

LIVING ARRANGEMENTS AND THEIR ASSOCIATION TO  
PHYSICAL FUNCTION AT THE AGES OF 90 AND OVER

Beatrice Silvestri-Hyrynen

Master's Thesis

University of Tampere

Tampere School of Public Health

Health Sciences (Public Health)

May 2011

## **ABSTRACT**

University of Tampere

Tampere School of Public Health

SILVESTRI-HYRYNEN, BEATRICE: LIVING ARRANGEMENTS AND THEIR  
ASSOCIATION TO PHYSICAL FUNCTION AT THE AGES OF 90 AND OVER

Master's Thesis, 69 pages

Supervisor: Tytti Sarkeala, PHD

Health Sciences (Public Health)

May 2011

---

Gains in longevity and improvements in health such as resulting effects on demographics are the subject of both research and everyday conversation. The purpose of this study is to extend these studies by evaluating relationships between living arrangements and physical function, one main aspect of health, among the oldest old populations. Another major goal is to investigate the impacts of these factors on gender. The intention is to throw more light on this area of study to better understand how the oldest old live, their physical function, and how these correlate with gender.

This research draws from the Vitality 90+ study, a cross sectional data based on postal questionnaires conducted in Tampere, Finland in 2007. The survey, focusing on nonagenarians, has been undertaken several times between 1996 and 2010.

The statistical analysis includes a descriptive component and a modelling part where binary logistic regression was applied to test association of the variables representing living arrangements and function by gender.

Outcomes reveal that one out of five study participants were male. Proportionately, men are more likely to live in the community. Further, women living at home are very likely to live alone. Overall, living alone is the most common arrangement but a considerable number of men also live with a spouse. Women show throughout all physical function tasks a higher dependence. Finally, logistic regression showed no gender difference of living arrangements in association with physical function and chronological age.

In conclusion it can be suggested that vulnerable men die but the survivors no longer differ from women in terms of physical function and age above ninety linked with living arrangements. However, apart from keeping older populations in general mobile for a long independent life, resources could, wherever possible, concentrate on the oldest old women because firstly there are comparatively more, secondly they tend to become frail more easily, and thirdly most of them live alone.

## Table of Contents

<b>ABSTRACT .....</b>	<b>2</b>
<b>ABBREVIATIONS.....</b>	<b>5</b>
<b>1. INTRODUCTION .....</b>	<b>6</b>
<b>2. LITERATURE REVIEW .....</b>	<b>8</b>
2.1. DEMOGRAPHICS .....	8
2.2. LIVING ARRANGEMENTS .....	10
2.3. PHYSICAL FUNCTION.....	13
2.4. RELATIONSHIPS BETWEEN LIVING ARRANGEMENTS AND PHYSICAL FUNCTION .....	16
2.4.1. Living arrangements and physical function .....	16
2.4.2. Marital status and its impact.....	19
2.5. GENDER DIFFERENCES .....	21
<b>3. AIMS AND HYPOTHESIS.....</b>	<b>24</b>
3.1. OBJECTIVE.....	24
3.2. HYPOTHESIS .....	24
<b>4. MATERIALS AND METHODS.....</b>	<b>25</b>
4.1. BACKGROUND AND SCOPE, CONCEPTUAL FRAMEWORK .....	25
4.2. MEASURES FOR LIVING ARRANGEMENTS .....	26
4.3. MEASURES FOR FUNCTION .....	27
4.4. STATISTICAL METHODS: ANALYTICAL APPROACH AND TYPE OF ANALYSIS .....	28
4.4.1. Descriptive part of the study .....	28
4.4.2. Modelling part of the study .....	29
4.4.3. Model 1: associations between place of residence and physical function.....	30
4.4.4. Model 2: associations between cohabitation and physical function.....	31
4.5. ETHICAL CONSIDERATION AND PERMISSION.....	32
<b>5. RESULTS.....</b>	<b>33</b>
5.1. RESPONSE RATE AND SOCIO DEMOGRAPHICS .....	33
5.2. LIVING ARRANGEMENTS .....	33
5.2.1. Place of residence.....	33
5.2.2. Cohabitation of the community dwellers .....	34
5.2.3. Rate and need of assistance of the community dwellers .....	35
5.3. PHYSICAL FUNCTION.....	36
5.4. ASSOCIATION BETWEEN LIVING ARRANGEMENTS AND PHYSICAL FUNCTION.....	37
5.4.1. Model 1: physical function predicting place of residence.....	37
5.4.2. Model 2: physical function predicting cohabitation.....	42
<b>6. DISCUSSION.....</b>	<b>47</b>
6.1. MAIN FINDINGS .....	47
6.2. STRENGTH AND LIMITATIONS OF THE STUDY .....	49
6.2.1. Strength, validity and reliability.....	49
6.2.2. Limitations .....	51

