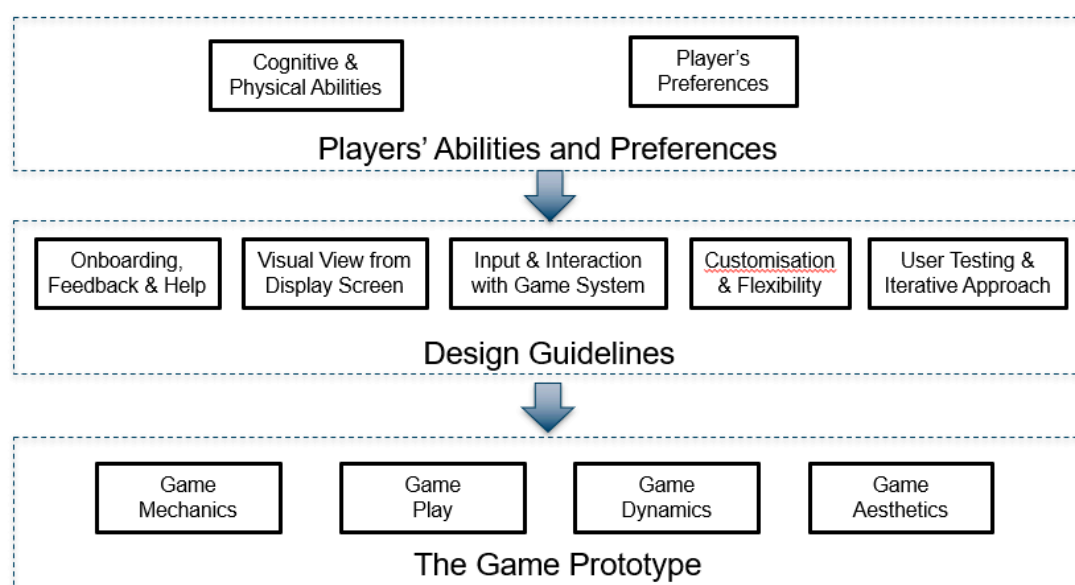


Figure 1: Key Guidelines for Designing Computer Vision Applications for Elderly People

Cognitive and Physical Abilities

It is important to identify what the targeted group of players could and could not do. It is necessary to consider the cognitive abilities of elderly and that includes their memory retention and attention span. It would be useful to provide concise instructions, prompts and design features that can support recalling. It may be necessary to avoid complex tasks. The physical abilities of the elderly include the type and range of movements they can cope with and safety in carrying out the movements. Design games that are within the physical limits of the intended audience and avoid complex and dangerous moves would be a consideration. Another factor is the vision of the elderly, and they may not have sharp vision as compared to people who are younger.

Players' Preferences

It is crucial to find out the elderly players' preferences and that includes the genre of the game, the type of game, the complexity level, the onboarding requirements, and other visual and audio needs.

Onboarding, Feedback & Help for the Game Application

Design application or games with gentle learning curve would make it easier for elderly to try out the game. It is beneficial to provide guided session, some tips and video tutorials for onboarding new players. There should be clear and accessible resources which include tutorials. It should be straightforward to get support and assistance information. It may be necessary to provide context sensitive help information for specific questions or people.

Visual View From the Display Screen

The screen of the application or game could be a monitor screen, laptop or mobile screen. The user interface is required be simple and intuitive. The fonts are to be legible and in high contrast. The graphics, icons and buttons must be large and highly distinguishable. For navigation and layout, there should be clear labels and visual cues. The content should be organised in a structured and well-organised manner. When giving instructions, they are to be clear and concise and complex information are to be expressed in digestible chunks. Acronyms and technical jargons are to be avoided. For a computer vision game, we need to be more specific in defining to the audience how much they are to be positioned away from the device (for e.g., the laptop) so that they can capture the human pose landmarks clearly.

