



**Aging in place among home-dwelling older adults in Canton Basel-Landschaft:
the INSPIRE Population Survey**

Inaugural dissertation

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Flaka Siqeca, MD, MPH

Born in Prizren, Republic of Kosovo

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Approved by the Faculty of Medicine

On application of

Primary Supervisor: Prof. Dr. Sabina M. De Geest

Secondary Supervisor: Prof. Dr. Michael Simon

External expert: Prof. Dr. Koen Milisen

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Prof. Dr. Primo Schär

Dean

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List of Abbreviations

AAL-JP	European Union`s Ambient and Assisted Living Joint Program
ABS	Allschwil, Binningen and Schönenbuch
ADL	Activities of Daily Living
AIC	Akaike Score
APG	Altersbetreuungs- und Pflegegesetz (Old-Age Care and Nursing Act)

Please note this translation is not official and is provided for informational purposes only

ATs	Assistive Technologies
BL	Canton Basel-Landschaft
BS6	Brief Social Support Scale
CGA	Comprehensive Geriatric Assessment
CHF	Swiss Francs
EQ-5D-5L	EuroQoL 5-dimensions 5-levels questionnaire
GFI	Groningen Frailty Indicator
HRQoL	Health-related Quality of Life
HUI	Health Utilities Index
IAC	Information and Advice Centre
IADL	Instrumental Activities of Daily Living
ICOPE	Integrated Care for Older People
INSPIRE	ImplemeNtation of a community-baSed care Pr ^o gram for home dwelling senIoR citizE ⁿ s
MAR	Missing at Random
MCAR	Missing Completely at Random
MICE	Multiple Imputation by Chained Equations
MRC	Medical Research Council
PEOU	Perceived Ease-of-Use
PU	Perceived Usefulness
QoL	Quality of Life
SD	Standard Deviation
SDG	Sustainable Development Goals

SELFIE	Sustainable intEgrated chronic care modeLs for multi-morbidity: delivery, Financing and performancE
SF-6D	Short-Form 6-dimensions
TAM	Technology Acceptance Model
VAS	Visual Analogue Scale
VIF	Variance Inflation Factor
WHO	World Health Organization
WHOQOL	World Health Organization Group on Quality of Life

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Summary

Due to medical and technological advancements, many individuals in countries around the world are living longer (1). In Switzerland between 2020 and 2050, a rise from 18% to 26% for those aged 65 years or older and from 5% to 11% for those aged 80 years and older is foreseen (2). The gains in life expectancy, although a positive outcome, are not always enjoyed in full health and free of limitations. As individuals age, many of them may suffer from the presence of multimorbidity and frailty (3, 4). Functional limitations as well as isolation and loneliness are also frequently reported among this population (3, 5-7). Moreover, these individuals usually receive care from different providers across various settings which can lead to their care being fragmented (8). Fragmentation of care is characterized by gaps in provision of care which could cause confusion and distress for older adults and their caregivers, as well as higher costs associated with unnecessary use of services (9). Despite challenges associated with aging, many older individuals prefer to remain living in their own environments for as long as possible (10, 11), an objective known as *aging in place* (12).

Aging in place is linked to the ability to maintain independence and live a thriving and highly qualitative life within an individual's own environment (13). It can therefore be fostered by designing environments that facilitate the mobility and engagement in social activities, which are important components for the health and quality of life of older adults (14). There is also an opportunity for countries to exploit existing and new assistive technologies, another pertinent facilitator of *aging in place* (15). Assistive technologies are an umbrella term including any device, equipment, instrument or software whose purpose is to maintain or improve an individual's functional status and independence (16).

To assist older adults to *age in place* and address their complex needs, the World Health Organization (WHO) has proposed an integrated care approach to support older adults' independence and make *aging in place* possible (8, 17). Integrated care models are complex, dynamic interventions targeting multiple levels of the healthcare system, which often entail behavior change in the way various health and social care providers provide joint care (18, 19). To successfully develop and implement an integrated model of care, not only the perspectives of the healthcare providers, social care professionals or policymakers are essential, but also the needs and preferences of older adults and their informal caregivers (15, 20). Understanding the demographic and social characteristics of a target population, is also fundamental in planning, developing and implementing integrated care for older people (21).

In 2018, an opportunity for integrated care for home-dwelling older adults was put

forward by a new care law in Canton Basel-Landschaft in Switzerland (22). The INSPIRE project is working together with the local policymakers to support the development, implementation and evaluation of an integrated care model for home-dwelling adults aged 75 and above living in this region (23). The INSPIRE project is an implementation science project, positioned within the three phases (development, feasibility and effectiveness evaluation) of the Medical Research Council (MRC) for developing and implementing complex interventions (18). The project incorporates the recommendations of the MRC framework with several implementation science components such as contextual analysis, stakeholder involvement, as well as using implementation strategies and implementation outcomes to ensure the successful implementation and sustainability of the care model in Canton BL.

During the development phase, an understanding of the context aids in ensuring the suitability of the intervention components for the implementation setting (23, 24). Therefore, we conducted the INSPIRE Population Survey (25, 26) as part of the contextual analysis, with the aim to understand the needs and preferences of older adults, as well as the support and services they currently require and anticipate needing in the future to maintain their independence and make *aging in place* possible.

The overall goals of this dissertation are threefold. First, we aimed to describe the development of the INSPIRE Population Survey and the marketing strategy we used to reach as many home-dwelling older adults as possible, a population that is known to be challenging to recruit in research (27). Second, we used an ecological approach to dive deeper into the health-related quality of life of this population, as one of the main goals of *aging in place*. Finally, we investigated factors associated with openness to use assistive technologies that can facilitate independence among home-dwelling older adults and support them to *age in place*.

Chapter 1 provides a general overview of challenges associated with caring for an aging population as well as the opportunities for integrated care for *aging in place* among home-dwelling older adults. The current literature on the concepts of quality of life and health-related quality of life, as well as the current state of the art on assistive technologies facilitating the autonomy of older adults is also provided. **Chapter 2** follows with the dissertation aims.

Chapter 3 chronicles the research conducted to develop the INSPIRE Population Survey, as well as an outline of the variables and measurements used in the survey (25). The work also describes the marketing strategy used for disseminating the survey and briefly reports on the response rate and participant characteristics. This population-based survey achieved a response rate of 30.7%, which is considerably high for postal surveys (28), particularly in those involving older adults (27). This accomplishment can be credited to the

ongoing stakeholder involvement strategies we used, including early engagement of all stakeholders during the development of the questionnaire as well as its marketing.

In **Chapter 4**, we evaluated HRQoL and factors related to it using an ecological outlook. The participants of our survey reported a high HRQoL, similar to findings from previous research (29, 30). We specifically looked at multilevel factors at the micro, meso and macro level related to how home-dwelling older adults perceived their HRQoL. This ecological perspective permitted the investigation of variables associated not only with the individual, but also with the environment around the older adult. We confirmed that among home-dwelling older adults, having a higher income, supplementary insurance, better education and generally a greater socio-economic status were associated with a higher HRQoL (31, 32). Our findings also validated previous studies indicating that individuals who report to be more frequently involved in one or more social activities, correspondingly report a higher HRQoL (33, 34). We also confirmed factors that negatively impact home-dwelling older adults' HRQoL, as previously researched, like being older and female, having multimorbidity and polypharmacy, and being lonely or socially isolated (35-46).

Chapter 5 presents the results from our study aiming to describe the current and anticipated use of assistive technologies among our participants, namely telemedicine, phone/SMS, wearables and assistive robots; as well the factors associated with openness to use such assistive technologies. We showcased that the current use of assistive technologies was rather low amid participants, compared to findings from two other surveys conducted on this topic among Swiss older adults (47, 48). Our results highlight a new finding that compared to current use, a higher percentage of home-dwelling older adults were open to using wearables and telemedicine in the future. We also found that openness to use assistive technologies in this population was positively associated with their current use, and also with receiving support from a spouse or a partner. Similar to the two previous surveys in Switzerland, openness to use assistive technologies was negatively associated with older age and with being female (47, 48).

Chapter 6 presents a summary of the findings from the three preceding chapters and interprets them in the context of the current literature. Furthermore, methodological strengths and limitations of these studies are discussed. At last, reflections on the implication of this thesis for future research, policy and practice are presented.

In conclusion, this dissertation was part of the development phase of an implementation science project aiming to implement and sustain an integrated care model for home-dwelling older adults. Our findings provide some important insight into the areas requiring the attention of care professionals and policymakers. We brought forward the need for considering the role

the environment and the social network surrounding home-dwelling older adults play in fostering care that augments their quality of life and supports them in maintaining their desired independence. We also showed the potential assistive technologies have in attaining this goal, possibly also alleviating some of the burden of informal caregivers who are providing care and support for home-dwelling older adults. From a research, practice and policy position, we believe our findings have the prospective to provide a better scientific and policy approach in assuring older adults are reaching their goal to *age in place*.

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Chapter 1: Introduction

1.1. An aging population

Improvements in living conditions, healthcare delivery and advancements in technology have increased life expectancy globally during the past few decades (1). The same has also been marked in the European countries, where the median age increased by 2.5 years between 2011 and 2021 (2). In 2021, 20.8 % of the European population was 65 years or older and 6.0 % was 80 years or older, a percentage estimated to continue rising (2). Similarly, in Switzerland between 2020 and 2050, an increase from 18.0 % to 25.6 % for those 65 years or older and from 5.0% to 10.6 % for those 80 years and older is predicted (3).

The newly won years of life, although a positive outcome in itself, are not always enjoyed in full health and free of limitations. Numerous changes to the physical and cognitive reserve as well as an increase in vulnerability to internal and external stressors is common in this population (4). As individuals age, many of them may suffer from the presence of two or more chronic diseases, also known as multimorbidity (5). Furthermore, the prevalence of frailty which is considered “the state of physiological vulnerability with a diminished capacity to manage external stressors” also increases (6). Coupled with the presence of multimorbidity and frailty, functional limitations as well as isolation and loneliness are frequently reported among this population (5, 7-9).

In 2022, the Swiss Federal Statistical Office reported that half of the population aged 75 and older suffers from long-standing health problems (10). Since older adults are increasingly faced with the above-mentioned challenges, their needs have also evolved from acute to chronic (11). This epidemiological transition, in parallel to the demographic aging of the population, is an indication that the demand for health care and social services will increase in the upcoming years, potentially leading to a rise in associated costs (12). These processes will challenge and pose additional burdens to the current healthcare systems around the globe (13).

1.2. Caring for an aging population

The majority of older adults, often suffering from multiple chronic conditions, require care that is continuous and frequently complex. While no single definition of “individuals with complex care needs” is available in the literature, this group is frequently defined as individuals with multimorbidity, commonly accompanied by socio-economic deprivation, and with a generally unpredictable evolution of care needs, which makes the management of their needs particularly challenging (5, 14, 15).

In addition, many home-dwelling older adults in industrialized countries receive long-standing care by a large number of health and social care providers, often in numerous care settings (16). This care across a multitude of providers and settings is seldom centralized or coordinated, subjecting older adults to the risk of fragmented care, which does not meet their needs and does not create favorable outcomes for them (16). Fragmentation of care is characterized by duplication of services, gaps in information transfer, and inappropriate or conflicting care recommendations, which can unsurprisingly lead to medication errors, confusion and distress for older adults and their caregivers, as well as higher costs associated with unnecessary use of services and otherwise avoidable hospitalizations (17).

In parallel, as the number of home-dwelling individuals depending on health and social services continues to rise, research and policy actions have shifted focus to support older adults to continue living in the community instead of only relying on long-term institutions (18). This is also favoured by older adults themselves, who prefer to resume living in their own environments for as long as possible (19, 20). This objective has been described by Cutchin et al. as *aging in place* (21).

1.3. Aging in place

Aging in place is defined as “remaining to live in the community rather than in residential care, with some level of independence (e.g., receiving help from family members or caregivers), but without the need to move away from the community” (22). Most older adults prefer to *age in place* because it fosters their independence and autonomy, and enables them to stay connected to their social circle (23), which can reduce social isolation and loneliness (24). Apart from being a preference of older adults, it is often also considered less costly than care in long-term care facilities such as nursing homes or other assisted living facilities (25, 26).

The WHO’s report on Ageing and Health suggests that in framing any public health response, aging should be seen as a dynamic process and an interaction between an older individual’s intrinsic traits such as adaptability, and the external factors such as social connections supporting them in coping with the dynamic changes related to getting older (27). This paradigm further suggests that *aging in place*, a concept traditionally focused on adapting the physical home or living space, now also incorporates features beyond it, such as the characteristics and the role of the environment where the older adults is aging (28). This report emphasizes that *aging in place* can be fostered by also creating age-friendly environments that enable mobility and allow older people to engage in activities, which are important for their

well-being and quality of life (27). This indicates that *aging in place* is linked to the ability to maintain independence and live a thriving and highly qualitative life within an individual's own environment (29). In making this goal more attainable in the future, emerging assistive technologies also play a central role in ensuring a safe and qualitative life for older adults as they *age in place* (27).

In this dissertation, we dive deeper into the concept of *aging in place*, which simultaneously is the overarching background of this work. More specifically, we explore three main concepts related to *aging in place* in the proceeding sections. First, we dive deeper into the relationship between *aging in place* and quality of life as one of the main goals of *aging in place*. Second, an introduction on the potential of assistive technologies to facilitate *aging in place* will ensue. Third, we outline how an integrated care approach can better support independence and *aging in place*. In liaison with the third section, we also describe how all these concepts amalgamate in the context of Canton Basel-Landschaft (BL) and the INSPIRE project (Implementation of a community-based care Program for home dwelling seniors).

1.3.1. Aging in place and quality of life

As Quality of Life (QoL) is significant in the *aging in place* concept, and *aging in place* is an important element contributing to the QoL of older adults, the two concepts are inextricably related (30). In the recent years, many researchers and public health authorities have encouraged the development of age-friendly social and physical environments to foster older adults' wellbeing, QoL and ultimately, their ability to *age in place* (31). QoL has become an increasingly important construct to be studied in relation to both healthcare and social research (30). The increase in number of older adults will be mirrored in the rising demand for care and support that is cost-effective and optimizes QoL of this population (32). Henceforth, understanding what constitutes QoL, and how to operationalize and measure it comprehensively and over time, is essential in planning future care needs of older adults.

Nonetheless, disentangling the concept of QoL remains a challenge, as this multi-component construct is not always clearly defined, nor there is a consensus of which domains it includes (33). A general agreement exists amongst researchers that QoL is multidimensional (34, 35), it can show variations between – and within- individuals during the life course (36) and acts as a conglomerate of both objective and subjective components (35, 36). Drawing on this multifaceted and holistic approach, the World Health Organization Group on Quality of Life (WHOQOL) defined QoL as: “individual's perception of his or her position in life in

the context of the culture and value system where they live, and in relation to their goals, expectations, standards and concerns” (37).

QoL has long been used as a generic term encompassing many aspects of life such as functional status, health, perceptions, living conditions, behaviours, satisfaction with life, happiness, lifestyle, symptom burden, etc (33). However, which specific domains have an impact on the way individuals perceive their QoL is yet another standpoint where no consensus in literature exists. In studies assessing this construct, health or physical well-being and social domains are always cited, followed by role of the environment next (30).

In healthcare research, Health-related Quality of Life (HRQoL) is hence a common approach on conceptualizing the broader concept of QoL (38). HRQoL is a key patient-reported outcome and an indicator of an individual’s perception of their overall health, be that physical, functional, emotional, or mental, and including the influence of the social determinants of health such as receiving support from family and community as well as being active in the society (39). QoL and HRQoL are often used interchangeably in the literature but a distinction between the two should be made. In short, QoL is broader than HRQoL, as QoL includes evaluation of non-health related features of life, whereas HRQoL is connected to an individual’s health or disease status.

There is a growing number of HRQoL measurement instruments available, and their sophistication, variety and scope is increasing. In recent years, many generic measures of HRQoL have been developed, such as the Short-Form 6-dimensions (SF-6D) (40), the Health Utilities Index (HUI) system (41) and the EuroQoL 5-dimensions 5-levels questionnaire (EQ-5D-5L) (42). In this dissertation, we used the EQ-5D-5L instrument as a generic measure for HRQoL. A reliable and user-friendly instrument that takes a short time for respondents (43), the EQ-5D-5L instrument has been increasingly used in research of HRQoL among older adults (44-47).

Recent evidence suggests that mobility, independence and HRQoL among older people is closely related to the perceived accessibility to services and sites (e.g., trading areas, public services, etc.) (48, 49). Therefore, the environment where older adults live, use the public transport, go to medical appointments, etc. plays a pivotal role (50). Additionally, connection to place (connection to the living environment itself) also plays an important role in successfully *aging in place* (51-53). Connection to place is expressed by close acquaintance with the physical environment, coupled with feelings of belonging to a place by being part of its social and cultural background throughout the lifespan (54).

Nonetheless, when assessing the relationship between connection to place and HRQoL

in home-dwelling older adults, influencing factors beyond the personal (micro) level are not always adequately explored (53). According to the environmental gerontology model (55), an appropriate match between older adults and their milieu, results in better HRQoL for them (54). This reinforces the importance of studying environmental factors associated with HRQoL in this population.

1.3.2. Aging in place and the role of assistive technologies

Another important aspect highlighted by the WHO is an opportunity for countries to exploit existing and new assistive technologies, a further important facilitator of *aging in place* (56). Assistive technologies is an umbrella term including any external product (devices, equipment, instruments or software) whose primary purpose is to maintain or improve an individual's functional status and independence, as well as to prevent further impairments or worsening health conditions, which jointly promote well-being (57).

Assistive technologies may be potential facilitators of *aging in place* as they have been found to contribute to improved functional status or delay functional decline, improve well-being and quality of life, improve safety and reduce risk of falls, reduce need for formal and informal care, improve independence, and generally, reduce worries among older people and their caregivers (29, 58). These tools are widely used for self-care and personal hygiene; to improve hearing, vision, memory and mobility; enhance social connectivity to avoid isolation and loneliness; improve safety; and assist in realizing daily tasks and leisure activities (59).

Numerous assistive technologies enhancing the independence have been developed, and these include but are not limited to communication technologies, health monitoring technologies, telemedicine, medication reminders and internet of things (e.g., wearable devices) (29, 58, 60). These various modes of assistive technologies are increasingly being used to support older people in maintaining their daily functions. Such examples include e-health tools or telemedicine that enable older adults to live independently in their own homes, all the while facilitating the communication with their healthcare providers (61). Furthermore, they can help improve self-management via web-based and telephone consultations, reminders for medication intake and remote monitoring of clinical indicators (62, 63). Through remote monitoring, the healthcare professional can continuously monitor an older adult by assessing their needs and supporting their caregivers, without the need to always be physically present (64). In short, assistive technologies support an individual to perform a task that they would otherwise be unable to or have difficulties to do (65, 66).

One of the key challenged associated with encouraging *aging in place* is to provide

continuous and qualitative care for older adults, in circumstances with limited healthcare resources and suboptimal informal and formal care available (67). Here, the use of assistive technologies has also the potential to offer cost-effective alternative solutions in the face of scarce professional healthcare workforce, while also alleviating the burden of informal caregivers (67, 68). To address these challenges, in 2008, the European Union's Ambient and Assisted Living Joint Program (AAL-JP) (68) was created, with the objective to develop products and services that make a real difference in the lives of older adults and of those caring for them (68). The created products were expected to offer solutions that allowed older adults to feel safe and confident, maintain their social skills and their participation in social life, remain autonomous longer and lead an active lifestyle (68).

Despite the abundant progresses in the development and implementation of assistive technologies, researchers have frequently detected an incongruity between the technologies developed and the perceptions of older adults and their caregivers (67, 69). Therefore, there is a need to explore what older adults need in terms of assistive technologies, as well as understand their concerns regarding the use of such assistive technologies (70). The involvement of older adults in this process remains inadequate (71), yet is imperative to ensure technology innovations are relevant and sustainable, and can contribute to older adults' independence.

The evaluation of these assistive technologies on health and other well-being outcomes among older adults is also lagging behind (67, 72). In parallel, several other issues such as distrust, worries about privacy and safety, and social stigma are also frequently reported as reasons older adults are reluctant to adopt assistive technologies (73, 74). There is also a lack of competence or negative attitudes towards assistive technologies, from the side of formal and informal caregivers, who are concerned that the quality of care provided could be reduced if certain types of technologies are used (75).

1.3.3. Aging in place and integrated care

Addressing the complex needs of older people in an integrated way has been shown to be more effective than services designated to react to diseases or demands independently (76-78). Integrated care is also increasingly being promoted as a cost-effective direction of organizing care for home-dwelling older adults (79). The WHO's Integrated Care for Older People (ICOPE) framework proposes an integrated care approach to guide health systems and services in better supporting independence and *aging in place* for older people (16, 80). This framework defines integrated care as a person-centered model of care led by a multidisciplinary

team that supports coordinated and pro-active care through communicating and cooperating across and within health sectors (16).

Integrated care models are generally considered complex multilevel interventions targeting multiple levels of the healthcare system, are dynamic in nature and frequently require behavior change in the way various healthcare providers communicate and work together (81, 82). Despite the fact that integrated care approaches for older adults are widely promoted (80, 83), many implementation issues across the macro, meso and micro level such as leadership, lack of communication infrastructure, funding, etc. have been identified (84). Moreover, the evidence-base evaluating the effectiveness of integrated care for older adults is mixed and inconclusive (64, 85-88).

There is no general consent that there is a “one size fits all” model for developing and implementing an integrated care program for the aging population (84, 89). However, an EU project named the Sustainable intEgrated chronic care modeLs for multi-morbidity: delivery, Financing and performancE (SELFIE) developed a framework based on the literature and through international expert meetings of five stakeholder groups: patients, partners and informal caregivers; professionals; payers and policy makers (the 5Ps) (90). This framework provides an integrated structure of relevant concepts and elements of integrated care for individuals with multimorbidity, which as previously described includes most older adults (90).