6.3. COMPARISON TO PREVIOUS STUDIES .....	52
6.3.1. Living arrangements: place of residence, cohabitation and rate and need of assistance. 52	
6.3.2. Physical function .....	55
6.3.3. Relationships between living arrangements and physical function.....	55
6.4. PUBLIC HEALTH IMPLEMENTATIONS .....	58
6.5. FURTHER RESEARCH PROPOSALS .....	59
<b>7. CONCLUSIONS AND RECOMMENDATIONS .....</b>	<b>60</b>
<b>ACKNOWLEDGEMENTS .....</b>	<b>62</b>
<b>REFERENCES .....</b>	<b>63</b>

## **ABBREVIATIONS**

- ADL           Activities of daily living, such as climbing stairs and walking.
- BADL          Basic activities of daily living, such as bathing, dressing and eating.
- IADL          Instrumental activities of daily living, such as preparing meals, shopping, and cleaning.
- PADL          Personal activities of daily living, such as mixtures of ADL and BADL.

## 1. INTRODUCTION

As a result of the increase in populations of elderly people, global ageing has become a very important and urgent subject for society in many ways. One main issue of concern is how the younger section of society is going to be able to care economically for the proportionately larger aged groups in society and how they can carry the weight of the ensuing costs. Since age is commonly associated with frailty and deterioration, another issue is developing concepts on how the retired segment of society could be kept healthy and fit. Both agendas aim to achieve an affordable, healthy and long life with dignity for the oldest populations without creating a burden for the younger societies to come.

Whereas ageing occurs at all stages of life, the consequences of changing demographics clearly affects the vulnerable, the oldest old, for many reasons. Two aspects which impact on this group are living arrangements and physical function. On the one hand, in addition to socio-economic characteristics of living arrangements, living arrangements as such may either reflect or even impact on health. This again can appear in various forms and a decline in health may impinge on women and men differently. On the other hand, therefore, the way we arrange our living and how we cope with daily, essential tasks, such as getting in and out of bed, are central. Those tasks are summarized as physical function, a main component of the multidimensional concept of health undergoing a continuous change (1). Gender issues may diverge in old age and, therefore, a gender focus of research on the oldest old is essential. This focus is not only crucial for more accurate research but may also possibly lead to more improvements in conditions for the elderly through a more appropriate allocation of funds and resources.

Research indicates that most elderly people in the West live in two person households, whereas in Finland the most common is living alone (2,3). It appears that in Finland women are more likely to live in institutions compared to men (4). Moreover, there is proof that women seem to be weaker in physical function among the older (5-10) and oldest old

populations (11-15), whereas men seem to be more easily afflicted with serious and fatal illnesses. Finally, there is agreement among scholars about the association between living arrangements and physical function (13,16-19).

It is well known that there is limited knowledge concerning the oldest old and the ways in which they live. Study results are at times controversial or difficult to compare due to diverging aims; for example, some have included only people living in the community, and often living alone or living with a spouse was the subject of main focus. It would, therefore, be of interest to learn how the oldest old live when looking at the oldest population as a whole. Furthermore, because there is such a small amount of existing information about the oldest old, it remains unclear whether living arrangements and physical function impacts with any significant difference on gender.

The data of this study is based on the 'Vitality 90+' study, a cross sectional study, conducted in Tampere, Finland in 2007. The 'Vitality 90+' studies are surveys which have been continuously undertaken since 1996 and followed up in 1998, 2001, 2003, 2007 and 2010. The answers to a postal questionnaire were quantified and processed with SPSS software. The analysis includes a descriptive part and a modelling part with binary logistic regression.

The main purpose of this study is to assess how men and women aged 90 years or over live and the condition of their physical function. Another aim is to investigate how living arrangements of these nonagenarians are related to their physical function. As a whole the basic focus of this study is to research gender differences.

## **2. LITERATURE REVIEW**

This chapter starts with highlighting issues related to ageing globally and in particular in Finland, looking at the oldest part of the population. Second, a summary of research conducted on living arrangements of the old and oldest old is provided. This is followed by an explanation of measurements and terminologies of physical function and a presentation of current available knowledge. Finally, I try to shed some light on the relation of living arrangements to physical function during the last stage of life and on gender.

This literature review was conducted between January and March 2010 as well as during October and November 2010. Besides information received from the National Centre for Statistics and the National Institute for Health and Welfare, articles found in search machines like Web of Science and Medline were included as well. Publications recommended by my supervisor and relevant material received in courses were also integrated. Finally, reference lists were screened in order to find more material related to this topic.

### **2.1. Demographics**

The author Sarah Harper predicted that by the year 2050 global ageing will reach a point where “the number of older people will outnumber the number of young people”, (20)(p3). Assuming that her calculation becomes a reality, the population pyramids will change into “top-heavy” shapes (20)(p11). In accordance with that, Kinsella and Phillips reflected this by being more gender specific:

Women constitute a majority of the older population in almost every country, and their majority increases with age (21) (p23).