Input and Interaction With the Game System

If there is a need for user to interact with the screen display, the buttons and interactive elements should be large, clear, and well-spaced. The input methods include keyboard, mouse, touch screen, VR tools and computer vision gestures. In our game, the player's human pose landmarks are captured by computer vision to be input into the system for analysis and feedback. It is important to note the range that the player must stand away from the screen display for the human pose landmarks to be captured by the web camera to achieve good accuracy of the vision capture which will impact the game play.

Customisation and Flexibility

We can consider allowing setting to be changed to accommodate individual's preferences and needs. There may be options to adjust font sizes, contrast level, audio setting and other relevant parameters. The customisation features should be easy to use and accessible.

User Testing & Iterative Approach

User testing should be conducted on targeted audience to gather feedback. The iterative design process can help to improve user's game experience.

Development of a Game Prototype

In a game system that interacts with our game model in memory, we have the following components:

- (1) Graphics as Output (projected onto the laptop screen or monitor screen)
- (2) Sounds and Music as Output (projected out from speaker on laptop)
- (3) User Inputs (from keyboard or mouse)
- (4) AI as Input and Output (Computer Vision from webcam and projecting onto the screen)

In our game prototype, we use deep computer vision algorithms in Processing. The library we have chosen is Deep computer vision algorithm for Processing by Florian Bruggisser (2022). This Deep Vision library can support object detection using different known models (such as YOLOv5, SSDMobileNetV2, Ultra-Light-Fast-Generic-Face-Detector), object segmentation, object recognition, keypoint detection (which includes facial landmark detection and single human pose detection based on lightweight openpose), classification, depth estimation and image processing.

In video games, game mechanics are rules of the games, and what are the player's actions and the game response to it. The game mechanic of this game is to encourage the player to make hand movements. In response to the player's action, the response would be adding a point to the player's score and sounding the buzzer.

The player is supposed to raise their right hand where the right wrist should be placed higher than the right shoulder. In this simple prototype, we programme to check if the player raises her right hand (i.e., Y coordinate of the right wrist is placed higher than the Y coordinate of the right shoulder). If so, the buzzer will ring.

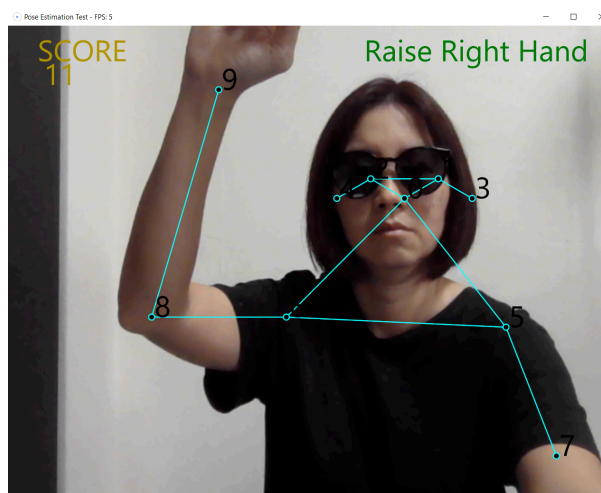


Figure 1: A demonstration of a player raising her right hand and scoring a point

Gameplay is a combination of different elements in a game. A basic gameplay refers to the core game mechanics which determines the features of the game. The basic gameplay of this game is to raise the hand as much as possible to reach the highest score within a predetermined time frame.

The game can be further modified to let the player move different parts of the body to exercise. This can include raising the left hand, raising the left leg, and raising the right leg as instructed by the game instruction. A point can be awarded for doing the correct action as instructed.

As the target audience of our game is elderly people and some of them may be wheelchair bound, we have two versions of the game with one requiring the player to move both arms and another version requiring the player to move both arms and legs.

Some of the dynamic game elements we can change include how frequently we can change the instruction of what the player should do (for e.g., raise right hand, raise left hand) and the duration of the gameplay experience. Dynamic game difficulty balancing is a process where

we can automatically change parameters or behaviour in the game depending on the player's ability to keep the player's from feeling too frustrated or bored. The game's difficulty can be increased by increasing the frequency of different movements the player has to be made. We can allow the player to pick a difficulty level to start the game or start at the beginning stage but to be subject to dynamic difficulty as the player progresses in the game.