Just as importantly, a rigorous methodological approach is also needed to ensure the integrated care interventions can be developed, implemented and more importantly sustained; so that older adults, their families and caregivers, and the healthcare system can reap the benefits associated with them. One such approach is through using methods of Implementation Science, which is defined as the “scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices into routine practice, and, hence to improve the quality and effectiveness of health services” (91). Implementation Science is concerned with studying which key elements are important to support the design, implementation and sustainability of interventions which can have an impact into the real-world (92). The Basel School of Implementation Science has defined seven such elements as being central: stakeholder involvement, contextual analysis, implementation science frameworks, implementation strategies, implementation outcomes, transdisciplinary teams and hybrid implementation-effectiveness designs (93). This thesis will primarily focus on two of the seven elements of the Basel School of Implementation Science: contextual analysis and stakeholder involvement.

Context is one of the key drivers of implementation of any new intervention (94), and

it is crucial for researchers and policymakers to consider the different care settings and perspectives in which a particular integrated care initiative is taking place (95). A grasp of the context helps ensure intervention components are well-suited for the environment where the intervention is being developed, and map out the actions needed to be taken for its rollout (96). A thorough contextual analysis is therefore central, and it entails investigating current structures and processes at higher provider and financial levels, as well as considering local service providers, service users and policymakers (97).

On the other hand, understanding the demographic and social characteristics of a target population, is also fundamental in planning, developing and implementing integrated care for older people (98). ICOPE recommends accessing local population`s current and anticipated needs to enable projections and plan resources (56). Other researchers also corroborate this approach by suggesting that integrated care approaches focused on reducing service fragmentation for a group of individuals are often more successful than top-down attempts to integrated care, underpinning the patient`s perspective as being at the core of integrated care (95).

Accordingly, to understand the demographic and social characteristics of our target population, we conducted the INSPIRE Population Survey, an important component of the comprehensive contextual analysis conducted as part of the INSPIRE Project (99). In the following subsections, we initially provide an outline of Canton BL and the INSPIRE Project, a project using implementation science methodology to an integrated care approach for older adults *aging in place* in this region. Then, we conclude with an overview of the INSPIRE Population Survey, before addressing the gaps and rationale for this dissertation.

1.3.3.1. Canton BL: an ideal testing field for integrated care for aging in place

Canton BL provided an ideal testing field for the development and evaluation of a community- based integrated care model for older adults because of two main reasons. First, this region has the second-highest (21%) share of population aged 65 and older in Switzerland (3). Second, a new legal framework named the Altersbetreuungs- und Pflegegesetz (APG) (100) was established in Canton BL in 2018, mandating the reorganization of the community care for older adults into larger care regions. The law required each care region to develop a care concept where outpatient, intermediate and inpatient care would be planned (100), and where an Information and Advice Centre (IAC) would be established. The community-based IAC would provide information about aging-related matters, especially if an entry to a nursing home is considered (100); and would be the setting where integrated care for older adults living

at home could be implemented. Therefore, by setting up these centres, a unique opportunity was put forward for Canton BL to be among the few Swiss regions in implementing an evidence-based integrated care model for home-dwelling older adults aged 75 and older, to support *aging in place*.

1.3.3.2. The INSPIRE Project – an implementation science project

The INSPIRE project was initiated in Canton BL with the aim to develop, implement and evaluate an integrated care model (The INSPIRE care model) for home-dwelling adults aged 75 and above. In brief, the INSPIRE care model is a complex intervention with four elements: i) Screening of older adults for risk of frailty; ii) Comprehensive Geriatric Assessment (CGA) delivered by the nurse and the social worker of the IAC, to identify the health and social care needs and goals of the older person; iii) Development of an individualized care plan by a multidisciplinary team, which will be coordinated by the nurse and/or the social worker; and iv) Follow-up depending on the situation of the older adult (101).

The INSPIRE project is positioned within the three phases (development, feasibility and effectiveness evaluation) of the Medical Research Council (MRC) framework for developing and implementing complex interventions (81). In addition to the recommendations of the MRC framework, the INSPIRE project incorporates several implementation science components such as contextual analysis, stakeholder involvement, implementation strategies, implementation outcomes, etc., to ensure the successful implementation and uptake of the INSPIRE care model into the newly formed IAC. During the development phase, a thorough contextual analysis was conducted across Canton BL to gather an understanding of the factors which may influence the development and implementation of the INSPIRE care model, as well as guide the selection of implementation strategies. The project iteratively involved all the relevant stakeholders such as: older adults and their families, cantonal policymakers, local health and social care providers, patient organizations etc., to ensure all the needs of those involved are considered.

1.3.3.3. The INSPIRE Population Survey

To successfully develop and implement an integrated model of care, not only the perspectives of the care providers, care professionals, policymakers, communities and evaluators are essential, but so are the needs and preferences of older adults and their caregivers (56, 102). In practice, however, the end-users are often overlooked, despite the strong promotion of involving them in the design, delivery and implementation of integrated service

research (103). The benefits of involving older adults as end-users to better understand their needs and preferences have been considerably studied and are manifold (103, 104). This process not only facilitates implementation of integrated care approaches, but can improve the quality and the relevance of research (103). Therefore, to support integrated care that can provide the ideal milieu for *aging in place*, engaging older adults in research and planning is fundamental (104).

We sent the INSPIRE Population Survey, a comprehensive population-based survey, by postal mail to all home-dwelling older adults aged 75 and above living in Canton BL. The ICOPE highlights the importance of focusing on target subpopulations with multifaceted needs who might benefit the most from integrated services, such as those aged 75 or older who live in the areas where the integrated care program is being implemented (56). The principal goal of the INSPIRE Population Survey was to understand the living preferences of older adults, as well as the support and services they currently require and anticipate needing in the future to maintain their independence and make *aging in place* possible. This dissertation is embedded within the development phase of the INSPIRE Project and the INSPIRE Population Survey serves as the data source for Chapters 3 to 5 of this dissertation.

1.4. Research gaps and rationale

Using the comprehensive data from the INSPIRE Population Survey, this dissertation aims to contribute in addressing the following methodological and knowledge gaps related to *aging in place* of home-dwelling older adults.

As previously mentioned, many positive outcomes associated with the involvement of older adults in research concerning them are frequently reported in literature. Despite this, older adults as the end-users of integrated care initiatives remain barely included. We made an effort to address this methodological gap by taking a population-based approach and involving older adults in the development and dissemination of the INSPIRE Population Survey. This allowed us to understand the needs and characteristics of our target population, which is a key component in implementing an integrated care approach to aid older adults *age in place*.

On the other hand, one of the main goals of *aging in place* is maximising HRQoL and enabling older adults to not merely live in their familiar environments as they age, but also lead a life that is qualitative and meaningful to them. This dissertation is in an ideal position to harness the benefits of the population-based methodology which collected not only information on the individual characteristics, but also captured important elements of their environment.

Therefore, we endeavour to study HRQoL and factors associated with it among home-dwelling older adults, using an ecological approach.

Finally, assistive technologies have the potential to support older adults in their daily functions and independence, and are important enablers of *aging in place*. The developed assistive technologies need to be relevant and meet the necessities of older adults. Therefore, involving older adults in research to gather their perspective is important in ensuring the developed technology products are relevant and qualitative. By using the data collected from a survey including all home-dwelling older adults, we strive to expand on the evidence base of factors influencing openness to use assistive technologies among the home-dwelling older population in Switzerland.

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Chapter 2: Dissertation aims

2.1. Dissertation aims

This PhD project is based on data from the INSPIRE Population Survey and includes the following aims:

- (1) Chronicle the development of the INSPIRE Population Survey; outline the variables and measurements used in it; describe the marketing strategy utilized to reach home-dwelling older adults and report on the response rate and general respondent characteristics ([Chapter 3](#))
- (2) Assess health-related quality of life (HRQoL) among home-dwelling older adults aged 75 and above, and investigate the correlates of HRQoL in this population, guided by the levels of the ecological model ([Chapter 4](#))
- (3) Describe the current and anticipated use of assistive technologies (telemedicine; phone/SMS; wearables and assistive robots), and assess the factors associated with openness to use assistive technologies among this population ([Chapter 5](#))

Chapter 3: The INSPIRE Population Survey: Development, dissemination and respondent characteristics

Flaka Siqeca¹, Katrina Obas², Olivia Yip¹, Samuel Stenz¹, Penelope Vounatsou², Matthias Briel³, Matthias Schwenkglenks⁴, Carlos Quinto⁵, Eva Blozik⁶, Andreas Zeller⁷, Leah L. Zullig⁸, Sabina De Geest¹, Mieke Deschodt⁹

¹ Department Public Health, Institute of Nursing Science, University of Basel, 4051 Basel, Switzerland

² Department of Epidemiology and Public Health, Swiss Tropical and Public Health Institute, 4051 Basel, Switzerland

³ Department of Clinical Research, Basel Institute for Clinical Epidemiology and Biostatistics, University Hospital Basel, 4051 Basel, Switzerland

⁴ Department Public Health, Institute of Pharmaceutical Medicine (ECPM), University of Basel, 4051 Basel, Switzerland

⁵ Aerztegesellschaft Baselland, 4132 Muttenz, Switzerland

⁶ Helsana-Gruppe, 8001 Zürich, Switzerland

⁷ Department Clinical Research, Center for Primary Health Care, University of Basel, 4051 Basel, Switzerland

⁸ Department of Population Health Sciences, Duke University School of Medicine, Durham NC 27701, USA

⁹ Department of Public Health and Primary Care, Gerontology and Geriatrics, KU Leuven, 3000 Leuven, Belgium

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3.1 Abstract

Background: Most older adults prefer to continue living at home despite increasing care needs and demand for services. To aid them in maintaining independence, integrated care models for community-dwelling older people are promoted as the most cost-effective approach. The implementation of such care models is challenging and often the end-users are not involved or their needs are not considered. We conducted a population survey in order to understand the needs and preferences of home-dwelling older adults living in Canton Basel-Landschaft (BL), Switzerland. The aims of this paper are to chronicle the development of the INSPIRE Population Survey, outline the variables and measurements, describe the marketing strategy utilized for survey dissemination and report on the response rate and respondent characteristics.

Methods: The INSPIRE Population Survey, conducted between March and August 2019, is a cross-sectional survey of older adults aged 75 and older living at home in Canton BL. The questionnaire was developed by expert input and stakeholder involvement. Its readability and acceptability were pilot-tested with older people. To ensure the likelihood of a high and representative response rate, a meticulous step-by-step marketing strategy was developed prior to the dissemination of the questionnaire.

Results: The overall response rate was 30.7% (n = 8,846), with variations between 20.6% and 34.5% across the different care regions in the Canton. A generally higher response rate was found in the care regions with a higher density and which bordered the urban city of Basel. We received support from local stakeholders, policy makers and media through using a broad combination of marketing channels and targeting our community partners who have a strong relationship with our target population.

Conclusions: Although recruiting older adults in research is challenging, our study shows that a high response rate can be achieved by developing the survey through expert input and by involving all important stakeholders, including older adults, throughout the entire process.

Key Words: Aged; Delivery of healthcare, Integrated; Demographic Survey, Surveys and Questionnaires; Community-care; Stakeholder involvement

3.2. Background

With older age, the health and social needs of older adults become more complex and the demand for services and associated costs increases (1). Older adults are considered to be at a higher risk of developing geriatric syndromes, such as delirium, falls, incontinence and frailty (2). Furthermore, multimorbidity, the coexistence of two or more chronic diseases, is prevalent between 62% to 81% among adults older than 65 years (3).

Despite the potential age-related decline in basic and instrumental activities of daily living, most older adults prefer to maintain their independence and continue living at home (4). Because older people often have multiple health needs, services designated to treat a single disease or demand are not optimal (5-7). In contrast, integrated approaches to service delivery can be more cost-effective and result in better outcomes for home-dwelling older adults (8). The World Health Organization has defined integrated care services as services managed and delivered in order for people to receive a continuum of care, coordinated across the different levels within and beyond the health sector and tailored to their individual needs (9).

Implementing integrated care services is rather challenging because they frequently include many intervention components, target several outcomes and occur at various system levels (10, 11). While they often involve different types of health professionals, policy makers and other stakeholders, the end-users are often overseen, despite the strong promotion of involving them in the design, delivery and implementation of integrated service research (12). There are several acknowledged benefits of involving older adults as end-users to better understand their needs and preferences (12). These include facilitating of implementation of health technologies, clarification of areas of practice that can improve care, enhancing the quality of research as well as improving chances of conducting more relevant research (12). Hence, in order to transform the system to support integrated care, engaging older adults in healthcare research and planning is essential (13).

Consistent with the recommendations to involve older people as important stakeholders in building better coordinated systems (9), the INSPIRE project (ImplemeNtation of a community-baSed care Program for home dwelling senIoR citizEns) is striving to develop and implement an integrated care model for people aged 75 and older living at home in Canton Basel-Landschaft (BL) in Switzerland. It is a project positioned within the first three phases of the Medical Research Council (MRC) framework for developing and evaluating complex interventions, all the while integrating implementation science components (Appendix A , Supplementary File F1) (14). During the first phase – the development phase - an understanding of the context aids in ensuring the suitability of the intervention components for

the implementation setting (15, 16). Consistently, the INSPIRE Population Survey was conducted as part of the contextual analysis of the INSPIRE project, with the principal aim to gain a better understanding of both current as well as anticipated needs and preferences of people aged 75 and above living at home in Canton BL.

The objectives of the current paper are to (1) chronicle the development of the INSPIRE Population Survey; (2) outline the variables and measurements used in the survey; (3) describe the marketing strategy utilized for the dissemination of the survey and (4) report on the response rate and respondent characteristics. The paper is specifically focused on the development, dissemination and respondents' characteristics and it is not intended to serve as a paper reporting on the overall results of the survey. Therefore, it is structured in a manner that the methods section is placed central to describe the way the survey questions were developed and which dissemination approach was utilized.

3.3. Methods

3.3.1. Design, sample and setting

The INSPIRE Population Survey is a cross-sectional study conducted between March and August 2019 in Canton BL in Switzerland, a German-speaking region with a mixture of urban and rural areas. All home-dwelling older adults who were 75 or older and living at home in this region were invited to participate in the study. Only older adults living in a nursing or a care home were excluded.

Canton BL is inhabited by 290,000 citizens distributed in 86 municipalities, and has the second highest proportion (21%) of population aged 65 and older in Switzerland (17). The municipalities were grouped into eight care regions as mandated by a new law published in January 2018 (Figure 1) (18). The range of municipalities comprising a given care region varied broadly between only 3 in the Allschwil, Binningen and Schönenbuch (ABS) region to as high as 29 municipalities in the Oberbaselbiet region.

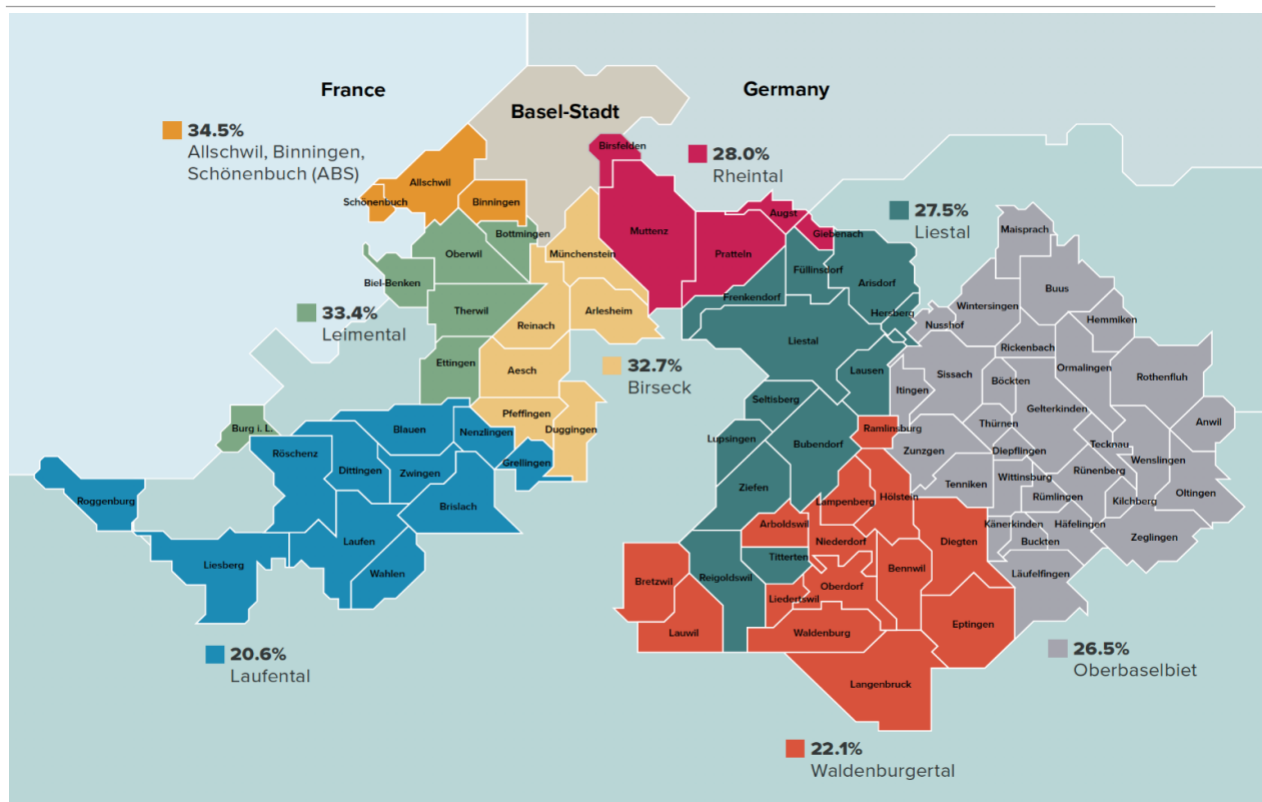


Figure 1: Map of the care regions of Canton Basel-Landschaft and their corresponding response rates

3.3.2. The development of the INSPIRE Population Survey

The INSPIRE Population Survey was developed through a comprehensive step-wise and iterative process involving various stakeholders. In November 2018, a draft version of the survey containing 154 questions was developed by the research team through a literature review and several internal discussion rounds. Several validated instruments were included in this draft, such as the Groningen Frailty Index (19), the Lawton-Brody Scale (20), the Barthel Index of Activities of Daily Living (21), the Brief Social Support Scale (22) and the Satisfaction with Life Scale (23). This draft version was discussed with an expert group consisting of 11 stakeholders from BL, a heterogeneous group of experts with different professional backgrounds and expertise. This group included representatives from the Cantonal Health Department and the association of the BL municipalities; organizations providing health and social services; the association of Swiss nursing homes; the Cantonal hospital; the association of general practitioners of Canton BL and the Ombudsman's office of Canton BL. These experts considered the questionnaire too long and stated that some questions were intrusive, such as those on independent grooming, bathing, toilet use and dressing coming from the Barthel Index of Activities of Daily Living (21). Based on this feedback, 71 questions were removed. As the entire INSPIRE project heavily relies on stakeholder involvement, we had to

find a balance between the researchers' needs and the stakeholders' preferences. The shortened version was e-mailed back to the experts to allow for supplementary input. Additionally, it was also sent for review to the Cantonal Stakeholder Committee which, in addition to the 11 aforementioned experts, also included representatives from various municipalities of Canton BL, representatives of working groups in charge of forming the care regions, as well as representatives from other health and social care providers in the region. Their main feedback was that the survey should not include clinical questions about the presence of chronic illnesses or a list of medications, but should instead mainly focus on the living situation and the needs of this target population. This prompted the removal of an additional 8 questions. This version, approved by all involved stakeholders, was ultimately also pilot-tested for clarity and readability with 6 older adults. One of the largest service provider organizations for senior citizens in Switzerland, which was part of our stakeholder group, supported us with the pilot-testing of the questionnaire. They helped us select a sample of 6 individuals aged 75 and above that were clients of this organization. Minor changes to the clarity of the questions as well as adaptations to answer choices were made following the pilot-testing, to produce the final version of the questionnaire which contained 75 questions.

3.3.3. The INSPIRE Population Survey

The majority of questions in the final survey were multiple-choice close-ended questions. Questions were formulated to be direct and specific, using the active voice and providing examples to illustrate key information. Special consideration was given to the easily readable font typeface with sufficiently large letters and limited use of italics, underlining or bolding for emphasis, as recommended by the National Institute of Aging of the U.S. Department of Health and Human Services (24). The questionnaire took approximately 30 to 60 minutes to be filled out. A detailed description of variables and instruments utilized can be found below whereas an English version of the INSPIRE Population Survey, which has been provided for informative purposes and for which no backward translation was performed, can be found in Appendix A, Supplementary File F2.

Baseline demographics

The demographic information collected included information on age (year of birth); gender; birth country; education level; German language competency level; household income and size; as well as the type of social and health insurance. Information on whether the

participant filled-out the questionnaire themselves or with the help of others as well as the degree of urbanization, defined by the postcode, was also collected.

Frailty

The Groningen Frailty Indicator (GFI) tool consisting of fifteen questions was embedded within the questionnaire to assess the prevalence of frailty among participants. This instrument is aimed at determining the level of frailty through measuring loss of function in four domains: physical (mobility functions, multiple health problems, physical fatigue, vision and hearing), cognitive (cognitive dysfunction), social (emotional isolation) and psychological (depressed mood and feelings of anxiety) (19). Answer choices are dichotomized for each question, with a score of 1 indicating a problem or dependency. The GFI score therefore ranges between 0 and 15, with geriatric experts agreeing that a score of 4 or higher represents frailty (19). The tool has been validated and adapted in German (25).