In Finland in 2007, 16.9 % of the population was 65 years old and older whereas 0.6 % was aged 90+. The latter group has more than doubled since 1990 and increased one-third during the past ten years (1997-2007). (22) Studying a longer period we recognize a



continuously falling share of the age category of 0 to 14 years since 1980 and a rapidly rising share of the age group 65+. However, population growth in Finland in 2007 was the largest since 1992. (23)

Not surprisingly, Finland belongs with Japan and eighteen other European countries to the twenty oldest countries worldwide, where the age group increasing the fastest is the group 80+(20)(p3) or 85+(24) depending on the age categories applied.

**Figure 1.** Proportion of each gender for the whole population, for ages above 65 and for ages above 90 in Finland 2007.

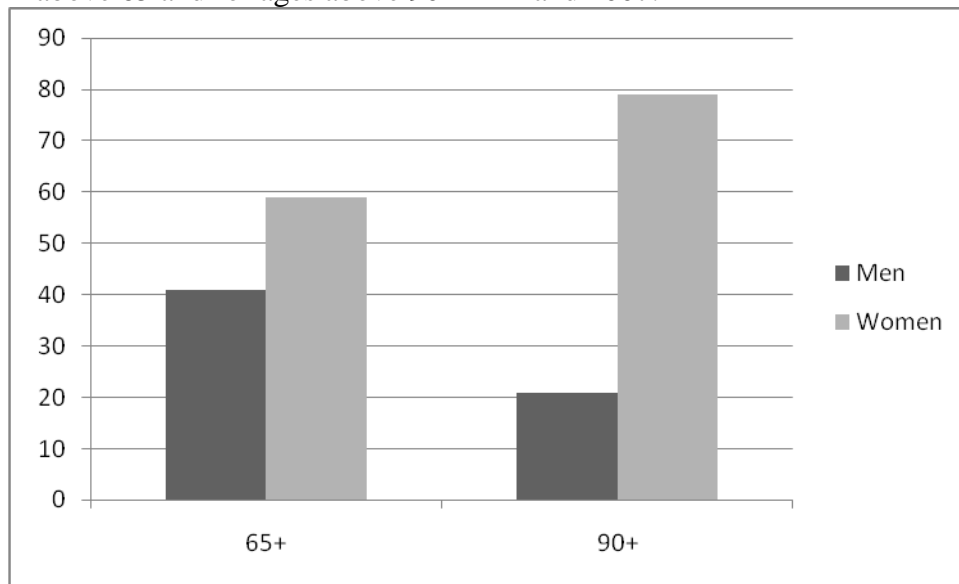


Fig. 1. illustrates the partitioning of the genders of the entire population into gender classes of the ages of 65+ and 90+ in Finland in 2007. In both groups women take on a higher proportion. This proportion rises with age. (22)

Life expectancy in Finland at birth and the remaining life expectancy at the age of 65 defined as the mean number of years still to be lived at the age of 65+, is higher for women than men. It does appear, though, that the trend towards longer life expectancy in both categories is increasing for both men and women. (25)

However, the observation that women make up the larger proportion in the oldest old

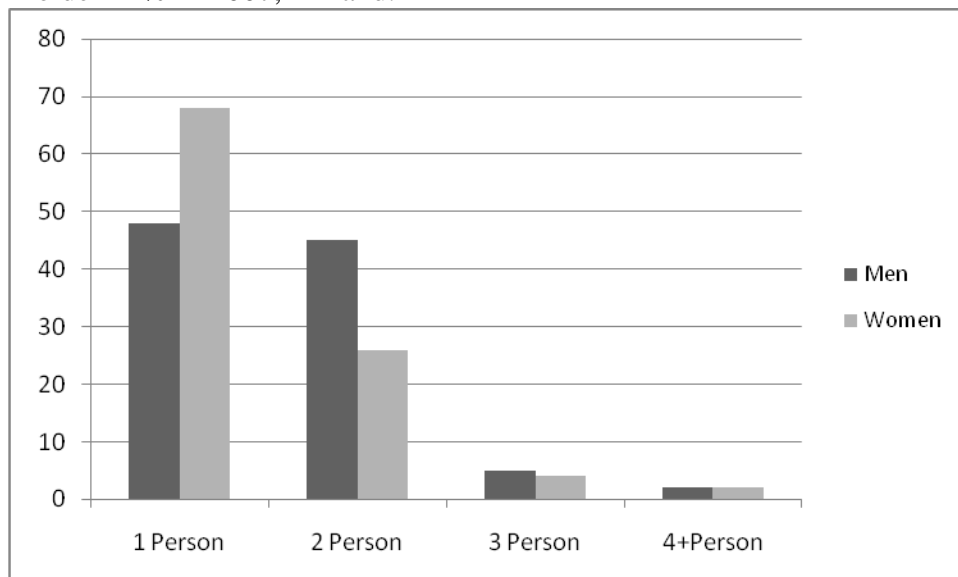
population (11,12,21) than men is most likely the reason why many studies had small oldest old male sample sizes which limits the study results (12,14,16) and may lead to inaccurate interpretations which in turn may affect the implications.