Game aesthetics is an important focus. In this prototype, we show the score of the game and instructions from the game. We need to shortlist a few colour schemes and layouts, and conduct a user survey before finalising on the game aesthetics.

Challenges & Discussion

There are numerous challenges we can identify when developing a prototype exercise game for the elderly.

Since this is a computer vision game, we should discuss some of its issues. In terms of accuracy of the game, the height of the male and female are different, and the physio of male and female are different. The game may need to be calibrated for different groups of players. Low lighting is an issue because the game may not be able to detect human poses if the lighting is not optimal and the game cannot be played. Different thresholds may have to be set when it comes to movement of arms and legs, and this may impact the difficulty of the game. There may be too many design considerations and it is important to prioritise the design considerations that are important, and bear in mind what are the "must-have" features to be implemented.

For the prototype, we still need to fine tune the game play, game mechanics, game dynamics and game aesthetics through a more comprehensive user testing of game experience.

Future Work

Moving forward, we would like to modify our prototype to different versions to cater to broadly 2 different groups of elderly people (wheelchair bound and non-wheelchair bound). Conducting more computer vision mechanics testing can be carried out to increase our understanding on the algorithm and mechanism limitations. It is important to improve the accuracy of the game for different groups of elderly people. A more detailed user testing will be conducted. Using the results, this would help in crafting a new framework which focuses on designing computer vision applications for elderly people.

Conclusion

The general design principles for universal design, human factor principles, gamification and gerontology are good to serve as references when designing a computer vision game for elderly people. It is not necessary to have a game that meets all the design principles but rather design a game that meets the needs of the intended audience. In our paper, we have developed a simple computer vision game prototype in Java to allow elderly people to exercise their arms.

It is useful to explore and evaluate computer vision algorithms and libraries that are available and decide if they are suitable to be used in your game design. The prototypes can be fine-

tuned to achieve a more engaging gameplay. It is an iterative process in design to improve gameplay.

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Precision Exercise Guidelines to Improve the Muscle Strength of the Elderly

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Abstract

WHO believes that aging is inevitable and is affected by the environment; how to create a healthy aging community space has become a trend in various countries. Taiwan's elderly population exceeded 7% in 1993. In 2022, 21.69% of Chiayi County will enter the "super-aged (>20%)" society. The government department proposed the "Precision Sports Instructor Training Program", through the assistance of academia to train instructors, and introduce instructors to the community to interact with the elderly (12 weeks). The purpose of this project: to develop precision sports courses, train teachers, and send communities to carry out teaching. Plan implementation: through joint research and development with academic units: 12-week sports course development, teacher training, personnel deployment, course implementation to assessment. After the course, it was found that the grip strength, static balance, and lower limb muscle strength of the elders in the community have significantly improved after sitting and standing for 30 seconds. Summary: Add precise exercise programs to implement community elders: healthy exercise, happy learning, and happy aging.

Keywords: Precision Sports, Training Program, Healthy Exercise

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Introduction: Background

The World Health Organization (WHO) believes that aging is inevitable and is affected by the environment. Creating healthy aging community spaces has become a trend in various countries. In 1993, Taiwan's elderly population exceeded 7%. It was projected that in 2022, 21.69% of Chiayi County would become a "super-aged (>20%)" society. The appropriate government department proposed the "Precision Sports Instructor Training Program" with the assistance of the academe, to train and introduce instructors to the community. These instructors interact with the elderly (12 weeks), promoting healthy lifestyle and aging within the community.

Literature Review

The theory of andragogy was proposed by Knowles, the father of American andragogy, in 1970. Andragogy refers to the art and science of helping adults learn. Knowles defines andragogy as: the art and science of helping adults learn, thereby showing the difference between pedagogy and andragogy. Knowles (1980) believes that.

The goal of human education should be to promote adult self-realization. Therefore, the adult learning process should promote the participation of the whole person (including emotion, psychology, and intelligence). Adult education teachers are positioned as facilitators, in other words, to help adults become self-directed learners.