Current and anticipated living situation and arrangements

These questions were developed by the research team to understand what comprises a good living situation for the participants (e.g., access to public transport, proximity to cultural or leisure activities, living in their own house, having a garden, etc.); what is their current living arrangement and household composition; the physical environment of their current living space (e.g., whether they had stairs with handles or whether their bedroom and bathroom were on the same floor); and their overall satisfaction with their current living situation. Furthermore, the anticipated living situation and arrangements were assessed by asking what the ideal living situation would be for them in case of dependency in the future. Most of these questions were categorical and allowed for multiple responses in a single question. Included were also three out of five questions from the Satisfaction with Life Scale, which was validated in German (23). The answer choices for the three selected questions included the following: “Agree”; “Neither Agree nor Disagree” and “Disagree”.

Health and social services utilization

Healthcare utilization, was assessed by asking participants about the frequency of visits to the general practitioner, specialists, emergency department and hospital overnight stays in the previous year. Additionally, the type of social services they had utilized in the previous year as well as information on the ones they anticipate to need in the future (e.g., meal services, assistance with chores, transport services, etc.) were also captured.

Use of technology

Four questions for each of the following types of technology assessed whether participants used telemedicine to communicate with their healthcare provider; used the phone or SMS services to get information and reminders about medication intake; utilized portable medical devices like heart rate and blood sugar monitors or used assistive robots for chores and other types of support in their household. An additional question in this category also explored to which type of technology (i.e., telemedicine, phone or SMS, portable devices or assistive robots) the participants would be open to use in the future.

Health-related quality of life

The EQ-5D-5L instrument was used in this survey to assess health-related quality of life (26). This instrument comprises of a short descriptive questionnaire and a visual analogue scale (VAS) that are cognitively undemanding and take a short time to complete. The descriptive questionnaire comprises of the following five different dimensions of health: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each dimension has five response levels of severity, ranging from 1- no problems, 2-slight problems, 3-moderate problems, 4- severe problems to 5- unable to/extreme problems. The respondents were asked to rate their health state by checking the box next to the most appropriate response level of each of the dimensions. A sum score ranging between 5 – 25 was then calculated, where a higher score denotes more problems. The VAS records self-rated health status on a scale from 0 – 100 where the endpoints are labelled ‘The worst health you can imagine (0)’ to ‘The best health you can imagine (100)’.

Health status

The health status of the participants was assessed by asking them whether they experienced vision, hearing or memory problems in their daily life, with dichotomized yes/no answer choices. Questions on the quality of sleep in the past four weeks, unintentional weight loss in the past six months as well as frequency and severity of pain were also included in the questionnaire. Furthermore, polypharmacy (defined as taking 4 or more medications at once) as well as the intake and the frequency of pain and sleep medication were recorded. One additional question also assessed whether the participants were able to independently take their medication correctly.

Social support

A question with six sub-questions, three of which assess tangible support and three assess emotional support from the Brief Social Support Scale instrument validated in German were used (22). In this instrument, responses are scored on a 4-point Likert scale ranging from 1- “never” to 4- “always”. Several additional questions also assessed from whom (both individuals and organizations) the participants currently received support from, as well as from whom they anticipate to receive help from, in case of dependency in the future.

Functional status

Functional status was assessed using (in)dependence on Instrumental Activities of Daily Living (IADL) instrument (27). The IADL was measured using the Lawton and Brody scale, which measures (in)dependency for eight activities (telephone use, shopping, food preparation, housekeeping, laundry, mode of transportation, medication use and finances) (27). The scale has been deemed ideal for home-dwelling older adults and its validity and reliability have also been reported (20).

Lifestyle

The lifestyle section included questions on frequency and types of physical activities within a typical week; the amount and frequency of alcohol intake within a typical week as well as the current smoking status. Moreover, we included a list of hobbies and activities (e.g., sports, political parties, church gatherings, etc.) which participants could check indicating whether they were active in or wished to be active in.

3.3.4. The marketing strategy and dissemination approach

To ensure a high and representative response rate to the INSPIRE Population Survey, we developed a wide-ranging marketing strategy before the dissemination of the survey. A designated team including members of the INSPIRE project as well as two administrative staff from the Institute of Nursing Science were in charge of all the marketing and ensured adherence to the strategy.

We issued a joint press release between the University of Basel and the Office of Public Health of Canton BL to help reach a broader audience and advertise the upcoming survey. Additionally, a designated Swiss member of the team continuously communicated with local newspapers, to ensure the information was reaching all municipalities of Canton BL. Continuous information and updates were also posted on the webpage and the social media platforms of the INSPIRE project. Support for marketing was sought by asking stakeholders

and collaborators to put up advertising posters and distributing flyers within their premises such as in doctors' offices; pharmacies; libraries; churches; grocery stores and local supermarkets; banks as well as in community and recreational centers. All social and healthcare organizations who were active in the region were also contacted and asked to put up posters, distribute flyers and forward an e-mail to their clients detailing the goal and the relevance of our study. Moreover, a local organization which provides support and help to the visually-impaired individuals offered to help any visually-challenged participant to fill out the survey. Finally, a phone help line was made available throughout the entire data collection period, in case the participants or their caregivers had any concerns or questions.

3.3.5. Data collection

Data collection started in March 2019 and was concluded at the end of August 2019. We had initially set the data collection time until the end of May 2019 (3 months) and did receive back more than 95% of the questionnaires during this period. However, in the subsequent weeks we continued to receive around 20-30 more questionnaires per week, so the research team decided to extend the data collection until the end of August to allow for more participants to express their wishes and preferences through the survey. A survey package containing the questionnaire along with instructions for filling it out, an information sheet, a personalized cover letter, a pre-paid return envelope and the informed consent form was mailed through the Cantonal Statistical Office to the home address of all home-dwelling older adults aged 75 years or older in Canton BL. The study information sheet included important information about the target population, the study procedures and the expected results. Participants were informed about the time needed to complete the questionnaire, the voluntary nature of their participation, the possibility to fill out the questionnaire with the help of a proxy and the data protection procedure. Individuals who presumably would be less likely to respond (i.e., non-native German speakers; the very old and frail; those with cognitive impairment, etc.) have been encouraged to respond with the help of a family member, relative or informal caregiver. No financial incentive was provided for participating in the survey. While we sent a reminder to some of our community partners to enquire if they needed additional marketing items, there was no reminder sent directly to the potential survey respondents.

3.3.6. Data Management

All the questionnaires were pseudonymized prior to being delivered with the intent to allow potential follow-up in the future. However, due to concerns of the general public on data

security and based on several stakeholder recommendations, we anonymized the questionnaires after having sent them and destroyed all documents containing identifiable information. Data collected in this project are archived following the current Swiss legal requirements for data protection and according to the Ordinance HRO Art. 5. All anonymized survey questionnaires are stored in a secure, password-protected server at the Institute of Nursing Science, University of Basel. Physical copies of the questionnaires will be stored in the locked archives of the Institute of Nursing Science for 10 years and destroyed afterwards.

3.3.7. Statistical analysis

General descriptive statistics have been computed for the demographic variables. Measures of central tendency (mean, median) and spread (range, standard deviation) were performed as appropriate for continuous data whereas categorical data have been expressed as percentages.

All statistical analyses were conducted using the latest version of SPSS (version 26.0) (28).

3.4. Results

3.4.1. Response rate

The INSPIRE Population Survey was successfully delivered to 28,791 eligible individuals. We received a total of 8,846 questionnaires back, thus giving us a total response rate of 30.7%. During the validation process, 60 questionnaires were excluded because ZIP codes were from other Cantons, respondents were younger than 75 years old or were residing in a nursing or a care home.

The response rate varied between care regions from as low as 20.6% in the Laufental region to as high as 34.5% in the ABS region (Figure 1). We noticed a generally higher response rate across the care regions that had a higher density and in care regions bordering the urban Canton of Basel, as compared to care regions located further and considered more rural (Figure 1).

3.4.2 The marketing campaign

We received media support in forms of both written and electronic newspapers as well as from several local radio programs. Seventeen of the local newspapers which are frequently read by older adults wrote articles about the survey to encourage participation. Additionally,

twenty-four municipalities published information about the INSPIRE Population Survey on their official websites.

We also received support from several health and social service providers in Canton BL. The Canton BL branch of the association of Swiss Nursing Homes wrote a Twitter post about the survey and the expected benefits of understanding the needs and preferences of older adults living in the region. Moreover, a large umbrella non-profit organization which provides outpatient health services as well as support on household and other chores, also promoted the INSPIRE Population Survey on their website. Some of the local branches of this organization also sent out a promoting flyer directly to their clients.

3.4.3. Demographic characteristics of the participants

The mean age of all respondents was 81.8 (SD=4.8) years and a little over half of them (51.8%) were female. More than a half of the respondents (50.7%) had completed an apprenticeship (*Ausbildung*) whereas around 10% had a university degree. Around 9% of the respondents reported the total earnings of their household to be less than 3000 CHF (Swiss Francs) per month which is comparable to reports on household monthly income on a national level (29). On the other hand, around 11% of the respondents reported monthly household earnings to be above 9000 CHF per month. A detailed description of the demographic characteristics as well as information on the number of inhabitants and population density compared across the eight care regions of Canton BL can be found in Table 1.

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Table 1: Participant characteristics of the INSPIRE Population Survey (total sample of Canton BL with comparisons across the care regions)

Variable	Canton BL	Care region							
		ABS	Liestal	Leimental	Laufental	Birseck	Rheintal	Walden-burgertal	Ober-baselbiet
Bordering Basel-City	n/a	Yes	No	Yes	No	Yes	Yes	No	No
Response rate, n (%)	8786 (30.7)	1503 (34.5)	1031 (27.5)	1336 (33.4)	280 (20.6)	2038 (32.7)	1368 (28.0)	269 (22.1)	752 (26.5)
Nr. of inhabitants 75+	28622	4371	3770	3995	1361	6216	4884	1180	2845
Density (sq km)	560	6900	6080	6283	2399	6340	8220	2587	7631
Age, mean (SD)	81.8 (4.8)	82.0 (4.8)	81.8 (4.8)	81.6 (4.6)	81.7 (4.6)	81.8 (4.7)	81.8 (4.9)	81.4 (4.9)	81.5 (4.8)
Female gender (%)	51.8	52.3	49.5	51.1	49.8	53.1	53.4	52.4	49.8
Education (%)									
No degree	1.0	1.1	1.0	0.5	1.1	0.9	1.3	1.9	0.8
Elementary school	14.8	12.1	14.2	9.1	24.9	13.1	19.7	22.1	19.8
Apprenticeship	50.7	49.6	51.3	48.8	53.1	51.3	51.3	51.1	51.7
Gymnasium	4.4	6.0	3.5	4.7	2.9	4.8	4.2	4.2	2.0
University of Applied Sciences	14.4	13.5	15.5	16.7	9.5	15.0	13.0	9.5	14.6
University	10.3	13.1	10.1	15.3	4.8	10.3	5.7	7.6	7.2
Other	4.5	4.5	4.4	4.8	3.7	4.8	4.8	3.4	3.9
Income (%)									
<3000	9.3	8.4	9.4	4.6	17.4	8.9	9.2	18.4	12.8
3001-6000	36.6	34.4	35.5	29.8	46.4	35.5	42.4	39.6	42.5
6001-9000	26.5	27.2	29.9	27.9	12.1	26.1	28.2	21.6	24.3
>9000	11.1	11.6	10.7	18.3	8.3	12.6	6.3	5.6	7.4
Do not know	1.1	0.8	1.1	1.3	0.8	1.3	1.1	0.4	1.1
Do not wish to answer	15.4	17.7	13.4	18.2	15.1	15.6	12.9	14.4	11.9

3.5. Discussion

The aim of the INSPIRE Population Survey was to gain a better understanding of needs and preferences of older adults living at home in Canton BL. The purpose of this paper was to describe the development of the questionnaire, the marketing strategy employed prior to its delivery and compare response rates and demographic characteristics of the participants across the newly formed care regions of Canton BL. We achieved an overall response rate of 30.7% on the cantonal level. In a general population study comparing response rates across postal, internet and telephone modes, our response rate is comparable to the one achieved with the telephone mode (30.2%) and considerably higher than the response rate to postal surveys (10.5%) (30). Hence, through using postal mail as a delivery method without any direct incentive for participation, we achieved a response rate which is much higher than the one reported by Sinclair et al. for the postal surveys (30).

We believe this response rate is particularly excellent given that our target population has been known to be challenging to reach and might have needed additional support to fill out the questionnaire (31). The overall success of this survey can be credited to a myriad of factors. First, we consider that testing the acceptability and the readability of the survey, tailoring it to the target population as well as continued feedback from both experts and collaborators has made the survey more appropriate for the respondents. Second, we employed a marketing strategy throughout the entire process to ensure the information was being disseminated thoroughly. We believe the real value of our approach was in using the channels most applicable and trusted by our target population, such as local newspapers and service providers. The marketing efforts which started from the beginning of the study and were constantly reassessed, with an emphasis on diverse methods and approaches, have further aided the success of the survey. Additionally, we also involved most stakeholders early on in the process. The time invested into building a relationship and trust with the stakeholders has undoubtedly contributed to the successful conduct of the study. Finally, we believe that we achieved a high response rate because the topic of the survey appeared to be very important to the respondents. We have received many hand-written notes from the participants expressing their gratitude for the opportunity to express their needs and preferences as they continue aging in their homes.

Nevertheless, we do acknowledge that our study comes with sampling limitations, as we targeted the entire eligible population rather than sampling with a probabilistic approach. We used a non-probabilistic sampling method because we aimed at exploring the needs and preferences of a very specific population to aid the implementation of the INSPIRE project.

Furthermore, this approach was a request by the stakeholders of the project, as they wished that the analysis be conducted on regional level to allow for mapping of the needs and preferences of this segment of the population to the specific regions. Moreover, because of the anonymous data collection, we had no means of knowing if non-respondents differed from respondents. There exists the possibility that older adults who responded to our survey were healthier and more engaged in social life than the targeted population on average, while the very old, most frail or cognitively challenged may have been less likely to respond, thus subjecting our study to additional selection bias. However, the percentage of frailty among home-dwelling older adults as measured by the GFI in comparable populations is in line with our observed results (not presented in this manuscript) (32). Further limitations may stem from the fact that the entire questionnaire was not tested for reliability and validity, but only included a number of validated instruments (19, 22, 26, 27) Although we tested the face and content validity, other forms of validity testing, and testing of reliability, were outside the scope of this research. The length of the questionnaire might have also discouraged some participants from responding, especially considering that answering survey questions can be both cognitively and physically demanding for older participants (31). This is particularly the case with older individuals whose poor vision along with potential decline in cognitive abilities can affect their capability to engage in survey research, especially in paper-based questionnaires (33). One further limitation that might have hindered us in reaching an even higher response rate is that we did not involve older adults in the very early stage of selecting questions. This could have potentially improved the relevance of the questionnaire for them and increased their willingness to respond (34). Furthermore, even when older adults were involved during the pilot-testing phase, the sample of older adults available for pilot-testing was a small sample of convenience and may not have fully represented the true diversity of this fragment of the Canton BL population. Another aspect of our study that might be considered a limitation could be the fact that we have not properly evaluated our marketing strategy, but instead made assumptions on its effectiveness based on the response rate achieved. Moreover, the limited opportunity to involve older adults in the development of the marketing strategy might have hindered our study from achieving an even higher response rate.

Unfortunately, some survey questions had to be substantially reduced as we aimed to reach a balance between research and stakeholder perspective. Hence, some of the information that could have provided further valuable insights, such as the presence of comorbidities and information on medication intake, were not captured in our study. However, the broad range of information collected on the social determinants, the assessment of potential predictors of

frailty, the self-reported health indicators and health and social resources of these older adults have the potential to enable projections on future needs of this subpopulation. In the upcoming years, this large and unique data set will be used to explore several research questions that will further inform service planning research. This will include the assessment of predictors of health-related quality of life among home-dwelling older adults as well as the assessment of whether an association exists between quality of life and the family structure of the older adult. Several of the variables collected from this survey will also be used to complement and compare outcomes with both the feasibility and implementation studies of the INSPIRE care model (16), such as for example potentially inappropriate medication use in older age or the social support they receive daily.

3.6. Conclusions

We achieved a desirable response rate compared to other population surveys (30), through an early involvement of most stakeholders in both the process of developing the questionnaire as well as during the marketing process. The data collected in this survey will inform the further development of the INSPIRE care model and can serve as a comparison in later evaluation. Additionally, we believe it will also serve the politicians and the local organizations in the community to tailor future health and social services they plan to provide for older adults living and aging at home in Canton BL.

3.7. Ethical approval and consent to participate

The ethical approval for conducting this survey was sought by the Ethics Commission Northwestern and Central Switzerland (Ethikkommission Nordwest- und Zentralschweiz – EKNZ). The ethical investigation did however show that this was not a study subject to approval in the sense of cantonal and federal legislation, as the project was not deemed a research study as defined by the Human Research Act Art. 2. Therefore, the EKNZ did not issue a formal ethical approval but instead concluded that the study did meet the general ethical principles for research involving human beings (cf. Art. 51 para. 2 Human Research Act). All methods in this study were carried out in accordance with relevant guidelines and regulations, and an informed consent was obtained from all participants in the study.

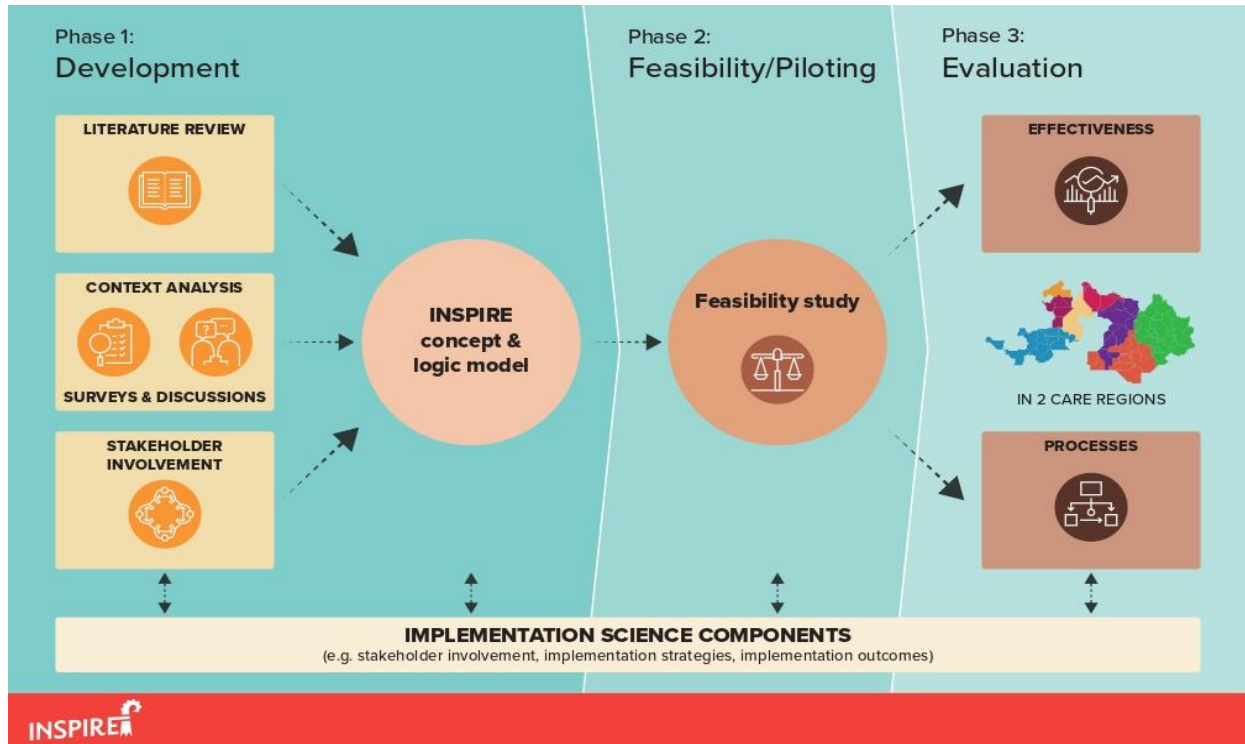
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3.9. Appendix A

Supplementary File F1: The INSPIRE project overview mapped according to the Medical Research Council (MRC) Framework



Supplementary File F2: The INSPIRE Population Survey in English
(Provided for informative purposes only and for which no backward translation was done)

Who are you?

Not all older people want and need the same thing.

We would like to respond to your personal needs.

Therefore we would like to get to know you better!



1. **Will you fill in the questionnaire alone or with the help of another person?**

- I'll fill it out alone.
- I'll fill it out with another person.

2. **Year of birth:**

3. **Postcode of your place of residence:**

4. **Sex:** Male Female

5. **What country were you born in?**

- Switzerland
- France (France)
- Germany (German)
- Others: _____

6. **What is your highest level of education?**

- No school leaving certificate
- Elementary school
- Completed training
- Gymnasium
- University of Applied Sciences / Technical University
- University
- Don't know
- Others: _____

7. **How well do you speak German?**

- Swiss German is my mother tongue
- German is my mother tongue
- good
- Bad

8. **What is the current total monthly income of *your household* (all persons) in Swiss francs?**

- <3000
- 3001-6000
- 6001-9000
- >9000
- Don't know
- I don't want to answer

9. **Do you have financial worries?**

- Yes
- No

10. **How are you insured with the health insurance?**

- General information
- Semi-private
- Private
- Flex
- No insurance

11. **Do you receive supplementary benefits?**

- Yes
- No.
- Don't know

12. **Do you receive helplessness compensation?**

- Yes
 - No
 - Don't know
-

How would you like to live?