## 2.2. Living arrangements

Over all, the most common older households in many Western countries are two-person households. (21) (p28) This is in line with statements about males from Martikainen et al, reporting the situation in Finland: 77% of the men and 42% females aged 65 and older live in Finland with a spouse or a partner. (16)

Looking at national statistics (see Fig. 2. below), the most common living arrangement among individuals aged 75 and older in Finland in 2007 was the one-person household. Moreover, nearly half of the men aged 75 and older lived in a two-person household, whereas more than about three out of four women lived in a one-person-household. This is consistent with earlier figures collected from 2005 onward. (2)

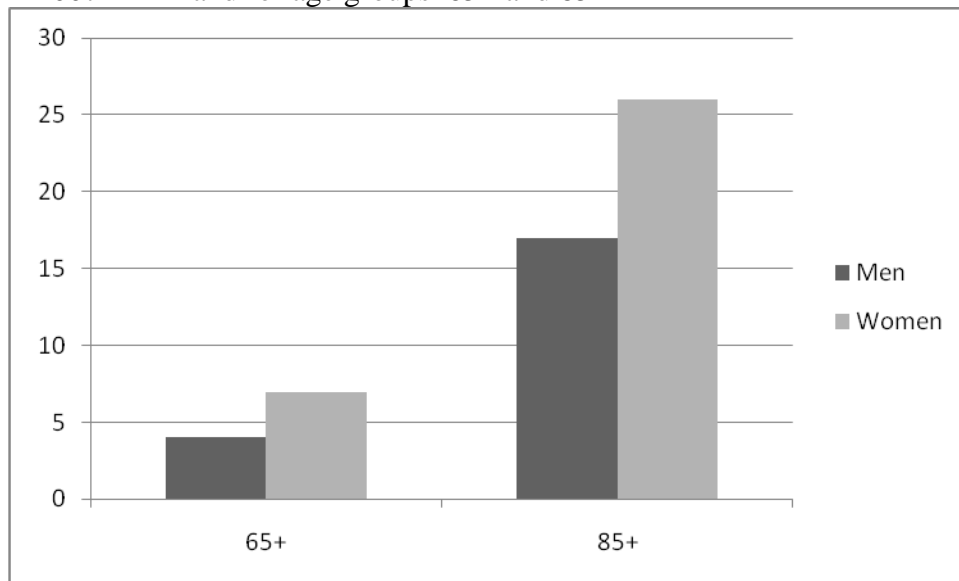
**Figure 2.** Number of household members by gender for 75 years and older in % in 2007, Finland.



The same conclusion of a higher proportion of women living alone in old age in Finland compared to men is reported graphically by the national statistics in 'Tallella ikä eletty...' (year 2005). In the same graph one can also trace the linear relationship between age and living in institutions for both genders. (3)(p18)

Nevertheless, from Fig. 3. below presenting people living in institutions in Finland in 2007 (age 65+ and 85+), equivalent results can be seen.(4) In addition, a larger proportion of women live in institutions than men. The proportions for both genders are rising with age. Considering the difference of the age categories applied, the proportion of the nonagenarians living in an institution over 15 years ago in Sweden, which appeared to be 20% Holmén et al presented in their study in 1994, was similar. (26)

**Figure 3.** Living in institutions as proportion of total population in 2007 in Finland for age groups 65+ and 85+



Martikainen et al studying Finns aged 65+ concluded, however, that among other risk factors for living in an institution, female gender is the strongest. This is followed by the

other significant variables like advanced age and living alone in a private household such as lower financial background.(27)

The rate of assistance is in the literature rarely commented on as a separate variable. Moreover, *need* may serve as an indicator for disability investigating activities of daily living like ‘needing help climbing stairs’. Living with a spouse (19,28) and or children (19) is understood as a source of informal help.

Therefore, Liang et al (USA) consider marital status (see 2.4.2.) and number of offspring as socio demographic key factors. These are important, because both are likely to have an effect on how older people live. Nevertheless, it has to be comprehended that it is not the status as such that is of relevance; it is the potential cohabitation or source of help. The benefits in this sense are then in practice, the availability of the spouse or children as a source of assistance.(19)

Nihtilä and Martikainen also concluded that in Finland the spouse is a resource of help (29) and as a result may reduce the risk or postpone admission to an institution.(30)

However, based on a previous cross sectional Vitality 90+ study in Finland, Jylhä and Hervonen (1999) described that a reasonable number of people aged 90 and over residing at home (not in an institution) appear to be basically independent. In other words, requiring habitual assistance of people living in the community increased the risk of long-term admission into an institution. (31)

Sarma et al discovered in Canada that officially provided help effects on being institutionalized. The effect is positive in the sense it reduces the likelihood of admission to an institution. (32)(see also 2.4.1.)