The theory of andragogy is widely used in adult teaching, activity design, and human resource development in the United States, and there are many related studies (Henschke, 2012).

In Taiwan, the trend of an aging society makes lifelong learning more necessary and promotes the vigorous development of adult education. How to apply the model of andragogy in education and training is even more important.

The main difference between senior learning and traditional activities for the elderly is the different courses. Traditional learning for the elderly focuses on personal interest courses, such as singing, dancing, calligraphy and painting, etc. Elderly learning emphasizes active aging learning (WHO, 2002). From the perspective of needs hierarchy (McClusky, 1971), the theoretical basis of training teaching design is the application of andragogy theory, based on current learning and current application, and creating attractive The learning atmosphere, training outcome assessment using Kirkpatrick (2006).

Four-level model, including: training satisfaction, learning, behavior change and learning transfer. The implementation of Taiwan's senior learning plan is mainly based on the establishment of a general guidance group by the National Chung Cheng University Senior Education Research Center, which is responsible for planning, training, visit evaluation and other research and development work and the design of practical models. The overall implementation of senior education has mastered the concept of system integration of research, training, assistance, research and training. The general guidance team designs talent training courses and effectiveness evaluation indicators based on this spirit, including: volunteer team, management team, and curriculum planning and Training for instructional designers.

Basically, the central government is responsible for policy formulation, and universities are responsible for the development of operating mechanisms, research and development of relevant materials, research of methods, establishment of resource networks, and provision of consultation and guidance by each center. The senior learning centers set up by the Ministry of Education in various townships and urban areas act as learning bases, and form partnerships with various district counseling groups. The non-government, government and academic circles jointly promote senior learning courses and activities.

Andragogical theory includes 6 presuppositions for adult learners. First, adults have self-directed learning abilities; second, adults have rich learning experiences; third, adults' learning readiness is related to their It is related to social role development tasks; fourth, adult learning tends to be problem-centered; fifth, adults need to know why they want to learn; sixth, adult learning motivation must be intrinsic rather than extrinsic.

Purpose

To develop precision sports courses, train instructors, and mobilize communities to carry out teaching activities. Share a personal athletic background and passion for seniors athletics. Explore the importance of active aging and the physical health benefits of exercise. Conduct a group discussion where participants share their expectations and goals for the exercise program. Guide participants in developing a personal exercise plan, encouraging them to set achievable goals and schedules. Provide encouragement and positive feedback to ensure participants understand and participate in the exercise program.

Methods and Materials

The training design adopts unit modular courses. In order to implement the application after the learning, we ask each center director to bring two volunteers to assist and sign up to participate in the training together to form a team.

Research and development collaborations with academic institutions: 12-week sports course development, teacher training, personnel deployment, course implementation and assessment.

- * Community Physical Activity Intervention Strategy
- * Exercise monitoring (fitness testing, recording of usual exercise behaviors)
- * Increased self-efficacy (introduction to physical fitness and knowledge of behavior change methods)
- * Social support (support from participants and relevant people in the community)
Reward and exercise (introduction to daily lifestyle and implementation of Festival campaign)
- * Daily dynamic life plan
Exercise at least 3 days a week, no less than 30 minutes a day, with heart rate reaching 130 beats per minute

Enhance Physical Fitness Program.

- * Strategies such as exercise intervention, nutrition consultation and safety assessment.

Results

The pioneer results showed that the grip strength, static balance, and lower limb muscle strength before activity of the elderly in the community, failed to meet standards. After 12 weeks of activities led by the "Precision Exercise Instructor," the post-test data showed significant improvement and progress.

In Taiwan, the majority of participants in elderly activities are women, with 5 males (19.2%) and 21 females (80.8%). The age range is 70-97(Table 1).