For older people, housing is crucial for their quality of life.

Therefore, older people have more options to choose how they want to live.

We want to know what is important to you.



What is a good housing situation for you?

13. **What makes a good living situation for you?** *Please check all possible answers.*

- Your own apartment / house
 - Barrier-free / wheelchair accessible
 - Own garden
 - Proximity to family and friends
 - Proximity to nature / parks
 - Proximity to the city
 - Proximity to shopping facilities, library, etc.
 - Proximity to doctors, health care facilities, etc.
 - Proximity to church or social facilities
 - Good public transport connections
 - Opportunities for participation in social life
 - Opportunities for exchange with other elderly people
 - Opportunities for exchange with people of all ages
 - Others: _____
-

14. **What would be your ideal idea for living in old age as long as you are independent?** *Please tick only 1 answer.*

- In my own home (*please specify*):
 - alone or with a partner
 - with extended family
 - with subtenant
- In the home of a family member (e.g. son, daughter)
- In a flat-sharing community
- In a flat for the elderly / assisted living
- In an old people's home / nursing home

15. **What would be your ideal idea for living in old age if you are dependent on the support of other people (e.g. Spitex, family, friends)?** *Please tick only 1 answer.*

- In my own home (*please specify*):
 - alone or with a partner
 - with extended family
 - with subtenant
- In the home of a family member (e.g. son, daughter)
- In a flat-sharing community
- In a flat for the elderly / assisted living
- In an old people's home / nursing home

What is your current housing situation?

16. **My current housing situation is:** *Please tick only 1 answer.*

- Own house
- Rented house
- Own apartment
- Rented apartment
- old-age flat
- Other: ___

17. **How many people live in your household (including you)?**

18. **Who lives with you in the same household?** *Please check all possible answers.*

- I live alone
- (Spouse)Partner
- Other adults
- Siblings
- Adult children
- Professional help (e.g. a paid caregiver)
- Other: _____

19. **Does your flat / house have anything of the following?** *Please check all possible answers.*

- Stairs **WITHOUT** handrail
- Stairs **WITH** handrail
- Stair lift
- Elevator
- Bath / WC on entrance level
- Bedroom or room used as a bedroom on the same floor.
- Wide door frames
- Trottoir in front of the house / apartment
- House / apartment is situated on a slope or on a hill

20. **Are you generally satisfied with your current housing situation?** *Please tick only 1 answer.*

- Yeah, I want to live as long as I can now.
- At the moment I am satisfied with my living situation, but I am planning to change it in the next few years
- No, I'd like to change my housing situation.

21. **What would you change?** *Please write.*

How much support do you need and receive in everyday life?

For most people, independence is important.

With increasing age, support is needed.

But support does not mean losing independence.



How independently can you move?

22. **Mobility:** Please tick the box that best describes your health TODAY.

- I don't have **any** trouble walking around.
- I'm having a **little** trouble walking around.
- I have **moderate** problems walking around.
- I have **big** problems walking around.
- I'm **not gonna be able to** walk around

23. **Do you use the following aids?** Please check all possible answers.

- | | | |
|--|-------------------------------------|---------------------------------|
| <input type="checkbox"/> Walking stick | <input type="checkbox"/> Crutches | <input type="checkbox"/> Walker |
| <input type="checkbox"/> Rollator | <input type="checkbox"/> Wheelchair | <input type="checkbox"/> No aid |
| <input type="checkbox"/> Others: _____ | | |

24. **Are you able to move completely independently outside the house?**
In the vicinity of the house or to neighbors.

Yes

No

25. **What kind of transport do you currently use?** *Please check all possible answers.*

I ride a bicycle / e-bike

I drive my own car

I use public transport

I order and use a taxi on my own, but no public transport

I use public transport in company

I make limited journeys in a taxi or car in company

I can't move outside the house anymore

26. **What kind of means of transport would you like to use in the future?**
Please check all possible answers.

bicycle

e-bike

My own car

Bus or other public transport

Help from friends or family

taxi

I don't intend to be mobile outside the house.

Others: _____

How independent are you when it comes to cooking and eating?

27. **Preparation of meals.** *Please tick only 1 answer.*

I plan and cook meals **independently**

I need **help preparing** meals

I **warm up** the meals prepared by other people.

The meals must be **prepared ready to eat.**

How independent are you when it comes to body care?

28. **Take care of yourself.** *Please tick only 1 answer.*

- I have **no** problems washing or dressing myself
- I have **slight** problems washing or dressing myself
- I have **moderate** problems washing or dressing myself
- I have **big** problems washing or dressing myself
- I'm **not able to** wash or dress myself.

29. **Are you able to go to the toilet on your own?**

- Yes No

How independent are you in managing your household?

30. **Everyday activities, e.g., housework, family or leisure activities.**

Please tick only 1 answer

- I don't have **any** problems with my daily activities.
- I have **slight** problems with my daily activities.
- I have **moderate** problems with my daily activities.
- I have **big** problems to do my everyday activities
- I am not in a **position to** pursue my everyday activities

31. **Shopping.** *Please tick only 1 answer.*

- I can do **all my shopping independently**
- I can only do **small purchases independently**
- I need **help** shopping
- I'm **not able to do** any shopping.

32. **Do the laundry.** *Please tick only 1 answer.*

- I can wash the laundry **myself**
 - I can do **small laundry**, e.g. socks, wash
 - My laundry must be done **completely by others**
-

33. **Money budget.** *Please tick only 1 answer.*

- I manage financial transactions **independently** (budget, cheques, deposit, bank transfer)
- I can make the **daily, smaller expenses**, but I need help with transfers and bank transactions.
- I'm **no longer able to** handle money.

34. **Phone.** *Please tick only 1 answer.*

- I use the phone **independently**
- I'm just dialing some **known numbers**
- I pick up **the phone**, but I don't dial on my own.
- I don't use the phone at all.

What support are you currently receiving?

35. **From whom do you receive regular support in everyday life?** *Please check all possible answers.*

- Family members of the same age (e.g. spouse, partner)
- Younger family members (e.g. children, grandchildren)
- Friends and neighbors
- I don't need

36. **From which organizations do you receive regular support in everyday life?** *Please check all possible answers.*

- Non-profit aid (e.g., Spitex)
 - Private help (self-paid)
 - Alzheimer's Association
 - Parkinson's association
 - Diabetes Association
 - Red Cross Baselland
 - Pro Senectute
 - Other: _
 - Other: _
-

37. What kind of help did you need or did you use in 2018?

Please check all possible answers.

- I didn't need any help in 2018.
 - Care and support at your home (*please perform*):
 - Public Organization
 - Private Organization
 - Help with the housework (*please do*):
 - Public Organization
 - Private Organization
 - Meal service
 - Physiotherapy
 - Transport and assistance services (e.g. to the doctor, shopping)
 - Day clinic
 - Night clinic
 - Old-age flat
 - Short stays in old people's homes / nursing homes
 - Others: _____
-

38. How often is the following support from other people available to you? Whether by professional people or support from family / friends.

- a. Someone who will take you to the doctor if necessary.
 - Never
 - Sometimes
 - Often
 - Always
 - b. Someone who prepares food for you when you're not able to.
 - Never
 - Sometimes
 - Often
 - Always
 - c. Someone to help you with your day-to-day work when you're sick.
 - Never
 - Sometimes
 - Often
 - Always
 - d. Someone who can give you good advice in difficult situations.
 - Never
 - Sometimes
 - Often
 - Always
 - e. Someone you can trust or talk to about personal problems
 - Never
 - Sometimes
 - Often
 - Always
 - f. Someone who understands your problems.
 - Never
 - Sometimes
 - Often
 - Always
-

39. **Does the support you receive in everyday life meet your needs?**

- Yeah, I'm getting the support I need.
 No, I need more support.

40. **Do you look after, care for or support another person yourself? e.g. children, elderly people, people with a disability**

- Yes No

What about the support in the future?

41. **If you become more in need of help, which people do you prefer to receive regular support from in everyday life? Please check all possible answers.**

- Family members of the same age (e.g. spouse, partner)
 Younger family members (e.g. children, grandchildren)
 Friends and neighbors

42. **If you become more in need of help, which organizations do you prefer to receive regular support from in everyday life? Please check all possible answers.**

- Non-profit aid (e.g. Spitex)
 Private help (self-payment)
 Alzheimer's Association
 Parkinson's association
 Diabetes Association
 Red Cross Baselland
 Old Age and Nursing Home (APH)
 Pro Senectute
 Others:
 Others:

43. **If you become more needy, which of the following services would you consider? Please check all possible answers.**

- Care and support at your home (*please perform*):
 Public Organization
-

-
- Private Organization
 - Help with the housework (please do):
 - Public Organization
 - Private Organization
 - meal service
 - physiotherapy
 - Transport and assistance services (e.g. to the doctor, for shopping)
 - day clinic
 - night clinic
 - old-age flat
 - Short stays in a retirement/nursing home
 - Don't know
 - Others: _____
-

44. **Would you consider the following technical aids or health technology in the future?**

- a. **Telemedicine:** The possibility to communicate with your doctor via video or mobile phone.
 - Yes
 - Maybe
 - No
 - I don't understand what this technical aid is used for.
 - b. **Mobile phone or SMS service:** Applications / programs that remind you of your illness or provide information on how to manage your illness or take medication.
 - Yes
 - Maybe
 - No
 - I don't understand what this technical aid is used for.
 - c. **Portable device** (e.g. heart monitor, blood glucose monitor, SOS device, activity monitor)
 - Yes
 - Maybe
 - No
 - I don't understand what this technical aid is used for.
-

d. **Robot for help**, for use in the household and in care at home

Yes

Maybe

No

I don't understand what this technical aid is used for.

e. **Which of these technological tools or health technologies do you currently use?**

telemedicine

Mobile phone or SMS service

Portable devices

auxiliary robot

I am not currently using any of these technical aids

How's your health?

Not all older people are equally healthy.

Health has a major impact on the needs of older people.



Your senses

45. Do you have problems in everyday life due to poor eyesight?

Yes

No

46. Do you have problems in everyday life due to bad hearing?

Yes

No

Nutrition

47. Have you accidentally lost a lot of weight in the last 6 months? (e.g. 3 kilograms in 3 months)

Yes

No

Aches

48. Do you regularly experience pain or discomfort? Please tick only 1 answer.

I have **no** pain or discomfort

I have **slight** pain or discomfort

I have **moderate** pain or discomfort

I have **severe** pain or discomfort

I have **very strong / unbearable** pain or discomfort

49. **Do you take painkillers regularly?** (e.g. Panadol / Dafalgan, Ibuprofen, Fentanyl, Tramal, Morphin)

Yes, daily Yes, weekly No Do not know

Sleep

50. **How would you rate the overall quality of your sleep over the last four weeks?**

Very good Quite good Quite poor Very poor Very poor

51. **Do you regularly take sleeping pills?**

Yes No Don' t know

Remembrance

52. **Do you have memory problems?**

Yes No

Do you regularly take medication?

53. **Are you currently taking four or more different medications?**

Yes No

54. **Do you need support to take your medication correctly?** *Please tick only 1 answer.*

I am taking my medication on my **own in** exact dosage and at the correct time.

I take **prepared** medications correctly (e.g. in dosettes)

I cannot manage the correct intake of medication on my **own.**

What does your lifestyle look like?

How active are you?

How are you emotionally?



Lifestyle and well-being

55. How many minutes of intense physical activity (e.g. jogging) do you exercise in a typical week?

- Less than 30 minutes
- 30-74 minutes
- 75 minutes or more

56. How many minutes of lightly strenuous physical activity (e.g. walking S) do you exercise in a typical week?

- Less than 30 minutes
 - 30-74 minutes
 - 75 minutes or more
-

57. **How often do you engage in physical activity that involves a combination of balance, muscle strengthening and endurance (e.g. dancing, yoga, tai chi, gardening)?**

- At least once a week
- Less than once a week
- Never

58. **If you had to rate your physical fitness with points from 0 to 10, where 0 means "very bad" and 10 "excellent", what score would you give yourself? Please circle a number.**

0 1 2 3 4 5 6 7 8 9 10

59. **How often do you consume an alcoholic beverage?**

- Never
- 1 time a month or less
- 1 time per week or less
- 2 to 3 times a week
- 4 to 6 times a week
- Daily

60. **How many alcoholic beverages do you consume on a typical day you drink (a drink can be a glass of wine, a can of beer (355 ml) or 40 ml of spirits)?**

- 0 Beverages
- 1-2 drinks
- 3-4 drinks
- 5 or more drinks

61. **Do you currently smoke?**

- Yes, daily
 - Yes, not every day
 - No, but I was a smoker
 - No, never
-

62. Do you feel a general emptiness?

Yes Sometimes No

63. Do you miss the company of other people?

Yes Sometimes No

64. Do you feel abandoned?

Yes Sometimes No

65. Have you been feeling miserable or depressed lately?

Yes No

66. Have you been nervous or anxious lately?

Yes No

67. How much do you feel anxious or depressed? *Please tick only 1 answer.*

- I am **not** anxious or depressed
 - I'm a **little** scared or depressed.
 - I'm **moderately** anxious or depressed.
 - I'm **very** anxious or depressed.
 - I'm **extremely** anxious or depressed.
-

68. Below you will find 3 statements. Please mark whether you agree or disagree with the individual statements.

a. In many respects my life is almost ideal.

Agreed Neither - nor I do not agree

b. My living conditions are excellent.

Agreed Neither - nor I do not agree

c. I am satisfied with my life

Agreed Neither - nor I do not agree

69. In the first column, please specify the activities/groups for which you are active. Please indicate in the second column which activities / groups you are not participating in but would like to participate in.

	<i>Active in this</i>	<i>Not active in it, but I want to be.</i>
Gymnastics clubs, sports groups	<input type="checkbox"/>	<input type="checkbox"/>
Hobby clubs, e.g. choir, music and theatre clubs	<input type="checkbox"/>	<input type="checkbox"/>
Professional associations, trade unions	<input type="checkbox"/>	<input type="checkbox"/>
Church congregation, religious groups	<input type="checkbox"/>	<input type="checkbox"/>
Political groups, parties	<input type="checkbox"/>	<input type="checkbox"/>
Self-help groups	<input type="checkbox"/>	<input type="checkbox"/>
Meeting with family, friends, neighbors	<input type="checkbox"/>	<input type="checkbox"/>
Voluntary work	<input type="checkbox"/>	<input type="checkbox"/>
Others: _____	<input type="checkbox"/>	<input type="checkbox"/>

How often do you need medical attention?



How often did you need medical help in 2018?

70. How many times did you visit your family doctor in 2018?

times or more than 10

71. How often did you visit a specialist in 2018?

times or more than 10

72. How many times did you go to an emergency ward in a hospital in 2018?

times

73. How many times were you in a hospital in 2018? Just count the hospital stays you've had to spend the night in.

times

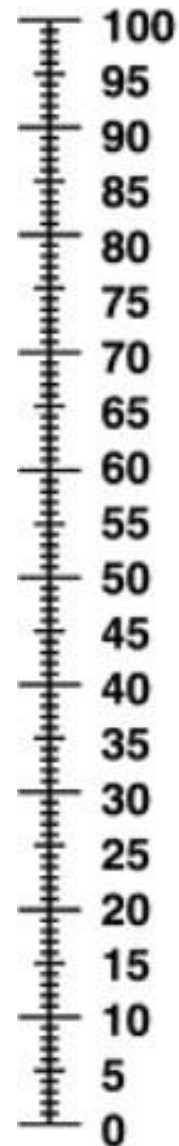
74. What other medical services did you use in 2018?

General health

75. We want to find out how good or bad your health is TODAY. Please tick the box on the scale that best describes your health and enter the number you ticked on the scale in the box below.

YOUR HEALTH TODAY =

Best health,
that you can imagine



Worst health,
that you can imagine

Thank you very much for your time!

Chapter 4: Factors associated with health-related quality of life among home-dwelling older adults aged 75 or older in Switzerland: a cross-sectional study

Flaka Siqeca¹, Olivia Yip¹, Maria José Mendieta^{1,2}, Matthias Schwenkglens³, Andreas Zeller⁴, Sabina De Geest^{1,2}, Franziska Zúñiga¹, Samuel Stenz¹, Matthias Briel^{5,6}, Carlos Quinto⁷, Eva Blozik^{8,9}, Mieke Deschodt^{10,11}, Katrina Obas¹², Suzanne Dhaini¹

¹ Department of Public Health, Institute of Nursing Science, University of Basel, 4051 Basel, Switzerland

² Department of Public Health and Primary Care, Academic Centre for Nursing and Midwifery, KU Leuven, 3000 Leuven, Belgium

³ Department of Public Health, Institute of Pharmaceutical Medicine (ECPM), University of Basel, 4051 Basel, Switzerland

⁴ Department of Clinical Research, Center for Primary Health Care, University of Basel, 4051 Basel, Switzerland

⁵ Department of Clinical Research, Division of Clinical Epidemiology, University Hospital Basel and University of Basel, 4051 Basel, Switzerland

⁶ Department of Health Research Methods, Evidence, and Impact, McMaster University, Hamilton, Canada

⁷ Aerztesgesellschaft Baselland, 4132 Muttenz, Switzerland

⁸ Helsana-Gruppe, 8001 Zürich, Switzerland

⁹ Institute of Primary Care, University of Zurich and University Hospital of Zurich, Zurich CH-8091, Switzerland

¹⁰ Department of Public Health and Primary Care, Gerontology and Geriatrics, KU Leuven, 3000 Leuven, Belgium

¹¹ Competence Center of Nursing, University Hospitals Leuven, Belgium

¹² Department of Epidemiology and Public Health, Swiss Tropical and Public Health Institute, 4051 Basel, Switzerland

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4.1. Abstract

Background: Health-related quality of life (HRQoL) is an indicator of individuals' perception of their overall health, including social and environmental aspects. As a multidimensional concept, HRQoL can be influenced by a multitude of factors. Studies of HRQoL and factors associated with it among home-dwelling older adults have often been limited to inpatient settings or to a sub-population with a chronic disease. Studying HRQoL and its correlating factors among this population, by providing an ecological lens on factors beyond the individual level, can provide a better understanding of the construct and the role of the environment on how they perceive their HRQoL. Thus, we aimed to assess the HRQoL and investigate the correlates of HRQoL among home-dwelling older adults, guided by the levels of the ecological model.

Methods: This is a cross-sectional population survey conducted in 2019 in Canton Basel-Landschaft, in northwestern Switzerland, and includes a sample of 8,786 home-dwelling older adults aged 75 and above. We assessed HRQoL by using the EQ-index and the EQ-VAS. The influence of independent variables at the micro, meso and macro level on HRQoL was tested using Tobit multiple linear regression modelling.

Results: We found that having a better socio-economic status as denoted by higher income, having supplementary insurance and a higher level of education were all associated with a better HRQoL among home-dwelling older adults. Furthermore, being engaged in social activities was also related to an improved HRQoL. On the other hand, older age, female gender, presence of multimorbidity and polypharmacy as well as social isolation and loneliness were found to all have a negative impact on HRQoL.

Conclusions: Understanding factors related to HRQoL by using an ecological lens can help identify factors beyond the individual level that impact the HRQoL of home-dwelling older adults. Our study emphasises the importance of social determinants of health and potential disparities that exists, encouraging policymakers to focus on policies to reduce socio-economic disparities using a life-course approach, which consequently could also impact HRQoL in later stages of life.

Key Words: Health Related Quality of Life; Quality of Life; EQ-5D; Healthy Aging; Ecological Model; Demographic Survey, Home-dwelling Older Adults

4.2. Background

Many European countries have experienced an increase in the number of people living longer. In 2021, 20.8 % of the European population was 65 years or older and 6.0 % was 80 years or older, a proportion projected to continue rising (1). Demographic data in Switzerland depicts a similar picture, where between 2020 and 2050, an increase from 18.0 % to 25.6 % for those 65 years or older and from 5.0% to 10.6 % for those 80 years and older is predicted (2). To cope with this demographic shift, research and policy actions have changed focus to support older adults to continue living in the community instead of relying on long-term institutions (3). This is also favored by older adults themselves, who prefer to age in their own home and familiar environment for as long as possible (4, 5), an objective described by Cutchin et al as *aging in place* (6). *Aging in place* has been shown to positively affect the quality of life of older adults (7, 8) as it fosters preservation of their autonomy and social connectiveness (9).

Quality of life is defined by the WHO as “individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns” (10). It is a broad concept that incorporates all aspects of an individual's existence whereas health-related quality of life (HRQoL) focuses on the health-related aspects of quality of life including people's level of daily functioning and ability to experience a fulfilling life (11). However, it is important to note that the terms are not interchangeable (12). HRQoL is a key patient-reported outcome and an indicator of an individual's perception of their overall health, be that physical, functional, emotional, or mental; and includes the influence of the social determinants of health such as receiving support from family and community as well as being active in the society (13). During the past decades, several generic measures of HRQoL have been developed, such as the Short-Form 6-dimensions (SF-6D) (14), the Health Utilities Index (HUI) system (15) and the EuroQoL 5-dimensions questionnaire (EQ-5D) (16). In this study, we used the EQ-5D-5L instrument, which is a simple, robust, reliable, and user-friendly instrument, that takes short time for respondents (17). It is an instrument constructed for use as a general measure of HRQoL, and has been increasingly used in research in older adults (18-21).