Another way of considering help can be recognized when studying Fujino’s and Matsudas work from Japan: living with someone else embodies in their eyes a source of informal help. As a consequence in their study living alone against not living alone was subject of investigation. Outcomes suggest among males that living alone without sources of informal

assistance increases mortality (33)(see also 2.4.1.)

As a whole, research examining living arrangements at old age has mainly concentrated on community dwellers and living alone, with others or with a spouse. In addition to that, living arrangements are seldom exclusively the focus of investigation. More commonly living arrangements are applied in combination with other factors researched. For that reason living arrangements will be discussed in more depths in chapter 2.4.

### **2.3. Physical function**

Measurements about an individual's ability to cope with personal care and housework are essential indicators of health in the oldest age group of a population because increasing difficulties are prevalent in this age group (21) (p20). Physical workout and keeping in as good shape as possible does not prevent the declining process of ageing itself (34) but it can postpone death and is strongly related to physical status (age 70-85) (35) . Nevertheless, a person's capacity to manage tasks of daily living may indicate a certain level of disability and, therefore, that individual is to some extent dependent. Terms like ADL (Activities of Daily Living) or physical function are used to describe the functional capacity of an individual.

Summarizing, the two most common measures used for physical function serving for levels of disability and dependence are: a) The Katz index and b) the ADL measure. The former, the Katz index investigates performance of six activities, namely, bathing, dressing, going to toilet, transferring, continence, and feeding. The answers are either 'able' or 'unable' and therefore give observational information of the dependence of the person examined (36). Most of the researchers used the Katz index or a slightly modified version of it (5,6,11,12,15,17,18,26,35,37-39). For example, continence was frequently not included or more alternative answers were offered. Moreover, some researchers used IADL (Instrumental Activities of Daily Living) measures as well that include preparing meals, shopping, and cleaning activities (5,19,38,39). Some (7,13,14,28,40-44) used several

modified methods that usually consisted in part of the same measures and sometimes combinations of ADL, BADL (Basic Activities of Daily Living), IADL, or PADL (Personal Activities of Daily Living) measures. Finally a few had a totally different approach, that is for example, they focused on how the individuals spend the day, shopping and frequency in going out (31), observed their walking during 60 seconds (8), classified the individuals into levels of mobility activities (33), used HUI health status index (32), employed “the Medical Outcomes Study Short-form 36 Health Survey (SF-36), a multidimensional measure of function health status”(45), quantified cardiorespiratory function and undertook blood assessments (9) or even applied qualitative methods (46).

To begin within the Western world, there is evidence from a Swedish study from the year 1994 that the considerable amount of about 60% nonagenarians appeared to be dependent on assistance inspecting physical function and applying the Katz index.(26)

“Cohort changes in physical functioning among centenarians” by Engberg et al clearly showed improvements of physical function among women but no improvement among men for home dwellers. The explanation for this result was that the younger female performed better. Despite this fact, the small group of male respondents may blur the potential improvements among centenarian cohorts and therefore this result should be considered carefully. However, the striking feature of this Danish study is the conclusion that “the increasing number of female centenarians does not entail an increasing proportion of disabled individuals”.(12) This is an encouraging perspective since ageing is generally associated with frailty and dependence.

Berlau et al, studying the population aged 90+ in the United States of America used the distinction of ADL difficulty and ADL dependency. The difference between the two is that ADL difficulty was defined as having difficulties or needing help in performing the tasks whereas the ADL dependency refers to help needed from an *individual* to perform the task. They have discovered that both dependencies and difficulties in ADLs increase with advancing age. Additionally, we learn that advanced age, female gender and living in an

institution can also be understood as predictive factors for either ADL difficulty or ADL dependency. The difference between genders manifests itself more and more with age.(11)

Nybo et al support with their findings from a cohort study of people in their nineties in Denmark, the assumption that women suffer lower mortality and are more disabled in ADL (Katz index) activities compared to men. (15)

It is worth viewing the disability issue with aging from the individual perspective and compare it to the society's perspective. Christensen et al examined the individual's and the society's perspective in Denmark and found the following results: for individuals aged 92 to 100 high life expectancy embodies an increased danger of becoming frail and dependent whereas from the society's perspective "mortality reductions are not expected to result in exceptional levels of disability in cohorts of the very old". In other words, gains in life expectancy do not necessarily mean an increased burden of disability of the very old from society's point of view.(44)

However within Finland, Martelin et al (47) (p7) studied the relation of functional disability by the level of education for the age of 65. From this study it can be concluded first, that women suffer more from disability than men. Second, within the genders, the proportion of disability is higher among the ones with basic education compared with the ones with middle and higher education (47,48).