Table 1: Analysis of basic information of participants

| Item | Data | Min | Max | % |
|---------------|-----------------|-------|-----|------|
| Sex | | | | |
| Male | 5 | | | 19.2 |
| Female | 21 | | | 80.8 |
| Age | | | | |
| | 26 | 70 | 97 | |
| | Quartile: 25 | 75.75 | | |
| | 50 | 82.50 | | |
| | 70 | 24.97 | | |

Pre-intervention test results: males greater than females. Grip strength: Male: 25.90>Female 18.21, 30 second sit-ups: Male: 13.00>Female 11.95, Stand on right: Male: 13,60>Female: 5.08, Stand on left: Male: 7.40>Female: 5.73 (Table 2).

Table 2: Pre-intervention data analysis

| | | Pre-activity | | | |
|--------|------------------|--------------|-------------------|----------------|---------------|
| | | Grip | 30-second sit-ups | Stand on right | Stand on left |
| | Average | 25.90 | 13.00 | 13.60 | 7.40 |
| Male | Normal count | 1 | 4 | 3 | 2 |
| | Normal Average | | 12.25 | 20.67 | 13.00 |
| | Abnormal count | 4 | 1 | 2 | 3 |
| | Abnormal Average | 20.60 | | 3.00 | 3.67 |
| | | Average | 18.21 | 11.95 | 5.08 |
| Female | Normal count | 8 | 11 | 3 | 3 |
| | Normal Average | 26.94 | 15.09 | 18.00 | 21.33 |
| | Abnormal count | 13 | 8 | 17 | 17 |
| | Abnormal Average | 12.25 | 7.50 | 2.29 | 2.88 |
| | Space | | 2 | 1 | 1 |

Post-intervention test results: males were greater than females. Grip strength: Male: 29.18> Female: 18.29, 30 second sit-ups: Male: 16.40> Female: 13.12, Stand on right: Male: 12.8> Female: 4.51, Stand on left: Male: 9.40> Female: 5.64 (Table 3).

Table3: Post-intervention data analysis

| | | Post-activity | | | |
|--------|------------------|---------------|-------------------|----------------|---------------|
| | | Grip | 30-second sit-ups | Stand on right | Stand on left |
| Male | Average | 29.18 | 16.40 | 12.80 | 9.40 |
| | Normal count | 1 | 5 | 4 | 2 |
| | Normal Average | | | 15.25 | 16.50 |
| | Abnormal count | 4 | 0 | 1 | 3 |
| | Abnormal Average | 21.73 | | | 4.67 |
| Female | Average | 18.29 | 13.12 | 4.51 | 5.64 |
| | Normal count | 11 | 13 | 3 | 3 |
| | Normal Average | 22.55 | 14.85 | 9.00 | 14.67 |
| | Abnormal count | 10 | 6 | 17 | 17 |
| | Abnormal Average | 12.51 | 8.83 | 3.24 | 3.82 |
| Space | | 2 | 1 | 1 | |

Post-intervention test results: Most of the men improved more than women. Grip strength: Male: 3.28>Female 0.08, 30 second sit-ups: Male: 3.4>Female 1.17, Stand on right: Male: -0.8>Female: -0.57, Stand on left: Male: 2>Female: -0.09.

This study also found that women's physical function data has not improved much, but the overall physical function has improved from the abnormal 13th place to the 10th place. In the future, more collection items should be added and analysis capabilities should be strengthened to understand more in-depth factors and propose more appropriate measures.

This data collection found that data collection items should be added: factors such as inability to participate in activities, long-term and short-term diseases, etc., to understand the factors that change the physical functions of the elderly during their activities.

Conclusion

The study found that women are more sexually active than men, but their physical performance feedback is not significant. In the future, we should explore the reasons for the slow growth of women's physical functions and propose more appropriate exercise intervention measures based on these factors to improve women's physical functions. In addition, it is necessary to understand the factors that prevent men from participating in

activities and increase men's participation in activities outside the home, so as to increase the participation of elderly people in the community and improve their physical functions.

Finally, guide participants to think about their health goals, including improving physical condition, controlling weight, or increasing activity. New precise sports items are added to help the elderly exercise healthily, study happily, and age happily.

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