HRQoL is a multidimensional concept and can thus be influenced by a myriad of factors. In older adults, sociodemographic factors such as advanced age; lower education and income; as well as the presence of chronic diseases, smoking, depression, and lack of social support were all found to be associated with a lower HRQoL (22-29). Furthermore, when exploring perceptions and lived experience of home-dwelling older adults in relation to their HRQoL, Levasseur et al. identified that for older adults, having a social role and engaging in

social activities also played an important part in determining their perceived HRQoL as better (30).

Despite the fact that HRQoL has been widely investigated in older age in terms of factors associated with it, to the best of our knowledge most studies have focused on assessing it in inpatient settings and in relation to a specific disease or chronic condition (31-34). We believe that investigating HRQoL among home-dwelling older adults in the community, while taking into account their ecosystem through an ecological perspective, has hence been overlooked. HRQoL and the factors associated with it are of interest to be studied among this population to not only foster individual well-being but also shape policies and strategies aimed at preserving the autonomy and social relations of older adults living in the community.

To support older adults to continue living in the community, we launched the INSPIRE project, which is an implementation science project. The project aims to develop, implement and evaluate a community-based integrated care model for home-dwelling older adults aged 75 and above in Canton Basel-Landschaft (BL) in Switzerland. During the development phase, an understanding of the context to ensure suitability of the integrated care model components for the implementation setting was pivotal (35, 36). Accordingly, we conducted the INSPIRE Population Survey to understand current and anticipated health and social needs as well as living preferences, in an effort to maintain HRQoL and support older adults to age in place (37). Aging in place has been shown to positively affect the HRQoL of older adults, as it fosters preservation of their autonomy and social connectiveness (7, 8, 9), and is the reason why we aimed to assess their current HRQoL and what factors influence this construct, using an ecological approach.

4.2.1. Conceptual model

As HRQoL is a multidimensional construct, using an ecological approach can provide a comprehensive understanding of the variables at the micro, meso and macro level that are associated with it. An ecological approach is founded on the idea that a dynamic interrelationship exists among various correlates at multiple levels including personal (i.e., biological, psychological), organizational/institutional, environmental (i.e., social and physical) and policy levels (38). Our proposed conceptual model is not explicitly based on a specific pre-existing framework, but instead draws from current literature on factors influencing HRQoL among older adults. The model places the older adults and their perceived HRQoL in the center, while enlisting the potential correlating variables from literature in the three levels of the ecological model (micro, meso and macro level) (Figure 1).

The overall objectives of this paper are to (1) assess the HRQoL among home-dwelling older adults aged 75 and above and (2) investigate the correlates of HRQoL in this population, guided by the levels of the ecological model.

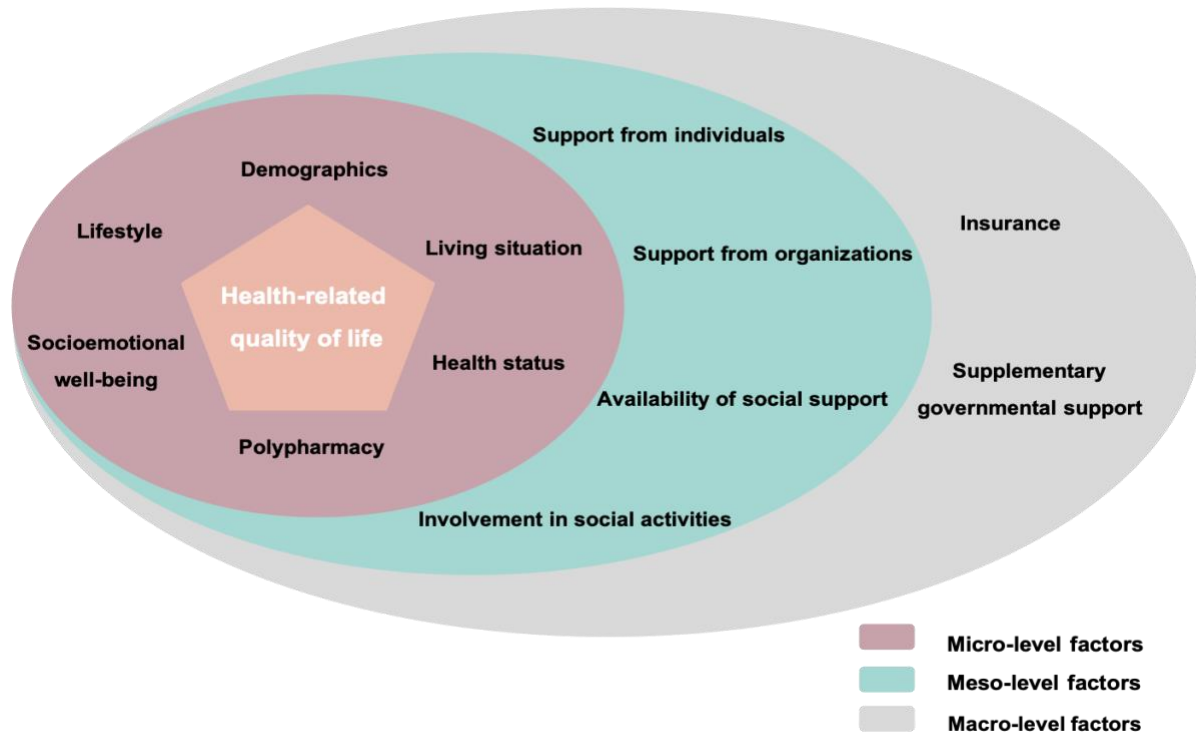


Figure 1: Health-related quality of life conceptual model (guided by levels of the ecological model)

4.3. Methods

4.3.1. Study design and setting

This is a cross-sectional study conducted in 2019 in Canton BL, in north-western Switzerland (37). Canton BL is a German-speaking region, inhabited by around 290,000 citizens and has the second-highest proportion of population aged 65 or above (22.4 %) and aged 80 or above (6.7 %) in Switzerland (2).

4.3.2. Study participants and data collection

The participants were recruited via postal mail, with no sampling method necessary as we included all those eligible, namely all home-dwelling older adults living in Canton BL who were aged 75 and above. The INSPIRE Population Survey is embedded within the larger INSPIRE project (<https://inspire-bl.unibas.ch/>), in which an important component of the care

model is screening for frailty. As frailty increases with age (39), the age cut-off of 75 years was chosen as an age when we consider older adults are more likely to be at risk of frailty and can thus benefit the most from the integrated care intervention.

A survey package containing the questionnaire along with instructions for filling it out, an information sheet, a personalized cover letter, a prepaid return envelope and the informed consent form was mailed to the home address of all home-dwelling persons aged 75 years or older in Canton BL, which we received from the Cantonal Statistical Office. Thus, the filled-out questionnaires were also returned by postal mail. All the questionnaires were pseudonymized prior to being delivered, with the intent to allow potential follow-up in the future. However, due to concerns of the general public on data security and based on several stakeholder recommendations, we anonymized the questionnaires after having sent them and destroyed all documents containing identifiable information.

The survey was successfully delivered to 28,791 older adults living at home in Canton BL and a total of 8,846 questionnaires were returned (Response Rate = 30.7%). During the validation process, 60 questionnaires were excluded from the analysis (i.e., based on ineligible ZIP codes, respondent's age, or residents in a long-term care institution), resulting in a final sample of 8,786 participants. We consider the response rate to be representative, as it is much higher than what is reported in literature for postal surveys (40). Furthermore, we found that the prevalence of frailty among home-dwelling older adults as measured by the GFI in a comparable study population to be in line with our observed results (41).

A detailed description on the development, dissemination and characteristics of the population survey have been reported elsewhere (37).

4.3.3. Variables and measurements

As the current study is part of an implementation science project, the survey was designed with the input of various stakeholders. The list of stakeholders includes but is not limited to a group of older adults, representatives of local policymakers, community care providers and representatives of nursing homes. The survey items are henceforth a combination of validated tools and investigator-developed items. Detailed information on the development of the survey and overall participants' characteristics have been reported elsewhere (37).

Outcome variable

HRQoL was assessed using the EQ-5D-5L instrument (16), a generic standardized instrument comprising of a short descriptive questionnaire and a visual analogue scale (EQ-

VAS). The descriptive questionnaire includes the following dimensions of health: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each dimension has a five-level response of severity, ranging from 1- no problems, 2- slight problems, 3- moderate problems, 4- severe problems to 5- unable to/extreme problems, which correspond to potential health states (42). These health states are then converted into a single EQ-5D-index, by applying a country-specific valuation algorithm (42). In lack of a Swiss value set, we used the German value set algorithm by Ludwig et al (43). Along with the descriptive questionnaire, this instrument also includes the EQ-VAS. This scale is similar to a thermometer, where the endpoints are labelled ‘The worst health you can imagine (0)’ and ‘The best health you can imagine (100)’. The construct validity of the EQ-5D-5L instrument is well examined in use among older adults, such as in the Bhaduri et al. study, who computed the Spearman’s rho between each of the EQ-5D items and the Barthel Index (Spearman coefficients 0.42) (44).

Micro level variables

Year of birth was used to calculate the **age** of the participants at the time of the survey completion and was recorded as a continuous variable. **Gender** information was collected as “Male” or “Female”. The original answers categories for the **level of education** question were regrouped into four categories: “Tertiary” (“University” and “University of Applied Sciences”); “Secondary” (“Gymnasium” and “Apprenticeship”); “Elementary or None” (“Elementary School” and “No degree”) and “Other”. Income, which was originally collected as a monthly household income in Swiss Francs (CHF), was converted to **individual income** by dividing the household income by the number of people living in the household, following the guideline of the Swiss Centre of Expertise in the Social Sciences on how to measure income in surveys (45).

Living situation of the participants was assessed through an investigator-developed item asking who they currently lived with. For the purpose of the analysis, the answer choices were dichotomized into: living alone vs living with others (a spouse/partner, an adult child, other adults, siblings or a professional caretaker).

The **health status** of the participants was assessed by asking whether they experienced **vision, hearing or memory problems** in their daily life, or if they had **unintentionally lost weight** in the past six months. **Polypharmacy**, defined by the Groningen Frailty Index (GFI) tool (46) as taking four or more medications at once, was also recorded. Variables pertaining to health status and polypharmacy had dichotomized “Yes” or “No” answer choices. The criterion validity of the GFI tool among older adults has been examined ($r = -0.62$) (47).

Socioemotional well-being of the participants was assessed using three questions from the GFI tool (46) which ask the participants whether they feel empty, miss the company of others or feel abandoned. The answer choices for these questions included: “Yes”, “Sometimes” or “No”, which for the purpose of the analysis were dichotomized into “Yes / Sometimes” and “No”.

The lifestyle section included questions on **smoking, alcohol intake** and **physical activity**. The participants were asked about their **smoking** habits, with answer choices being regrouped into “No” (“Not currently, but I was a smoker before” and “No”) and “Yes” (“Yes, daily” and “Yes, not daily”). Additionally, **alcohol intake** was assessed by asking the number of drinks a participant consumed in a typical day; with a glass of wine, one dosage of beer of 355ml or a 40 ml spirit alcohol counting as one drink (48). The answer choices for this question included: “No drink”, “1-2 drinks”, “3-4 drinks” and “5 or more drinks”. The answer choices were dichotomized into “ ≤ 2 drinks/day” or “ > 2 drinks/day”, based on recommendations of the Swiss Federal Commission for Issues Related to Addiction and Prevention (49). The participants were also asked about how many minutes they engaged in **vigorous-intensity physical activity, moderate-intensity physical activity** and in **muscle-strengthening activities** in a typical week. The WHO recommends that an older adult should engage in at least 75 minutes of vigorous-intensity, or in at least 150 minutes of moderate-intensity physical activities within a typical week (50). For additional health benefits, the WHO recommends that an older adult engages in muscle strengthening physical activity at least 2 days per week (50). Due to potential multicollinearity among these three variables, we computed one variable related to physical activity. If a person scored 1 or above, which indicated they engaged in any of the three activities as recommended, it was recorded as being physically active. The answer choices were thus scored as: “Per WHO recommendations” and “Below WHO recommendations”.

Meso level variables

Informal daily support from individuals was also assessed and answer choices were dichotomized into: currently receive support from another individual (spouse, younger family member, friend or neighbour) or currently do not need such support. Participants were also asked whether they currently received daily **support from organizations**, through listing common organizations that older adults receive support from in Switzerland. These include home care organizations, social care organizations, humanitarian organizations (e.g., Red Cross) and disease-specific associations (i.e., Diabetes association, Alzheimer’s association

and Parkinson's association). The answer choices for this question were dichotomous "Yes" or "No".

Availability of social support was assessed through the Brief Social Support Scale (BS6), which has been validated in German (51). This instrument includes three questions to assess the availability of tangible support (i.e., someone to accompany them to doctor's appointments, someone to prepare their meals when unable to and someone to help with daily chores when sick) and three others to assess the availability of emotional support (i.e., someone who can give them good advice, someone they can confide in during a crisis and someone who understands their problems) (51). The responses are scored on a 4-point Likert scale ranging from 1- "never" to 4- "always". A sum score of the six-items, ranging from 1-24, is calculated and then dichotomized into: "Low to moderate support (a score of up to 17)" and "High to very high support (score of 18 and higher)" (51). Reliability of the subscales has also been proven, as indicated by Cronbach's alpha: emotional support $\alpha = .87$, tangible support $\alpha = .86$ and overall $\alpha = .86$ (51).

To assess involvement in **social activities**, the questionnaire included an investigator-developed list of hobbies and activities (e.g., sports, political parties, church gatherings, volunteering, meeting with family and friends) for which participants could indicate whether they were active in or wished to be active in. To provide more granularity in the results, we grouped the participants into three groups: those who were active in more than one of the activities, those who were active in only one, and those who wished to be active in at least one of the listed activities, but were not currently.

Macro level variables

Type of insurance of the participants was assessed by asking them whether they were insured with statutory health insurance alone or with statutory health insurance plus supplementary private insurance. Although health insurance can be considered an individual factors as well, we have included it as a macro-level factor because in Switzerland, basic health insurance is mandatory. The benefit package of the basic insurance is more comprehensive than in most other countries and defined at the national level, where payment mechanisms are largely defined by federal and cantonal regulations.

Information on **supplementary government support** was captured by asking the participants whether they received this type of support or not. Supplementary government support is a specific type of help in Switzerland, that support individuals financially if their pension or income do not cover minimum living costs.

4.3.4. Statistical analysis

General descriptive statistics were computed for the EQ-5D-5L domains and all independent variables. Categorical variables (e.g., gender, education, etc) are reported as frequencies and percentages whereas continuous variables (e.g., age and income) are reported as medians and interquartile ranges or means and standard deviations. The EQ-5D-5L descriptive results are presented by recording the number and percentage of patients reporting each severity level of each dimension of the EQ-5D-5L instrument.

To gain an initial understanding of the association of the independent variables with HRQoL (for both the EQ-VAS and the EQ-5D-index), standard univariate tests such as Mann-Whitney U test and the Kruskal-Wallis test were used for categorical variables. The Spearman's correlation coefficient was used to test the association of the outcome with continuous predictors.

The influence of independent variables at the macro, meso and micro level on both EQ-5D-index and EQ-VAS were tested using multiple linear regression modelling. All covariates of the conceptual model, from all levels, were included in the regression model, irrespective of significance, in order to determine the relationships of each variable with the outcome variable. Because ceiling effects were observed in previous studies using the EQ-5D-5L in general population surveys (52), we used Tobit-regression modelling. This is a variation of multiple regression, which is capable of correct inference in the presence of ceiling effects (53). We tested if the underlying assumptions of the linear modelling were met and used the Variance Inflation Factor (VIF) to test the presence of multicollinearity among independent variables. The level of significance was set at 0.05.

Data was primarily missing due to item nonresponse, and after the analysis of missing patterns, we considered our data to be missing at random (MAR). In our dataset, we observed two variables with more than 5% of missing data: individual income (5.3%) and availability of social support (26.6 %). As our data met the recommendations of Jakobsen et al. (54) for when to use multiple imputation (i.e. missing data is above 5% but below 40%, data was missing not only on the dependent variable, the Missing Completely at Random - MCAR assumption could not be plausible, and data is considered MAR), we applied multiple imputation by chained equations (MICE) to impute missing values (55). We also ran a sensitivity analysis using the observed data and found no significant differences in results between the observed and the imputed data.

All analyses were performed using R, version 1.3.1093 for Mac OS (56).

4.4. Results

4.4.1. Health-related quality of life descriptive results

Table 1 presents the EQ-5D-5L descriptive results by recording the number and percentage of older adults reporting each severity level of each dimension of the EQ-5D-5L instrument. The mean score of EQ-VAS was 75.2 (SD=15.9, range 0-100; skewness -0.98) whilst the mean score of EQ-5D-index was 0.9 (SD=0.13, range -0.66 to 1; skewness -3.33).

Table 1: EQ-5D-5L frequencies and proportions by dimension and level

Response level	Dimension				
	Mobility n (%)	Self-care n (%)	Daily activities n (%)	Pain / Discomfort n (%)	Anxiety / Depression n (%)
No problems	6172 (70.7)	8093 (92.5)	6973 (79.9)	3090 (35.6)	6251 (71.8)
Slight problems	1576 (18.1)	423 (4.8)	1187 (13.6)	3682 (42.4)	1864 (21.7)
Moderate problems	759 (8.7)	151 (1.7)	384 (4.4)	1605 (18.5)	414 (4.8)
Severe problems	191 (2.2)	48 (0.5)	99 (1.1)	278 (3.2)	53 (0.6)
Extreme problems	28 (0.3)	37 (0.4)	86 (1.0)	25 (0.3)	8 (0.1)
Total (%)	8726 (99.3)	8752 (99.6)	8729 (99.4)	8680 (98.8)	8590 (97.8)

4.4.2. Descriptive results of factors associated with health-related quality of life by levels of the ecological model

Micro level variables

The mean age of participants was 81.8 (SD=4.8) and 51.8% were female. 24.6% of the participants had a tertiary education, and the mean individual income was CHF 4569 (SD=1886) per month.

Of the 8,786 participants, 23.6% stated feeling empty or sometimes feeling empty, a higher percentage (35.7%) stated to miss or sometimes miss the company of others whereas 10.6% stated feeling abandoned or sometimes feeling abandoned. Almost half of them (47.6%) reported polypharmacy, while the highest proportion in health problems was reported for memory problems (19.4%) (Table 2).

Meso level variables

Among our participants, 36.4% reported receiving daily informal support from another

individual while 30.6% reported receiving daily support from one or more of the listed organizations. In terms of social support, 80.7% reported to have low to moderate support available (Table 2).

Macro level variables

Of the 8,786 participants in our study, 45.9% reported to have statutory insurance coupled with a supplementary private insurance, and 4.8% reported to receive supplementary government support (Table 2).

Further detailed descriptive results can be found in Table 2, whereas more detailed results on the values of EQ-5D-index and EQ-VAS by level of each independent categorical variable can be found in Appendix B, Supplementary Table S1.

Table 2: Participant characteristics per levels of the ecological model

Variables	Median (IQR) / n (%) N=8786
Micro level variables	
Age (in years)	81.0 (7)
Gender (Female)	4552 (51.8)
Education	
<i>Tertiary</i>	2159 (24.6)
<i>Secondary</i>	4854 (55.2)
<i>Primary / No education</i>	1376 (15.6)
<i>Other</i>	397 (4.5)
Income (in CHF)	4500 (1628)
Living situation	
<i>Living alone</i>	3161 (36.0)
<i>Living with others</i>	5625 (64.0)
Reported vision problems	783 (8.9)
Reported hearing problems	1570 (17.9)
Reported memory problems	1713 (19.4)
Reported unintentional weight loss in past 6 months	379 (4.3)
Reported polypharmacy	4184 (47.6)
Reported feeling empty / sometimes feeling empty	2079 (23.6)
Reported to miss company / sometimes miss company	3134 (35.7)
Reported feeling abandoned / sometimes feeling abandoned	936 (10.6)
Physical activity	
<i>As per recommendations of WHO</i>	6895 (78.4)
<i>Below the recommendations of WHO</i>	1891 (21.5)
Alcohol intake	
<i>≤2 drinks/day</i>	8187 (93.1)
<i>>2 drinks/day</i>	599 (6.9)
Reported to be currently smoking	611 (6.9)
Meso level variables	
Receive support from individuals	3204 (36.4)
Receive support from organizations	2688 (30.6)
Availability of social support	
<i>High to very high</i>	1727 (19.7)
<i>Low to moderate</i>	7059 (80.3)
Social activities	
<i>Active in more than one activity</i>	4382 (49.9)
<i>Active in one activity</i>	3145 (35.8)
<i>Not currently active / wish to be</i>	1259 (14.3)
Macro level variables	
Insurance type	
<i>Statutory insurance</i>	4755 (54.1)
<i>Statutory + supplementary private insurance</i>	4031 (45.9)
Receive supplementary government support	417 (4.8)

4.4.3. Multivariate regression of factors associated with health-related quality of life by levels of the ecological model

Micro level factors

The Tobit regression showed that older age was associated with a lower HRQoL only for the EQ-5D-index. On the other hand, female gender was significantly associated with both a lower EQ-VAS and a lower EQ-5D-index. In addition, having a lower level of education was found to be associated with a lower HRQoL. More specifically, having a primary level education or no education as compared to higher education, was significantly associated with a lower EQ-VAS and EQ-5D-index. A higher individual income was significantly associated with a higher EQ-5D-index.

In terms of health status, having vision, hearing and memory problems in daily life, as well as taking more than four types of medications daily were significantly associated with a lower EQ-VAS and EQ-5D-index. The same was true for the three variables denoting socioemotional well-being (feeling empty, missing company of others and feeling abandoned), which were significantly associated with a lower HRQoL (Table 3).