Disability is decreasing in general in Finland. This decrease was particularly noticeable for the ages ranging from 65 to 74 during the last two decades (7). Sulander et al also observed similar trends in 2006 for Finns aged from 65 to 84 (40). Still, these findings may not be absolute for all the old people: outcomes from the Vitality 90+ Study suggest a need to distinguish the old from the oldest old because dependence among the oldest old has *not yet* improved between 2001 and 2007.(48) However,

the number of fit and active nonagenarians is clearly set to increase in the future, but so too is the number of frail nonagenarians in need of daily help and care. (41)

It seems, first, to be an undoubted fact that women are more disabled, meaning that they show weaker physical function compared to men (5-15). Second, the signs for enhancement in physical disability are stronger (5,7,15,40,43) than for a deterioration trend (38). However, physical function among the oldest old is not improving yet (41).

The widely used method of using self-reported ADLs as a measurement for physical function embodies the danger of reporting bias (8). In addition comparing functional status is a challenging task due to the different applied methods and methodologies. As a result, for example, the line of physical function or functional status that is defined as being disabled or dependent is expansive.

## **2.4. Relationships between living arrangements and physical function**

### 2.4.1. Living arrangements and physical function

The importance of health as one key point in the decision making process of aging people who consider changing their living arrangements is described by Sarma et al (32). Apart from issues concerning various assets like finances, health as such may provide opportunities in terms of the spectrum of choices and limitations. This, however, illustrates the strong linkage and meaning of health and living arrangements. Sarma et al used the self-reported HUI health status index to assess functional health including vision, mobility, cognition, emotions, and pain to mention only a few out of the eight factors observed. The authors of this Canadian longitudinal study (age 65+) also took numerous socioeconomic factors into account and showed first (mentioned in 2.2.) that “provision of publicly-provided homecare reduces the likelihood of institutionalization” and second, that good physical function may decrease the risk of moving from self-determining living, e.g. living alone or with a spouse, to living with children or to a care place. (32)

Fujino and Matsuda (Japan) chose to classify physical function into levels of ability (5-0). Level five reflected ability “to climb stairs without aid or assistive devices” and level zero stood for “cannot roll over on a bed while lying without aid”. These methodologies for



function and also for living arrangements applied by these researchers were different from other scientists conducting studies with similar topics. However, this is exactly the interesting point: they viewed living arrangements as a potential source of receiving informal help and classified living arrangements accordingly. Their focus was on individuals living alone compared to those living not alone and examined survival. (33)

In summary, these authors concluded that “living arrangements according to the ability to receive informal care was significantly associated with survival in elderly men but not in women” (study population 60+). The result among men was even stronger among the frailer ones. Specifically this means that men residing on their own without a potential source of informal help showed increased mortality irrespective of the fact that the disabled sustain their functional status. (33)

A study conducted in England examined retired (65+) aged not-impaired community dwellers living alone or with someone else. It showed that the ones living on their own were more prone to estimate problems in IADLs and BADLs than those living with someone else. As a conclusion the authors claim an association between the non-disabled community dwellers who live alone and several health indicators, especially physical function. (39) This is somewhat surprising since other studies suggest that living alone enhances good physical health.

Based on a study conducted in England as well, Bury and Holme found evidence twenty years ago already, that subjects in institutions aged over 90 show higher disability due to weaker physical function compared to those living in the community.(13)(p156)

Studying only women in the United States of America and longitudinally, Michael et al conclude that elderly females living on their own (age 60+) do not show a higher danger of becoming physically frailer than those women living with a married partner. (45) This does not completely accord with Kharicha et al mentioned above, who came down from a randomized controlled trial investigating similar ages with the proposal that residing alone stands in strong relation to difficulties in physical function (39).

Concentrating more on Scandinavia and Finland, a longitudinal analysis (1997-2002) published in 2008 with 65+ aged Finns examined the relation of socio-economic factors and health such as chronic diseases on changes in living arrangement (living alone or with a partner) to the ultimate outcome, death. However, even though the focus was on socio-economic effects the conclusion the authors derived from their results suggests a strong association between physical function and living arrangements: (16)

health conditions associated with functional difficulties were major determinants of institutionalisation and death and were associated with transitions between private households. (16)

An alternative longitudinal study by Hallberg and Lagergren also from Sweden in 2009 undertook the following approach: they examined the relationship of age (75 and over) and gender concentrating on disability (ADL) and informal help from a spouse or cohabitant. They concluded that the tendency to undertake adjustments in living arrangements to a more supportive provision is higher for women than for men. Moreover, elevated dependency represented by PADL such as age shows the same tendency (28)

However, hereafter the focus is on the oldest old:

A relatively old study conducted in Sweden in the late nineties (17) notes heterogeneity of the oldest old, which is in accordance with a large body of knowledge (13,14,17,31,44), and that resident status is associated with ADL. In particular Femia et al refer to evidence that institutionalisation reinforces dependency. They examined which factors promote stability in ADL functioning (Katz index) at very old age (age 84-90). Apart from various measurements they applied psychological correlates of function (subjective health, depression and mastery) because they believe that functioning loss in the beginning does not lead to disability. Moreover, the gap can be even closed if the individual has control over his or her situation. Accordingly, the researchers conclude, unlike the commonly held assumption that the oldest old suffer only from increased risk of poor health and disability, that about half of the individuals investigated showed stability through the period of examination. Last but not least, one other significant finding was the strong relation of the

living arrangement, classified in either living in an institution or in the community, to constancy in ADL functioning.(17)

As part of the ENABLE-AGE project, a Swedish research team interviewed men and women aged 80-89 about their home and its relation to health. Results show that the home is a place of support and security, the most important place in the lives of the very old. This age group showed also “having an inner driving force to maintain health”. Nevertheless, considering the health perspective, individuals tend to give up activities like shopping or socializing if they appear to be too challenging in terms of functional demands. (46)

Hence, there is a common tenor among scholars about the association of living arrangements and physical function (13,16-19). Scrutinizing results in more detail reveals that good physical function may have a protective effect against moving to an institution (age 65+)(16,32). In other words needing help increases risk for moving to a more dependent living arrangement like with children or institution (age 65+)(32) or institution (age 90+) (31). It can be said, therefore, that living in an institution is associated with worth physical function. Individuals living alone appear to have more difficulties in physical function than compared to the ones living with someone else (age 65+) (39), where women living alone compared to women living with a spouse are not more likely to become physically disabled (age 60+) (45).

#### 2.4.2. Marital status and its impact

Even though marital status is not a variable in this thesis, there is some research which is worth mentioning as a possible underlying factor in respect to living arrangements and physical function among the older people:

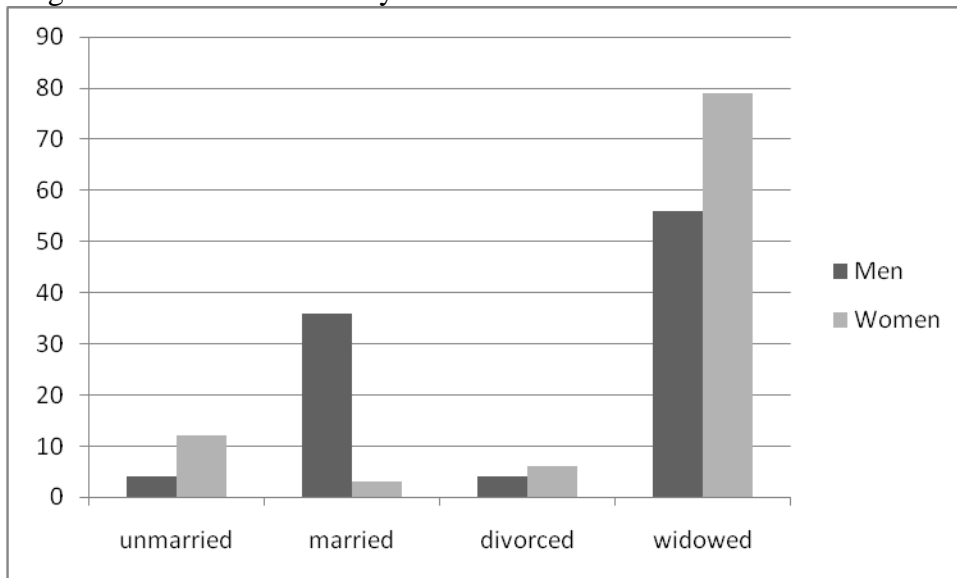
Liang et al, studying Americans aged 70+, found results supporting the view that a wife or a husband embodies the main source of help at the last stage of life. Their focus was to compare the married to the unmarried cases. As a result the nature of their living

arrangements definition was dependent on marital status. The outcome confirmed the hypothesis that physical function stands in strong relation with living arrangements within the unmarried group. Last, most important, “given the same functional status, unmarried elders are significantly more likely than their married counterparts to reside with their children or with others” (19).

Moreover, Liang et al, recommend for future research to distinguish ‘married’ from ‘cohabitation’ because cohabitation is associated with more freedom and less responsibility. (19)

We learn from Fig. 4. (49) that among the population of interest of this study in Finland, nearly 80% of the women are widowed. Even though Fig. 2. number-household-members also includes younger individuals (75+) one can still argue that marital status has a clear impact on living arrangements in Finland judging solely by the proportions. This again implies that women, compared to men, do seem to have fewer opportunities to receive assistance from their spouse or cohabitants.

**Figure 4.** Proportion of marital status distribution for each gender aged 90+ in Finland in the year 2007



Nihtilä and Martikainen claimed in two follow-up studies investigating Finns aged 65+ that

having a spouse plays a key role studying linkages with institutionalization (29,30). Comparing to the ones living in the community alone, the ones living with a spouse have a significantly higher chance in not becoming institutionalized at all or at least experience longer periods of living at home (30). As a result they conclude first, strong associations of socio economic factors with living arrangements (29,30) and second, the spouse as a resource of help overcoming difficulties in physical function such as IADLs or PADL(29).