Meso level factors

Availability of social support and participation in social activities were significantly associated with both EQ-VAS and EQ-5D-index. More specifically, participants who reported to have a lower level of social support available, had a higher EQ-VAS and EQ-5D-index. Furthermore, participants who reported to engage in only one of the social activities listed had a significantly lower EQ-VAS and EQ-5D-index. The same was also true for participants who reported to engage in none of the social activities listed, who also had a significantly lower EQ-VAS and EQ-5D-index (Table 3).

Macro level factors

The Tobit linear regression revealed that having a supplementary private insurance in addition to statutory insurance was significantly associated with a higher HRQoL, for both EQ-VAS and EQ-5D-index (Table 3).

Table 3: Results of Tobit multivariate regression by levels of the ecological model

Variable	EQ-VAS			EQ-5D-index		
	Coeff.	95 % CI		Coeff.	95 % CI	
<i>Micro level variables</i>						
Age	-0.02	-0.08	0.03	-0.0006*	-0.001	0.0001
Gender (Ref: Male)	-1.2*	-1.8	-0.6	-0.02*	-0.025	-0.015
Education (Ref: Tertiary)						
Secondary	0.2	-0.4	0.9	-0.009	-0.006	0.004
Primary or none	-1.2*	-0.2	-2.1	-0.01*	-0.002	-0.018
Other	0.7	-0.7	2.2	-0.001	-0.001	0.026
Individual Income	-0.008	-0.0001	0.0001	0.0065*	0.006	0.007
Living situation (Ref: Living alone)	0.05	-0.25	1.3	0.001	-0.007	0.005
Vision problems (Ref: No)	-4.6*	-5.7	-3.5	-0.04*	-0.05	-0.03
Hearing problems (Ref: No)	-3.0*	-3.9	-2.2	-0.02*	-0.02	-0.01
Memory problems (Ref: No)	-3.3*	-4.0	-2.5	-0.02*	-0.03	-0.01
Unintentional weight loss (Ref: No)	-7.9*	-9.4	-6.5	-0.05*	-0.06	-0.04
Polypharmacy (Ref: No)	-8.7*	-9.3	-8.1	-0.05*	-0.06	-0.04
Feel empty (Ref: Do not feel empty)	-4.6*	-5.4	-3.8	-0.05*	-0.057	-0.044
Missing company of others (Ref: Do not miss company of others)	-1.4*	-2.1	-0.8	-0.010*	-0.015	-0.004
Feel abandoned (Ref: Do not feel abandoned)	-2.9*	-3.9	-1.8	-0.049*	-0.057	-0.040
Physical activity (Ref: Per WHO recommendations)	0.2	-0.5	0.9	-0.013	-0.007	0.004
Alcohol intake (Ref: ≤ 2 alcoholic drinks/days)	0.5	-0.6	1.6	0.003	-0.006	0.012
Smoking (Ref: No)	0.2	-0.9	1.3	0.007	-0.001	0.017
<i>Meso level factors</i>						
Receive support from others	0.02	-0.4	0.9	-0.0008	-0.006	0.005

<i>(Ref: Support not needed)</i>						
Receive support from organizations <i>(Ref: No)</i>	-0.002	-0.6	0.6	-0.004	-0.009	0.0007
Availability of social support <i>(Ref: Very high to high)</i>	1.4*	0.6	2.1	0.034*	0.027	0.04
Social activities <i>(Ref: Active in more than one activity)</i>						
Active in one activity	-2.5*	-3.1	-1.9	-0.02*	-0.028	-0.018
Not currently active / wish to be	-4.5*	-5.4	-3.6	-0.04*	-0.048	-0.033
<i>Macro level factors</i>						
Insurance type <i>(Reference: Statutory insurance)</i>	1.1*	0.5	1.7	0.005*	0.0003	0.01
Suppl. government insurance <i>(Ref: No)</i>	-0.4	-1.8	0.8	0.004	-0.007	0.012
Adjusted R-Squared	0.2354			0.2402		

* p < 0.05

4.5. Discussion

In this cross-sectional population survey conducted in one Swiss Canton, we assessed the overall HRQoL and factors associated with it among home-dwelling older adults aged 75 and above. These factors were organized into levels of the ecological model to account for the multidimensional nature of this construct. The mean EQ-VAS values in our study were slightly higher but similar to findings of König et al., who compared the HRQoL of older adults in six European countries using the same measurement tool as our study (57). Our results also corroborate those of another national Swiss survey of home-dwelling older adults, where the mean EQ-VAS scale score was reported to be similar to our findings (29). Moreover, the distribution of frequencies and proportions by dimension and level of the EQ-5D-5L instrument were also similar between our study and the one of Luthy et. al (29).

The findings of our study provide a more comprehensive understanding of factors that play a role in how older adults perceive their HRQoL and provide insight into which modifiable factors could be targeted to improve HRQoL in this population. We found that being privately insured was associated with a better HRQoL. We assume that in Switzerland, having supplementary private insurance is positively correlated with higher financial resources because while everybody is insured with the statutory insurance, supplementary insurance is typically only purchased by those who can afford the schemes. This is also in line with our results and findings of several other studies from countries with an aging population similar to Switzerland, which found a significant association between higher income and better HRQoL (58, 59).

Another important sociodemographic factor that was associated with HRQoL was level of education. Having a better education, which is a factor that is typically defined in younger stages of the life course, was linked to a better HRQoL among older adults. This finding corroborates with findings from studies in other countries with different cultures (60-62), pointing to the widespread influence of education, as well as of income, as important social correlates of health and HRQoL. Having a better education has been previously linked to higher health literacy which has been also shown to be linked to better HRQoL (63). However, because we have not measured health literacy specifically, we refrained from assuming such an association.

From the literature, we had expected that having more availability of social support would be associated with a higher HRQoL among older adults (64, 65). Interestingly, we observed the opposite among participants in our study, where receiving a low to moderate (tangible and emotional) social support was associated with a better HRQoL. We detected that

the majority of participants had reported the availability of social support to be low to moderate. This might indicate that these participants do not require as much social support and might be more independent in the first place, thus consequently also reporting a better HRQoL. In addition to social support, being active, especially in more than one social activity, was found to be associated with a better HRQoL (66, 67).

Concerning health status and polypharmacy, our findings support those from the current literature on older adults. Self-reported hearing difficulties were consistently found to be associated with a lower HRQoL (22, 68, 69), and the same has been reported for visual impairment (70-72) as well as polypharmacy (73, 74). In line with physical well-being, our analysis also revealed that socioemotional well-being played an important role in how older adults perceived their HRQoL. Feelings of emptiness and abandonment, along with missing the company of other people were all found to be negatively associated with HRQoL, findings which are also substantiated by other researchers (75, 76).

In line with other research findings, we also found that being female and older was associated with a poorer HRQoL (60, 77). However, in our study we found that age was significantly associated with HRQoL as measured by the EQ-5D-index but not the EQ-VAS. This difference in significance can be explained by the different methodological measurements applied for these two constructs: EQ-5D-index is based on standard value sets whereas the EQ-VAS is based on the self-rating of our participants. We used the German value sets in lack of Swiss ones, based on the general recommendations to select a value set based on geographic proximity (78). A Swiss study on cancer patients compared the use of both German and French value sets, as two countries sharing the geographical border with Switzerland, and found that the French value sets were more appropriate for this population (79). Nevertheless, due to the fact that German language is spoken in the region of our research and considering our study was conducted in home-dwelling older adults, we believe our methodological choice was appropriate.

Based on the presented results, we reflect upon the fact that there might be a proportion of home-dwelling older adults who are living at a socio-economic disadvantage. Having fewer financial resources and a lower level of education, coupled with the presence of multimorbidity and loneliness, may contribute to deepening the disparities amid this population. Improving access to financial and social resources that facilitate a better standard of living can influence older adults' HRQoL and can potentially impact their ability to remain independent and age within their own familiar environments. To the best of our knowledge, this is the first Swiss study that uses an ecological approach based on the notion that HRQoL is a multidimensional

concept and that in addition to health and social well-being, the environment plays an important role in how older adults perceive their HRQoL. While the outcome variable of our study implies an individual perception, HRQoL is a construct that is influenced by factors beyond the individual and thus further research studying a wider range of meso and macro variables such as for instance housing, age-friendly neighbourhoods and improved access to social activities is necessary.

We emphasise the importance of social determinants of health and potential disparities that exist, suggesting policymakers ought to focus on policies to reduce socio-economic inequalities. The impact of social determinants of health among the older population are a result of inequities from early stages of life and might not always be modifiable at a later stage in life, such as for example access to education or employment opportunities. However, and ideally, policymakers should focus on policies to reduce disparities considering a life-course approach, which could ultimately impact HRQoL in later stages of life. The social determinants of health are typically seen as being accountable for health inequities and can play an important role in the ageing trajectory of an individual and how they perceive their HRQoL. Therefore, exploring elements such as socioeconomic status, education, the physical environment, employment, and social support networks through an ecological lens like we proposed, can provide a deeper understanding of which factors influence the self-reported HRQoL. Our results also highlight that many of the identified factors are modifiable correlates of HRQoL, and provide public health indications that could support concrete actions. For example, investing in improving social networks and activities of older adults, which could help reduce loneliness or feelings of abandonment, could not only potentially improve their HRQoL, but also aid them in maintaining the desired independence to continue living longer within their communities.

Strength and Limitations

We consider the population survey methodology to be a considerable strength of our study because it provides a representative sample of the population we targeted. We achieved an overall response rate of 30.7% which is considerably higher than the average response rate found in other population surveys using postal delivery modes (40). This response rate is also particular given that our target population has been known to be challenging to reach and might have needed additional support to fill out the questionnaire (80). Furthermore, we believe that using the ecological approach has provided a more comprehensive lens on the HRQoL of older adults, by placing them at the center of their ecosystem.

The present study does however come with certain limitations that we acknowledge. It is possible that older adults who responded to our survey might have been healthier and more engaged in social life compared to their older, frailer or cognitively challenged counterparts who did not respond, thus subjecting our study to potential selection bias. Furthermore, this study was conducted among home-dwelling older adults, excluding an important segment of the older population who reside in long-term care facilities. As of 2017, the proportion of the population aged 80 years or older in Switzerland that resides in a nursing home is around 15% (81), meaning our study could not capture the HRQoL and factors correlated with it in this portion of the population. Moreover, we conducted our research in only one Swiss Canton, whose language and socio-cultural aspects might make it unique and distinguishable from other regions and accordingly might limit the generalizability of our results. Furthermore, the cross-sectional nature of the design also limits us in inferring any direct causal link between the variables and HRQoL. Finally, although a plethora of micro level factors was available for analysis, we were limited in the variables available on the meso and macro level.

4.6. Conclusions

Understanding factors related to HRQoL by using an ecological lens can help identify factors beyond the individual level that impact the HRQoL of home-dwelling older adults. Our study emphasises the importance of social determinants of health and potential disparities that exists, encouraging policymakers to focus on policies to reduce socio-economic disparities and support interventions that take social factors into account. We anticipate that this study helps to increase awareness that HRQoL in older adults is multidimensional and thus multifaceted interventions that try to interrelate health services, social services and environmental factors are needed.

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4.8. Appendix B

Supplementary Table S1: Values of EQ-5D-index and EQ-VAS by level of each independent categorical variable (reported by the levels of the ecological model)

Variables	EQ-VAS (mean, SD)	EQ-index (mean, SD)
Micro level variables		
Gender		
<i>Male</i>	76.1 (15.2)	0.91 (0.12)
<i>Female</i>	74.5 (16.4)	0.88 (0.14)
Education		
<i>Tertiary</i>	74.8 (15.9)	0.89 (0.12)
<i>Secondary</i>	75.2 (16.0)	0.89 (0.14)
<i>Primary / No education</i>	76.1 (15.3)	0.91 (0.12)
<i>Other</i>	75.5 (15.6)	0.91 (0.10)
Living situation		
<i>Living alone</i>	75.0 (15.9)	0.90 (0.13)
<i>Living with others</i>	75.4 (15.8)	0.90 (0.13)
Vision problems		
<i>No</i>	76.2 (15.3)	0.90 (0.12)
<i>Yes</i>	65.5 (18.0)	0.81 (0.20)
Hearing problems		
<i>No</i>	76.5 (15.3)	0.91 (0.12)
<i>Yes</i>	69.4 (17.0)	0.85 (0.16)
Memory problems		
<i>No</i>	76.7 (15.2)	0.91 (0.11)
<i>Yes</i>	69.2 (17.2)	0.85 (0.17)
Unintentional weight loss in past 6 months		
<i>No</i>	75.8 (15.4)	0.90 (0.12)
<i>Yes</i>	62.0 (18.8)	0.80 (0.22)
Polypharmacy		
<i>No</i>	80.5 (13.1)	0.93 (0.08)
<i>Yes</i>	69.4 (16.6)	0.86 (0.16)
Feeling empty / sometimes feeling empty		
<i>No</i>	77.6 (14.6)	0.92 (0.10)
<i>Yes</i>	67.6 (17.4)	0.82 (0.18)
Miss company / sometimes miss company		
<i>No</i>	77.6 (15.1)	0.92 (0.11)
<i>Yes</i>	71.0 (16.4)	0.86 (0.16)
Feeling abandoned / sometimes feeling abandoned		
<i>No</i>	76.2 (15.3)	0.91 (0.11)
<i>Yes</i>	66.7 (17.8)	0.80 (0.20)
Physical activity		
<i>As per recommendations of WHO</i>	75.4 (15.8)	0.90 (0.13)

<i>Below the recommendations of WHO</i>	74.8 (15.9)	0.90 (0.13)
Alcohol intake		
<i>≤2 drinks/day</i>	75.1 (16.0)	0.90 (0.13)
<i>>2 drinks/day</i>	76.7 (14.2)	0.91 (0.12)
Smoking		
<i>No</i>	75.2 (15.9)	0.90 (0.13)
<i>Yes</i>	75.2 (15.8)	0.90 (0.12)
Meso level variables		
Receive support from individuals		
<i>No</i>	75.3 (15.8)	0.90 (0.13)
<i>Yes</i>	75.1 (15.9)	0.89 (0.13)
Receive support from organizations		
<i>No</i>	75.4 (15.6)	0.90 (0.13)
<i>Yes</i>	74.8 (16.3)	0.89 (0.14)
Availability of social support		
<i>High to very high</i>	73.5 (17.8)	0.86 (0.18)
<i>Low to moderate</i>	75.6 (15.3)	0.90 (0.11)
Social activities		
<i>Active in more than one activity</i>	77.9 (14.2)	0.92 (0.09)
<i>Active in one activity</i>	73.7 (16.2)	0.88 (0.14)
<i>Not currently active / wish to be</i>	69.6 (18.2)	0.85 (0.18)
Macro level variables		
Insurance type		
<i>Statutory insurance</i>	74.3 (16.4)	0.89 (0.14)
<i>Statutory + supplementary private insurance</i>	76.3 (15.1)	0.90 (0.12)
Receive supplementary government support		
<i>No</i>	75.3 (15.8)	0.90 (0.13)
<i>Yes</i>	74.7 (16.1)	0.89 (0.13)

Note: Results in bold indicate a significant difference ($p < 0.05$) as revealed by the Tobit multiple linear regression modelling

Chapter 5: Current use and openness to use assistive technologies among home-dwelling older adults in Switzerland: a cross-sectional study

Flaka Siqeca¹, Suzanne Dhaini¹, Sabina De Geest^{1,2}, Andreas Zeller³, Mieke Deschodt^{4,5},
Thekla Brunkert^{1, 6}

¹Department Public Health, Institute of Nursing Science, University of Basel, 4051 Basel, Switzerland

²Department of Public Health and Primary Care, Academic Centre for Nursing and Midwifery, KU Leuven, 3000 Leuven, Belgium

³Department Clinical Research, Basel Institute for Clinical Epidemiology and Biostatistics, University Hospital Basel, 4051 Basel, Switzerland

⁴Department of Public Health and Primary Care, Gerontology and Geriatrics, KU Leuven, 3000 Leuven, Belgium

⁵Competence Center of Nursing, University Hospitals Leuven, Belgium

⁶University Department of Geriatric Medicine FELIX PLATTER, 4055 Basel, Switzerland

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5.1. Abstract

Research question: This study aimed to examine the current use and openness to future use of assistive technologies (ATs), as well as factors that drive the latter among home-dwelling older adults. Hence, our research question is twofold: (1) what is the current and anticipated use of ATs (telemedicine, phone/SMS, wearables and assistive robots)? (2) Which factors are associated with this population's openness to use ATs?

Methods: This is a secondary data analysis of a survey of home-dwelling older adults aged 75+ in Canton Basel-Landschaft, Switzerland (n=8,876). We descriptively assessed their current use and openness to future use of the four abovementioned types of assistive technologies. Moreover, multiple logistic regression was used to determine factors associated with openness to future use.

Results: Only few participants (17.9 %) reported to currently use ATs. Openness to use ATs was associated with current use of telemedicine (OR: 5.7, 95% CI: 4.9 – 6.5), phone/SMS (OR: 2.7, 95% CI: 2.5 – 2.9), wearables (OR: 4.8, 95% CI: 4.3 – 5.3) and assistive robots (OR: 8.6, 95% CI: 7.2 – 10.1), as well as receiving support from a spouse/partner (OR: 1.1; 95% CI: 1.0 – 1.2). In contrast, older age (OR: 0.9; 95% CI: 0.9 – 0.9) and being female (OR: 0.7; 95% CI: 0.6 – 0.8) were associated with lower odds of being open to use ATs.

Conclusions: Understanding which factors drive openness to future use of ATs among home-dwelling older adults is key to improving independence and supporting older adults achieve their desired goal of aging in place.

Key Words: Aging in Place; Assistive Technologies; Assistive Technology; Aged; Demographic Survey

5.2. Background

As individuals age, the risk of frailty and chronic conditions rises, leading to increased health and social care needs (1). Most older adults prefer to age at home, rather than living in a nursing home or in an assisted-living facility (2). Fostering this community-based living is also encouraged by policymakers as a cost-effective alternative to long-term care placements (3), and is known as *aging in place* (4).

Aging in place can be facilitated by assistive technologies (ATs). ATs include any device, equipment, or software, primarily aimed at maintaining an individual's functional status and independence, while delaying impairments or secondary complications (5). Furthermore, ATs show promise in supporting older adults maintain their desired autonomy and social inclusion (6, 7). They serve purposes like health monitoring, detecting deteriorating functional status or onset of frailty, facilitating (Instrumental) Activities of Daily Living - (I)ADL or assisting communication between older adults and care providers (6-17).

Despite technological advancements, a systematic approach in developing and implementing ATs for older adults is lacking. To ensure such innovations are relevant and of lasting effect, understanding this populations` needs and concerns is paramount (18). Yet, the involvement of older adults in this process remains limited (19), and there is a mismatch in priorities and relevance of ATs for them (20, 21). In parallel, a plethora of concerns related to using ATs have been identified, such as: privacy and trust issues, functionality/added value, costs, ease of use and sustainability for daily use, perception of no need, stigma, and fear of dependence (15).

Thus, there is an emphasis on gaining an understanding on what influences the attitude of home-dwelling older adults towards ATs (22, 23). A literature review found older age, being female, lower health status and lack of social support were associated with lower openness to using ATs (24). In another longitudinal study, being older and female, having lower income, and the presence of frailty were also found to be associating factors (25). With older age, diminished health may impede the ability to perform tasks or to understand processes involved in using ATs, whereas availability of social support and level of income may influence the ability to acquire such devices (26, 27). In Switzerland, two cross-sectional studies looked into current use and barriers towards usage of ATs among those aged 65 years and above (28, 29). One survey (n=1,149) focused on barriers and attitudes towards usability of ATs and found complicated use, security concerns, and too much effort to learn and use ATs to be hindering factors (29). The other survey (n=537) focused on the frequency of using a wider array of ATs,

and found males and those younger than 80 were more frequent users (28).

Accordingly, using a population-based survey of home-dwelling older adults in Canton Basel-Landschaft (BL), Switzerland, we aimed to: (1) describe the current and anticipated use of ATs (telemedicine, phone/SMS, wearables and assistive robots) and (2) assess the factors associated with openness to use ATs among this population.

5.3. Methods

5.3.1. Design, setting and participants

This is a secondary data analysis of the INSPIRE Population Survey, conducted in 2019 in Canton BL (30). The survey was sent to all home-dwelling older adults aged 75 years and older living in this region and 8,786 participants returned the questionnaire (Response Rate= 30.7%) (30). The entire sample was used in the current study. Details on the development of the survey and participants characteristics are reported elsewhere (30).

5.3.2. Variables and measurements

Outcome variable

Openness to use ATs was assessed by asking if participants would be open to: a) use *telemedicine* to communicate with their healthcare providers, b) use *a mobile phone or SMS* for information or reminders about medication intake, c) utilize *wearables* like heart rate and blood sugar monitors or d) use *assistive robots* for chores and other tasks. The answers were dichotomized: “Yes” (“Yes” and “Maybe”) and “No” (“No” and “I do not understand what it is used for”).

We also generated a **combined outcome**, where 0 was assigned to those open to none, whereas 1 to those open to at least one type of ATs.

Predictor variables

Current use of ATs was captured by asking which of the four types of ATs (telemedicine, phone/SMS, wearables, assistive robots) participants were currently using (Yes / No).

Living situation was assessed by asking who participants currently live with. Answers were grouped: “Living alone” vs and “Living with others” (“With a spouse/partner”, “With another adult”, “With siblings”, “With adult children”, “With a professional/paid caretaker”).

Daily informal support was measured by asking whom participants received daily

support from. This was a multiple response question with answers: “From a spouse/partner”, “From a younger family member”, “From friends or neighbours” or “Currently do not need support”.

The Groningen **Frailty** Indicator (GFI) was used to assess the prevalence of frailty, defined as “the state of physiological vulnerability with a diminished capacity to manage external stressors” (31). It includes fifteen questions measuring loss of function in four domains: physical, cognitive, social and psychological (32). Answers are dichotomous “Yes (1) /No (0)”, 1 indicating a problem. The GFI score ranges between 0 and 15, where ≥ 4 represents frailty (32). The tool has been validated ($r = -0.62$) and adapted in German (33).

Age was recorded as a continuous variable, using the year of birth at the time of the survey.

Gender information was collected as “Male” or “Female”.

The original answers on **level of education** were regrouped using the International Standard Classification of Education (34): “Tertiary” (“University”, “University of Applied Sciences”), “Secondary/Professional apprenticeship” (“Gymnasium”, “Apprenticeship”), “Primary or None” (“Elementary School” and “No degree”) and “Other”.

Monthly **household income** in Swiss Francs (CHF) was dichotomized for analysis: “Below national average” and “Above national average”, based on national average income data from 2008-2018 (35).

5.3.3. Statistical analysis

Categorical variables are reported as frequencies and percentages, whereas age is reported in mean and standard deviation (SD). The multiple response question is reported as a percentage of cases. We checked for multicollinearity using the χ^2 test. Five variables had more than 5% of missing data: openness to use phone/SMS (6.2%), wearables (8.4%), assistive robots (8.4%), individual income (5.3%), and GFI (14.2 %). As recommended by Jakobsen et al. (36), we imputed data using multiple imputation by chained equations (MICE) (37).

We used multiple logistic regression to test the association of predictor variables and outcomes (combined outcome and all four types of ATs separately). We used a backward elimination approach and the Akaike score (AIC) to determine model fit, a lower AIC denoting a stronger model. The p-value was set at 0.05.

Analysis was performed using R (38) and R Studio, version 1.3.1093 for Mac OS (39).

5.4. Results

5.4.1. Description of the sample

All participants (N=8786) were included and Table 1 summarizes their characteristics. Mean age was 81.8 years (SD=4.8), 51.8% were women, and 26.8 % had a GFI score of ≥ 4 . About 25 % had a tertiary education, and 45.8% reported their income to be below national average (35). More participants (63.0%) stated to be living with others, and support from a spouse/partner (36.4%) was the most common source (Table 1).

5.4.2. Descriptive results of current and openness to use assistive technologies

Only a small number (17.9 %) reported to currently use ATs, with phones/SMS (12.9 %) used most frequently. Openness to use ATs was highest for wearables (62.2 %) and telemedicine (56.9 %) (Table 1).

5.4.3. Factors associated with openness to use assistive technologies

Openness to use ATs was associated with current use of telemedicine (OR: 5.7, 95% CI: 4.9 – 6.5), phone/SMS (OR: 2.7, 95% CI: 2.5 – 2.9), wearables (OR: 4.8, 95% CI: 4.3 – 5.3) and assistive robots (OR: 8.6, 95% CI: 7.2 – 10.1) as well as with receiving support from a spouse/partner (OR: 1.1; 95% CI: 1.0 – 1.2). On the contrary, older age (OR: 0.9; 95% CI: 0.9 – 0.9) and female gender (OR: 0.7; 95% CI: 0.6 – 0.8) were associated with lower odds of being open to use ATs (Table 2).

Detailed results of openness to use the types of ATs individually can be found in Appendix C, Supplementary Tables S1-S4.

Table 1: Descriptive characteristics of the participants

Variables	Mean (SD) / n (%) N=8786
Predictor variables	
Age (in years)	81.8 (SD 4.8)
Gender (Female)	4559 (51.8)
Education	
<i>Tertiary</i>	2153 (24.5)
<i>Secondary</i>	4853 (55.2)
<i>Primary / No education</i>	1384 (15.8)
<i>Other</i>	396 (4.5)
Household income (below national average)	4030 (45.8)
Living situation	
<i>Living alone</i>	3256 (37.0)
<i>Living with others</i>	5530 (63.0)
Daily informal support (<u>more than one answer possible</u>)	
<i>Support from a spouse/partner</i>	3204 (36.4)
<i>Support from a younger family member</i>	2091 (23.7)
<i>Support from friends or neighbours</i>	839 (9.5)
<i>Currently do not need such support</i>	4232 (49.7)
Prevalence of frailty (Groningen Frailty Index score ≥ 4)	2359 (26.8)
Currently use telemedicine	167 (1.9)
Currently use phone or SMS	1114 (12.9)
Currently use wearables	234 (2.6)
Currently use assistive robots	60 (0.6)
Outcome variable	
Open to use telemedicine	4997 (56.9)
Open to use phone or SMS	4844 (55.1)
Open to use wearables	5466 (62.2)
Open to use assistive robots	3366 (38.3)

Table 2: Results of the logistic regression for the combined outcome (all models presented)

Openness to future use of assistive technologies (combining all outcomes)						
Covariates	OR (95% CI)					
	Model 1*	Model 2	Model 3	Model 4	Model 5	Model 6**
Support from partner (<i>yes</i>)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)
Support from younger family member (<i>yes</i>)	1.1 (0.9, 1.2)					
Frailty (GFI score ≥ 4)	1.0 (0.9, 1.2)	1.0 (0.9, 1.2)				
Education						
<i>Secondary Education</i>	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)			
<i>Primary/No Education</i>	1.1 (0.9, 1.3)	1.1 (0.9, 1.3)	1.1 (0.9, 1.3)			
<i>Other Education</i>	1.0 (0.7, 1.2)	1.0 (0.7, 1.2)	1.0 (0.7, 1.2)			
Household Income (<i>above national average</i>)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)		
Current use of telemedicine	5.7 (4.9, 6.5)	5.7 (4.9, 6.5)	5.7 (4.9, 6.5)	5.7 (4.9, 6.5)	5.7 (4.9, 6.5)	5.7 (4.9, 6.5)
Current use of phone /SMS	2.7 (2.5, 2.9)	2.7 (2.5, 2.9)	2.7 (2.5, 2.9)	2.7 (2.5, 2.9)	2.7 (2.5, 2.9)	2.7 (2.5, 2.9)
Current use of wearables	4.8 (4.3, 5.3)	4.8 (4.3, 5.3)	4.8 (4.3, 5.3)	4.8 (4.3, 5.3)	4.8 (4.3, 5.3)	4.8 (4.3, 5.3)
Current use of assistive robots	8.5 (7.1, 9.9)	8.5 (7.1, 10.0)	8.6 (7.1, 10.0)	8.6 (7.2, 10.0)	8.6 (7.2, 10.1)	8.6 (7.2, 10.1)
Living with others (<i>yes</i>)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)	
Age	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)
Gender (<i>female</i>)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)
<i>Observations</i>	8,786	8,786	8,786	8,786	8,786	8,786
<i>Log Likelihood</i>	-4,348.7	-4,349.1	-4,349.3	-4,350.0	-4,350.6	-4,350.6
<i>Akaike Information Criterion (AIC)</i>	8,729.4	8,728.1	8,726.7	8,721.9	8,721.2	8,719.2

Significant differences ($p < 0.05$) presented in bold

*Model 1: the saturated model containing all predictors

** Model 6: the final model that best explains the data (after the backward elimination)

5.5. Discussion

Using a population-based survey, we aimed to describe current and anticipated use of ATs and to assess factors associated with the use of ATs among home-dwelling older adults in Canton BL, Switzerland. Overall, our results indicated a rather low current usage of ATs (17.9%) among participants. Specifically, only 12.9 % of participants indicated to use phone/SMS for health services, more than twofold lower than findings from previous surveys in Switzerland (29).

We found current use of ATs was associated with openness to use ATs. Similar to Seifert et al. (29), advanced age and female gender were associated with lower odds of being open to use ATs. In contrast to their findings, we found no significant association with openness to use ATs and level of education. This might be related to the higher age of our participants. With increased age, support from caregivers might come more into play than level of education (40). Accordingly, we could show that receiving support from a spouse/partner was associated with higher odds of being open to use ATs. This highlights the importance of informal caregivers, as older adults might require additional help to operate some of devices (41).

Previous research shows that age-associated cognitive impairment, reduced fine motor movements, difficulties in hearing or seeing, and emotional anxiety can pose challenges to using ATs (42, 43). Barriers like lack of familiarity and access, discomfort requesting assistance, issues of trust, and concerns about privacy have also been reported to reduce the confidence of using ATs (44), and need to be addressed to improve their acceptability and usage.

To harness the potential of technology to enable *aging in place*, understanding what facilitates or obstructs the use of ATs is of utmost importance (45). Despite their wide availability, few products are used routinely in the care for home-dwelling adults. Researchers frequently find that only some are used beyond piloting, indicating their adoption to enhance independence is lagging behind (20). Development and implementation of innovative ATs should not only focus on process evaluation, but also on important outcomes for independence, quality of life and social autonomy (20). Furthermore, their evaluation should not be restricted to quantitative assessments, but lived experiences, expectations and personal values of older adults as end-users should be qualitatively explored (20). Co-creation, especially by involving vulnerable individuals, e.g., those with multimorbidity or a cognitive decline (46), is particularly important to improve acceptance and openness to use ATs.

Our study corroborates findings from international and national literature (24, 28, 29) and provides insights into drivers of openness to ATs among home-dwelling older adults. We consider the response rate to be a strength, which is high compared to other mail-based population surveys (47), especially considering this population is challenging to reach and might need support to respond (48). However, the study comes with some limitations. The outcome was assessed by a limited number of questions, and we could not assess other factors influencing openness to use ATs, such as perceived usefulness or expected benefits (24). We substantially reduced the number of questions, as stakeholders were concerned about its length burdening to the participants. Future surveys should be designed specifically for the purpose of exploring technology openness guided by conceptual frameworks, to also account for behaviors and attitudes towards ATs (49, 50).

5.6. Conclusions

Our study made a first attempt to gain insight into the current usage and openness to future use of ATs in home-dwelling older adults. We found current use of ATs, sociodemographic factors, frailty and receiving informal support from a caregiver play important roles in openness to use ATs in home-dwelling older adults. Understanding what drives the openness of home-dwelling older adults to use ATs is important, as it can enhance their autonomy and supports them to *age in place*.

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5.8. Appendix C

Supplementary Table S1: Results of the logistic regression for openness to use telemedicine (all models presented)

Openness to use telemedicine					
Covariates	OR (95% CI)				
	Model 1*	Model 2	Model 3	Model 4	Model 5**
Support from partner (<i>yes</i>)	1.1 (1.0, 1.1)				
Support from younger family member (<i>yes</i>)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)			
Frailty (GFI score ≥ 4)	1.0 (0.8, 1.1)	1.0 (0.8, 1.1)	1.0 (0.8, 1.1)		
Education					
<i>Secondary Education</i>	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)	
<i>Primary/No Education</i>	1.1 (0.9, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	
<i>Other Education</i>	0.9 (0.7, 1.2)	0.9 (0.7, 1.2)	0.9 (0.7, 1.2)	0.9 (0.7, 1.2)	
Household Income (<i>above national average</i>)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)
Current use of telemedicine	7.8 (7.3, 8.4)	7.8 (7.3, 8.4)	7.8 (7.3, 8.4)	7.8 (7.3, 8.4)	7.8 (7.3, 8.4)
Living with others (<i>yes</i>)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.1, 1.2)	1.1 (1.1, 1.2)	1.1 (1.1, 1.2)
Age	0.9 (0.9, 1.0)	0.9 (0.9, 1.0)	0.9 (0.9, 1.0)	0.9 (0.9, 1.0)	0.9 (0.9, 1.0)
Gender (<i>female</i>)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)
Observations	8,786	8,786	8,786	8,786	8,786
Log Likelihood	-5,775.2	-5,776.0	-5,776.0	-5,776.5	-5,777.7
Akaike Information Criterion (AIC)	11,576.5	11,575.9	11,574.1	11,573.0	11,569.3

Significant differences ($p < 0.05$) presented in bold

*Model 1: the saturated model containing all predictors

** Model 5: the final model that best explains the data (after the backward elimination)

Supplementary Table S2: Results of the logistic regression for openness to use phone/SMS (all models presented)

Openness to use phone / SMS services					
Covariates	OR (95% CI)				
	Model 1*	Model 2	Model 3	Model 4	Model 5**
Support from partner (<i>yes</i>)	1.0 (0.9, 1.1)				
Support from younger family member (<i>yes</i>)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)			
Frailty (GFI score \geq 4)	0.9 (0.8, 1.1)	0.9 (0.8, 1.1)	0.9 (0.8, 1.1)		
Education					
<i>Secondary Education</i>	1.1 (0.9, 1.2)	1.1 (0.9, 1.2)	1.1 (0.9, 1.2)	1.1 (0.9, 1.2)	
<i>Primary/No Education</i>	1.1 (0.9, 1.2)	1.1 (0.9, 1.2)	1.1 (0.9, 1.2)	1.1 (0.9, 1.2)	
<i>Other Education</i>	0.9 (0.7, 1.1)	0.9 (0.7, 1.1)	0.9 (0.7, 1.1)	0.9 (0.7, 1.1)	
Household Income (<i>above national average</i>)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)
Current use of phone /SMS	2.9 (2.7, 3.0)	2.9 (2.7, 3.0)	2.9 (2.7, 3.0)	2.8 (2.7, 3.0)	2.8 (2.7, 3.0)
Living with others (<i>yes</i>)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)
Age	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)
Gender (<i>female</i>)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)
Observations	8,786	8,786	8,786	8,786	8,786
Log Likelihood	-5,689.8	-5,690.0	-5,690.0	-5,691.9	-5,693.4
Akaike Information Criterion (AIC)	11,405.5	11,403.9	11,403.8	11,402.1	11,400.7

Significant differences ($p < 0.05$) presented in bold

*Model 1: the saturated model containing all predictors

** Model 5: the final model that best explains the data (after the backward elimination)

Supplementary Table S3: Results of the logistic regression for openness to use wearables (all models presented)

Openness to use wearables						
Covariates	OR (95% CI)					
	Model 1*	Model 2	Model 3	Model 4	Model 5	Model**
Support from partner (<i>yes</i>)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)
Support from younger family member (<i>yes</i>)	1.0 (0.9, 1.1)					
Frailty (GFI score \geq 4)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)				
Education						
<i>Secondary Education</i>	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)			
<i>Primary/No Education</i>	1.0 (0.8, 1.1)	1.0 (0.8, 1.1)	1.0 (0.8, 1.1)			
<i>Other Education</i>	0.9 (0.6, 1.1)	0.9 (0.6, 1.1)	0.9 (0.6, 1.1)			
Household Income (<i>above national average</i>)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)		
Current use of wearables	5.0 (4.6, 5.4)	5.0 (4.6, 5.4)	5.0 (4.6, 5.4)	5.0 (4.6, 5.4)	5.0 (4.6, 5.4)	4.9 (4.6, 5.3)
Living with others (<i>yes</i>)	1.1 (0.9, 1.2)	1.1 (0.9, 1.2)	1.1 (0.9, 1.2)	1.1 (0.9, 1.2)	1.1 (0.9, 1.2)	
Age	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)
Gender (<i>female</i>)	0.8 (0.7, 0.9)	0.8 (0.7, 0.9)	0.8 (0.7, 0.9)	0.8 (0.7, 0.9)	0.8 (0.7, 0.9)	0.8 (0.7, 0.9)
Observations	8,786	8,786	8,786	8,786	8,786	8,786
Log Likelihood	-5,671.4	-5,671.5	-5,671.6	-5,672.4	-5,672.6	-5,674.1
Akaike Information Criterion (AIC)	11,368.9	11,367.0	11,365.2	11,360.9	11,360.1	11,359.1

Significant differences ($p < 0.05$) presented in bold

*Model 1: the saturated model containing all predictors

** Model 6: the final model that best explains the data (after the backward elimination)

Supplementary Table S4: Results of the logistic regression for openness to use assistive robots (all models presented)

Openness to use assistive robots					
Covariates	OR (95% CI)				
	Model 1*	Model 2	Model 3	Model 4	Model 5**
Support from partner (<i>yes</i>)	1.0 (0.9, 1.1)				
Support from younger family member (<i>yes</i>)	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)			
Frailty (GFI score ≥ 4)	0.8 (0.7, 0.9)	0.8 (0.7, 0.9)	0.8 (0.7, 0.9)	0.8 (0.7, 0.9)	0.8 (0.7, 0.9)
Education					
<i>Secondary Education</i>	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)		
<i>Primary/No Education</i>	1.0 (0.9, 1.2)	1.0 (0.9, 1.2)	1.0 (0.9, 1.2)		
<i>Other Education</i>	1.1 (0.8, 1.3)	1.1 (0.8, 1.3)	1.1 (0.8, 1.3)		
Household Income (<i>above national average</i>)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	
Current use of an assistive robot	10.8 (10.1, 11.5)	10.8 (10.1, 11.5)	10.8 (10.1, 11.5)	10.8 (10.1, 11.5)	10.8 (10.1, 11.5)
Living with others (<i>yes</i>)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)	1.1 (1.0, 1.2)
Age	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)	0.9 (0.9, 0.9)
Gender (<i>female</i>)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)	0.7 (0.6, 0.8)
Observations	8,786	8,786	8,786	8,786	8,786
Log Likelihood	-5,596.9	-5,597.0	-5,598.6	-5,599.2	-5,599.5
Akaike Inf. Crit.	11,219.9	11,219.1	11,217.9	11,214.5	11,213.0

Significant differences ($p < 0.05$) presented in bold

*Model 1: the saturated model containing all predictors

** Model 5: the final model that best explains the data (after the backward elimination)

Chapter 6: Synthesis and Discussion

The aging of the population and the associated rise in prevalence of multimorbidity and functional limitations comprises a challenge to the health and social care system, but also presents an opportunity for a paradigm shift from disease- towards person-centered integrated care. Building integrated care programs by using implementation science methodologies can ensure the successful implementation and sustainability of such initiatives. The ultimate goal of integrated care is to provide a cost-effective model of care for home-dwelling older adults, which takes into consideration their needs and goals, and guarantees a qualitative life as they *age in place*.

In this closing chapter, we initially present the key findings from Chapters 3 to 5 of the dissertation. Furthermore, we provide a reflection on what our findings signify in terms of *aging in place*, guiding the discourse by the relevant components of the SELFIE framework (Figure 1) (1). The chapter resumes by addressing what we consider the methodological strengths and limitations of this work, and closes with a discussion on key implications in terms of research, policy and practice, also guided by some of the domains of the SELFIE framework.

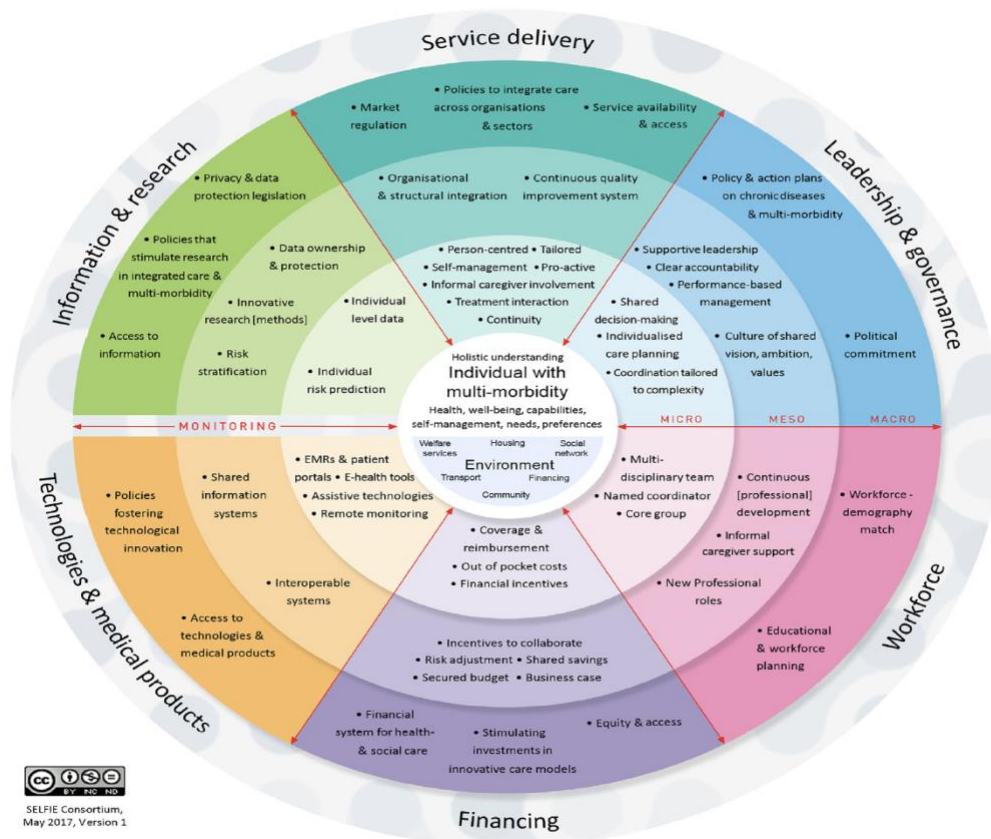


Figure 1: The SELFIE Framework for Integrated Care for Multi-Morbidity

6.1. Key findings

In **Chapter 3** we present the development and dissemination approach of the INSPIRE Population Survey, one of the first population-based surveys aimed at understanding the needs and preferences of home-dwelling older adults in Switzerland. The survey was embedded within the contextual analysis of a larger implementation science project, the INSPIRE project (2). A response rate of 30.7% was achieved, which is a considerably high rate for postal survey (3), particularly because older adults are known to be difficult to be reached in surveys (4). This achievement can be primarily attributed to the extensive stakeholder involvement strategies we employed, strengthened by specific strategies we used for marketing the survey.

In **Chapter 4**, we assessed HRQoL and factors related to it using an ecological perspective. In our survey, the participants reported a high HRQoL, similar to findings from other European countries with comparable populations (5, 6). In terms of factors, we specifically looked at multilevel factors at the micro, meso and macro level related to how home-dwelling older adults perceived HRQoL. This ecological view allowed us to investigate variables associated not only with the individual, but to also take into account the role environment plays in HRQoL. We found that having a higher income, supplementary insurance, better education and generally a greater socio-economic status were all associated with a higher HRQoL among this population (7, 8). Our results also corroborated the findings indicating that individuals who are more frequently involved in one or more social activities, generally also report a higher HRQoL (9, 10). Nonetheless, our analysis confirmed findings from previous research that there are also factors which negatively impact HRQoL among home-dwelling older adults, such as being older and female, having multimorbidity and polypharmacy, as well as being lonely or socially isolated (11-22).

Chapter 5 presents the findings from our study aiming to describe the current and anticipated use of assistive technologies, namely telemedicine, phone/SMS, wearables and assistive robots; as well assess the factors associated with openness to use these assistive technologies among home-dwelling older adults. We found the current use of assistive technologies to be rather low amongst the participants of the survey, compared to findings from two other studies conducted among Swiss older adults (23, 24). Our results showcased a new finding that, compared to the current use, higher percentage were open to using assistive technologies in the future, especially to using wearables and telemedicine. Furthermore, we found that openness to use assistive technologies in this population was positively associated with current use of telemedicine, current use of phone/SMS, current use of wearables and current use of assistive robots. Moreover, we also shed light on the fact that this openness was

also associated with receiving support from a spouse or a partner. In contrast, openness to use assistive technologies was negatively associated with older age and with being female, which confirms findings from the research of Seifert et al. (23).

6.2. Aging in place: a discourse guided by the SELFIE framework

Aging in place is a common goal not only for older adults and their families, but also for care providers and policy makers (25-29). The overarching goal of the dissertation was to dive deeper into HRQoL, studied through an ecological lens, as one of the main goals of *aging in place*. Furthermore, we investigated factors associated with openness to use assistive technologies that can facilitate *aging in place* by supporting the independence of home-dwelling older adults.

Finding the appropriate components to build integrated care models is largely driven by the local context; the current healthcare and social service delivery systems; as well as the existing barriers and facilitators at the political, legal and financial level (1). The SELFIE framework, although not a recipe for designing the ideal integrated care initiative, can be used as a starting point in comprehensively describing and understanding the important elements of integrated care for individuals with multimorbidity (*micro-meso level of the framework*) and their respective target groups (*the core of the framework*) within their respective context (*meso-macro level of the framework*). We believe this framework is suitable to guide the discussion pertaining our target population, as older adults are a population with a high prevalence of multimorbidity (19, 30).

6.2.1. Holistic understanding of the individual and their environment

The WHO proposed an integrated care approach to guide system and providers to better support the independence and *aging in place* for an aging population (31, 32). Person-centered integrated care has its basis on understanding the entire situation of the individual's health and well-being, their social network, as well as the environment they live in (33-35). The SELFIE framework highlights such an approach, by emphasizing the need to encourage individuals to clarify their goals, preferences and priorities (1, 36-39).

The research conducted as part of this dissertation places the older adults and their environment at the center, taking their capabilities and preferences into consideration. The findings from our studies and the concurrent reflections point towards the importance of assessing the environmental elements which play a role in enabling older adults to *age in place*.

We will provide some granularity in the discussion in the next sections, by making reflections on the considerations for *aging in place* on the micro, meso and macro level of the SELFIE framework, combined across its six domains (*service delivery; leadership and governance; workforce; financing; technologies and medical products; and information and research*).

6.2.2. Considerations at the micro level for aging in place

Individuals living with multiple chronic conditions and their caregivers have to deal with many health and social challenges (1). Henceforth, tailoring these needs to the individual and their environment by also addressing the social determinants of health is a key aspect to consider. Our findings from **Chapter 4** emphasize many social aspects surrounding the older adult that determine their well-being and quality of life. These social aspects, as we showed in **Chapter 5**, were also important in determining the attitude and intention to use assistive technologies. We confirmed findings from many studies and policy recommendations that suggest social determinants of health play an important role in *aging in place* and should be given considerate weight (40, 41). These determinants encompass non-medical conditions that play a role in health inequities, the unfair and avoidable differences observed in health and well-being within a population (42). Our findings suggest that a proportion of home-dwelling older adults might be living in a lower socio-economic, which is impacting their HRQoL and their independence. In this context, considerations ought to be given to the financial situation, housing, the physical surroundings, the availability of community services, transportation, etc. (1). We thus support the viewpoint that integrating social care when designing integrated care models is crucial in supporting older adults in maintaining their independence, especially those who might be living in socio-economic disparities (43). This integration of social and health care is at the core of the INSPIRE care model and we believe it will be an important driver in reducing avoidable admissions to long-term care facilities and enabling home-dwelling older adults reach the goal they desire, that of *aging in place*.

6.2.3. Considerations at the meso level for aging in place

Adding on to the social determinants, our findings reconfirmed that the informal caregivers, especially those closest to the older adult such as their spouse or their partner, are key stakeholders. The role of the social network surrounding the older adults, such as the availability of family, friends and neighbors who can provide informal care for them is an important element to consider according to the SELFIE framework (1). Our research suggests that informal care from a spouse or a partner was associated with both higher HRQoL

(**Chapter 4**), as well as with higher odds of being open to using assistive technologies in the future (**Chapter 5**). Both these findings reiterate the importance of informal caregiver in ensuring older adults are supported and are aging well. This was reconfirmed by a mixed methods study conducted as part of the INSPIRE project, where Yip et al., used the quantitative data from the INSPIRE Population Survey to assess health and social care, as well as needs for support of the respondents (44). The study emphasized that currently 71% of them indicated to rely on at least one source of informal support, whereas in the future, 56% of such support is anticipated to come from a spouse or a partner (44).

Informal caregivers play dynamic roles in caring for older adults, and are progressively relied upon by older adults for diverse support in daily lives (44, 45). However, this process may result in physical and mental burden for the caregivers (46). Therefore, considerations to support this important group of individuals is very important, as they play a crucial role in the workforce providing care for older adults *aging in place* (1, 47). Some of the various forms of support for the informal caregivers, according to the SELFIE framework, are increased education and training of the caregivers to increase their competences and confidence; as well as reducing the pressure of being the sole caregiver, by establishing clear responsibilities or fostering opportunities for caregivers to have a break (1).

6.2.4. Considerations at the macro level for aging in place

An integrated care approach is leveraged to support older people to *age in place*, and this is also reflected by the SELFIE framework (31, 32). This person-centered approach involves a multidisciplinary team that proactively coordinates the health and social care needs for older adults. This coordination of care relies on interprofessional collaboration, where communicating between the older adults and their caregivers on one side, and service providers on the other side is key (48).

An important consideration at the macro level is therefore the need for nationwide policies that foster technological development and innovation, especially in regard of e-health and other assistive technologies that can benefit individuals with multimorbidity (*technologies and medical products domain*) (1). In parallel, it is pivotal to ensure that the policies put in place will consider the necessity to harmonize the data protection policies and the need for continuous information exchange (*information and research domain*) which is crucial for continuity of care (1) and *aging in place*. In **Chapter 5** we uncovered that home-dwelling older adults will be open to using telemedicine in the future, a significant finding in the approach to integrated care. Amid interventions proposed to increase efficiency of integrated care systems,

the use of telemedicine has already shown promising results in numerous care areas (49). This advent of assistive technologies can help deliver better health and social care for home-dwelling older adults, while taking into account types of tools and devices they deem acceptable and useful.

6.3. Methodological strengths and limitations

We consider the population-based approach, inviting all eligible home-dwelling older adults to participate, is the main methodological strength of the survey (**Chapter 3**). Specifically, the survey was built by an iterative contribution from experts and stakeholders who understood our target population and the local context, while a group of older adults tested the acceptability and the readability of the survey. In terms of the marketing strategy, we involved the social and health care providers most trusted by older adults, and constantly reevaluated and adapted our marketing strategies.

Another important methodological strength of this dissertation is the fact that we used the EQ-5D-5L instrument, a widely renowned tool designed as a generic measure of HRQoL (**Chapter 4**) (50). This instrument is considered succinct, easy to use, and does not require much time or effort to be filled out. These features are important to consider when conducting research involving older adults, who frequently have poorer vision, might suffer from cognitive decline and might require help from others to engage in research (51). Moreover, the psychometric properties of the EQ-5D-5L instrument are well-examined, with several studies specifically substantiating its reliability and validity amongst the older population (52-54). Using a proven instrument also allowed for an easier comparison with findings from other European countries and the wider literature.

Nonetheless, there are some methodological limitations associated with this dissertation that we would like to bring to attention. First, the community-academic partnership we had with multiple stakeholders in developing the survey, although pivotal to its success, meant a compromise in the number and content of questions. Some of the stakeholders were concerned about the length and potential intrusive nature of some of the questions, especially those related to health. Specifically, we were not able to capture some information, as initially planned, on the presence of chronic diseases and diagnoses and types of medication used, or include questions for a thorough assessment of unmet needs. Moreover, due to logistical and funding restrictions, we were unable to include questions targeting informal caregivers, and the potential burden of caring for their aging family member. We believe this uncaptured data

would have made the mapping of the needs of this population much richer, as well as provided us with more in-depth information when examining the role of the informal caregiver in HRQoL (**Chapter 4**) as well as their attitudes towards assistive technologies (**Chapter 5**).

The above-mentioned reduction in the number of variables we could collect created another methodological drawback, especially when examining openness to use assistive technologies in **Chapter 5**. Openness to use a technology tool, device or software is a compound construct to measure, as it entails more complex psychological and behavioral components. In literature, an extensively researched and used theoretical model on the subject is the technology acceptance model (TAM) which models how users come to accept and use a technology (55). This model highlights that there are behavioral elements that lead people to use a given technology, which is also influenced by their attitudes, representing their general impression of the said technology (55). Regrettably, our study was restricted in collecting such determinants, potentially undermining the influence of these components on our outcome of interest.

For a final limitation, we used the EQ-5D German value sets as the closest proxy for the Swiss population living in the German-speaking Canton of BL (**Chapter 4**). We had to make an arbitrary choice following the general recommendations of the EuroQoL Group to select value sets based on geographical proximity and similarities in cultural background (56). Although linguistically similar, the use of German value sets might have not completely reflected the cultural and social values individuals assign to health and quality of life in the Swiss context.

6.4. Implications for research

There are several implications for further investigation stemming from the research conducted as part of this dissertation. We expanded the knowledge base on HRQoL and its associated factors among home-dwelling older adults by also reconfirming the impact the environment poses on how this population perceives their HRQoL. We believe the use of an ecological approach like in our study should be taken into consideration in further research on exploring this important topic, especially considering the interweaved impact HRQoL has on independence and the overall ability of the older adult to *age in place* (57). Our study confirmed findings from the broader literature that HRQoL is a multifaceted construct challenging to define and measure (57, 58). Despite the considerable body of knowledge, we consider that there are still aspects that are important to be explored in future research

pertaining HRQoL among home-dwelling older adults. First, we believe in-depth qualitative explorations looking at this construct could further enrich the understanding of the beliefs, perceptions and expectations of home-dwelling older adults when they think about what makes their life qualitative and meaningful. The other aspect, and more related to the Swiss context, is that despite the EQ-5D-5L being an established measurement tool, the methodological valuation of HRQoL remains widely influenced by value sets deriving from other populations (59). Switzerland is known for its diversity as well as social and cultural values which, although close to neighboring countries, remain unique to this small country in the center of Europe. It might be worth the while exploring prospects among HRQoL researchers in creating a standardized Swiss value set for the EQ-5D-5L instrument, which would better mirror the preferences of this population in how they value their HRQoL.

As highlighted in section 6.3, the use of a conceptual model underpinning behavioral and psychological factors is key in assessing what drives openness to use assistive technologies. Research shows that when users are presented with a new technology, a number of factors influence their decision on if, how and when they will use (60). Two such influencing factors are particularly important to assess when researching openness to use technology among individuals: perceived usefulness (PU) and perceived ease-of-use (PEOU). PU is defined as "the degree to which a person believes that using a particular system would enhance their life and independence" (60). This variable provides valuable information on whether or not someone perceives a given technology to be useful for what they intend to do. The other important variable to consider in future research on openness to use technology is the perceived ease-of-use (PEOU). PEOU is defined as "the degree to which a person believes that using a particular technology would be free from effort" (60). Seifert et al, found that among Swiss older adults aged 65 years above, perceived burden with use of technology was an important barrier reported (23). If an older adult finds a tool not easy to use and its interface complicated, they would probably not have a positive attitude towards using it in the future. Thus, we consider future research on openness to use technology among home-dwelling older adults should include variables like PU and PEOU.

Our survey included a comprehensive overview of several areas of the life, health and social well-being of home-dwelling older adults. However, several aspects of the necessities of this particular population remained either superficially explored or not explored at all. An important aspect that we were not able to dive deeper into is a comprehensive assessment of the unmet needs in our target population. We had no means of conducting an in-depth assessment of the unmet needs, but we already know from a sister study using the data from

our survey that 6.5 % of home-dwelling older adults in Canton BL reported their current support did not match their needs (61). A home-dwelling older adult is said to have unmet needs if he or she does not receive services they need, or if the received services are insufficient to meet such needs (62-64). These needs can be either health needs such as for treatment or rehabilitation, or can include social or home support needs to perform daily activities such as toileting, feeding, bathing, walking, clothing, shopping, meal preparation, housekeeping, and managing finances (63, 65). Ample research in this area suggests that in case such needs are not met, older adults report a lower quality of life, utilize more health and social care services and generally have a higher risk for adverse outcomes (66).

The other just as important aspect we were not able to capture in the survey was assessing the perspectives of the informal caregivers who provide daily care and support to home-dwelling older adults. The SELFIE framework emphasizes the role of the social network and the need for assessing not only the role of the informal caregivers, but also assessing their insights and the burden of care that they may experience (1, 33, 67). An informal caregiver is defined as any individual who provides some type of unpaid ongoing assistance with Activities of Daily Living (ADL) or Instrumental Activities of Daily Living (IADL) (68, 69). Hence, we support calls upon taking into consideration the needs of the informal caregivers as well, when assessing the needs for support of home-dwelling older adults (70). We highlight both these research areas, assessing the unmet needs and the needs of informal caregivers, as we consider them intertwined. An informal caregiver's role in meeting the needs of the person they are providing care for is undoubtedly important in terms of creating favorable conditions for *aging in place*. We also encourage future research to undertake qualitative explorations of both these research areas, as we consider it important to individually assess older adults by understanding their unique needs and goals, as well as the distinctive needs of the caregivers involved in their care network.

6.5. Implications for policy and practice

Policymakers are increasingly recognizing that sustainable strategies to enable older adults to *age in place* lie in a population-based health approach, with a focus on older adults as key partners (71-73). This is also highlighted by the SELFIE framework, emphasizing it is essential to not only assess the needs of the population in a holistic manner, but to continuously plan formal assessments, as the situation of an older adult living with multimorbidity is dynamic and may change over time (1). The INSPIRE Population Survey serves as a rather

unique information source to record the needs and preferences of home-based older adults. The survey is a building block of the contextual analysis (2), and has paved the initial steps forward to help the local politicians and organizations in the community in tailoring future services needed by older adults *aging in place* in this region.

Nonetheless, population planning approaches stemming from the type of research we conducted is just the initial step in harmonizing policies with the challenges associated with longevity. Our findings emphasize several social factors that play an important role in the ageing trajectory of an individual and how they perceive their HRQoL (**Chapter 4**). Some of the identified factors influencing HRQoL among home-dwelling older adults are modifiable determinants of health, and are important for consideration by the policymakers. We believe our findings can guide local and federal policymakers in investing on improving economic stability and social capital of home-dwelling older adults. For instance, health promotion and prevention activities targeting the social networks of older adults, do not only improve their HRQoL but also empower their independence as they *age in place*.

The SELFIE framework calls upon policymakers to encourage policies and financial incentives that promote interprofessional collaboration and stimulate integrated care (1), which can support older adults to *age in place*. In this regard, considerations should be prioritized on three of the domains of the SELFIE framework, namely *leadership*, *workforce* and *financing* (1). Successful implementation of integrated care models for *aging in place* can be stimulated by an established leadership that is fully committed and has clear goals, in an environment that promotes organizational transparency and accountability (1). Moreover, the policymakers need to ensure workforce development will harmonize with the two challenges of the aging society: an increase in the proportion of the individuals in the formal and informal workforce retiring and a rise in the number of individuals living longer with multimorbidity (1). In addition to a sustainable workforce, legislation needs to be in place to provide financial incentives for integrated care, such as for example putting in place reimbursement structures that guarantee paid time spent caring for an older population in an integrated way, for both professionals and informal caregivers (1).

In Canton BL, the Cantonal law enforced in 2018 ensued older adults living at home will have access to new services provided by the IAC, an excellent source to achieve this desired goal. However, getting older is not a linear process and while some older adults experience aging in full health and are surrounded by a caring community, others might be affected by multimorbidity and may lack a support system (33). Identifying and reaching the latter group will probably be one of the most challenging obstacles the staff of the IAC will

face. We showcased in **Chapter 3** that targeting older adults, especially those with complex needs who are frail and suffer from multimorbidity, is challenging. However, a scientific and iterative approach based on Implementation Science methodology successfully guided us in reaching this vulnerable population. The services that will be provided by the IAC are new, and the centers are looking to engage older adults in visiting them and benefiting from the community-based assistances they provide. We believe local lawmakers and the staff of the IAC could benefit from lessons learned in conducting the INSPIRE Population Survey in two main aspects, both elements of the Basel School of Implementation Science (74).

Initially, the policymakers and the providers of the new service would benefit from having a stakeholder engagement strategy. As shown in **Chapter 3**, an iterative and dynamic strategy to reach stakeholders from multiple levels (older adults, health and social care professionals and organizations and policymakers) drove the accomplishments of the survey (75). In the context of the IAC, creating a strong marketing strategy targeting specific stakeholders is of utmost importance, as the long-term goal is to encourage all home-dwelling older adults in the region to visit and benefit from the services the center will provide. These groups of interest should include older adults and their families; their GPs and other health and social care providers; secondary care institutions such as outpatient hospital wards or nursing homes that offer short-term stays; and other organizations providing services to this population. As highlighted by Kumpunen et al., ongoing contributions from stakeholders are important not only for the development, but also for the acceptability and sustainability of the novel services (76).

The other equally important aspect of our research from which lessons could be drawn is the use of contextually-adapted implementation strategies. We used preferred sources such as the local newspapers and radio, as well as the reliable services providers, with a special emphasis on the role of the general practitioner. By mobilizing the trusted information and care network of home-dwelling older adults in this region, we believe the IAC could reach their goals. On one hand, this approach would serve to raise awareness in the community that new services are available, as well as what these services entail. On the other hand, the approach would aid in reaching older adults most in need, like those frail or with multimorbidity, who are the ones that would benefit the most from integrated care services.

Our work from **Chapter 5** has also important implications for policy and practice we would like to list. The new integrated care approach that is being rolled out in Canton BL puts the older adult at the center, entrusting the nurse and the social worker employed by the IAC to coordinate their care with a wide network of professionals. Thus, there will be a constant

need to facilitate the information flow to ensure the previously fragmented care components can be brought together to create favorable outcomes for older adults. By enhancing the communication between formal and informal care, assistive technologies can facilitate this collaboration, leading ultimately to a care that is coordinated and enhances the independence of older adults (48). Nonetheless, the broader contextual analysis in the INSPIRE project revealed that there is still a high diversity in the information-sharing technologies currently in place in the Swiss healthcare system in general (2, 77). Lawmakers and care providers in Canton BL should leverage our findings that the use of telemedicine is anticipated in the future by home-dwelling older adults, as this assistive technology is already known to effectively support collaboration in integrated care programs (78).

6.6. Conclusions

Current trends in healthcare systems in many countries project their populations will continue aging, and older adults will increasingly be faced with complex health and social care needs. This process is expected to pose additional burdens in societies with already existing budgetary constraints and reduced resources for informal and formal care. On the other side, when asked about their future preferences, most older adults state they prefer to stay in their homes as they age. This concept is known as *aging in place* and has received attention in the recent years from researchers and policymakers alike.

To support the increasingly aging population and help older adults in reaching this goal, the WHO has proposed cost-effective alternatives such as integrated care models for home-dwelling older adults. These person-centered models of care are expected to create favorable conditions for older adults to continue living within their familiar environments, by guaranteeing they receive the support and care that matches their needs. To help implement such models, it is key to directly assess the current and anticipated health and social needs of this population. Involving older adults and their informal caregivers, as well as formal care providers and policymakers, is also central in ensuring these innovative approaches are relevant and sustainable.

In this dissertation, we used a stakeholder engagement approach, deriving from methods of Implementation Science, to pave the road forward for implementing an integrated care model. Our findings shed light upon some important areas of care that require attention from both care providers and lawmakers. We found that including social components in the care of older adults and involving informal caregivers who provide daily support for them are

key in fostering a care that enhances the quality of life and assists older adults in maintaining their independence. We also demonstrated the potential of assistive technologies in improving daily function and well-being among older adults, which could potentially also reduce some of the caregiver burden in the future. Our findings showcased that, despite the reported barriers among this population, the home-dwelling older adults are open to using such technologies in the future, provided they are supported by their informal caregivers. From a research, practice and policy standpoint, we believe the findings of this dissertation have the potential to contribute towards a better scientific and policy approach in making certain older adults are reaching their goal to *age in place*.

6.7. References

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