## **2.5. Gender differences**

Women's higher occurrence of difficulties in physical function and loss in older populations are consistently pointed out in the literature as well as in studies in the USA, e.g., Oman et al. These scholars aimed to shed light on the reasons for this phenomenon by examining people in the community aged 55 and over. Usually researchers either focus on the different modes on how the genders judge their own physical health or on the fact that chronic diseases occur more frequently among females. In contrast to these approaches Oman et al used mainly observational measures and investigated relations of prevalence, incidence and recovery rates. Prevalence refers to a situation at a single point in time whereas incidence describes the speed of occurrence of a condition (50). However, Oman et al found among women increased prevalence of physical function difficulties compared to men but not for incidence rates. Their suggested explanation for these elevated prevalence rates was that women might have an extended period of suffering of physical disability "due to lower recovery and mortality rates" (and "due to worse risk factor profiles"). Interestingly, forecasters of incidence in physical disability were established as chronic illnesses, inactivity and number of social contacts but not gender. (8)

Finally, the strength of Oman's study is that the age-stratified sampling provided more or less the same number of participants in all age groups, including age 85 and over. In addition the age-adjusted analysis yielded strong reliability. On the other hand, the terminology of the oldest age-group ( $\geq 85$ ) implies that there were not many oldest old included: subsequently it could be questioned whether these results could be generalized to

the oldest old because people between the ages of 85 and 90 and people of 90 and over may be significantly different.

What are the implications of this finding that distinguishes prevalence and incidence rates by gender? Prevalence measures relate to the burden of disease and provide information of a population at a single point in time whereas incidence measures refer more to pace like how fast a condition is occurring and is manifesting itself. Summing up it can be learned from Oman et al that the trend of development of both genders concerning functional ability is not as such a reason for concern. More apprehension exemplifies the gender differences of the burden of disease indicating the focus of the needs. Accordingly the authors suggest a more intensified concentration on reducing causes of disability for both genders and improving “recovery rates among women” (8).

Similarly as Oman et al, in Italy, Ferrucci et al (37) found among community dwellers, that women are less prone than men to die due to disability caused by loss of physical function (study population 65+). They suggested that the reasons could be the differences in the fatality characteristic of the disabilities. However, a key finding of this follow-up study looking at IADL and BADL, was that the age of disability inception does not differ between men and women, but the time of physical impairment affliction differs between the genders: women suffer a longer period of physical impairment before they die. (37)

Romoren and Blekesaune, studying “trajectories of disability among the oldest old” in the 1980s and 1990s in Norway concluded that the oldest old (80+) may experience severe ADL disability, especially women. Even more, a large proportion of men seemed to pass away experiencing no or only a brief episode of reduced physical function and resulting disability. Hence, one could argue that higher mortality among men might spare them from long term dependence. (6)

Parker et al in Sweden described over a period of 25 years gender differences of function among a population aged 65-84. Regarding mobility, they comment that men are more capable than women of running, and concerning disability (ADL, IADL), they state that

women seem to have more difficulties with housework and leaving the house to go shopping where men are more challenged with arranging a meal. Thus they propose that social and environmental changes as possible explanations for this development. Summing up, changing gender roles as such may influence gender differences of physical function. In addition such gender role transformations might be reflected in how individuals picture their own health and understand their personal contextual condition.(5)

Verbrugge discussed as early as in 1989 worse health of women, such as higher morbidity than men. Additionally he also suggested that this stems from the social circumstances, the meaning of the role in the family, their employment and influences of the society. (10)

To sum up, women seem to be more disabled among older (5-10) and oldest old populations (11-15), suffer longer periods of loss in physical function (8,37) but are potentially more likely to improve (12). In contrast, men seem to live a relatively long, healthy life but then it is more common for them than women, to contract a fatal disease. A Japanese study with its statement that women over 65 age biologically slower but also show “relatively lower functional capabilities compared with men” (9) may provide one explanation for this observation.

### **3. AIMS AND HYPOTHESIS**

#### **3.1. Objective**

The objective of this study is to evaluate how men and woman aged 90 years or over live and how their living arrangements are associated with their physical function. The intention is to examine them overall with a focus on gender.

The specific aims are to examine among the oldest old men and women:

- (1) Place of residence, cohabitation, and rate and need of assistance
- (2) Physical function, and
- (3) Relationships between living arrangements and physical function

#### **3.2. Hypothesis**

First, the assumption that cohabiting individuals are more likely to receive help if needed because living with somebody implies a source of help has impacted the hypothesis. Second, the evidence that a larger proportion of men than women aged 90+ are married (49) suggests cohabitation and has likewise had an influence. These two issues were then taken into account when conducting this study and prompted the phrasing of the hypothesis as follows:

There is a difference in place of residence / cohabitation between men and women aged 90 and over with similar physical function and age.

The aforementioned goals of this study refer to a more social view of men and women and, as a result, hereafter discussing both, women and men, the term gender is used rather than the biological term sex.



## 4. MATERIALS AND METHODS

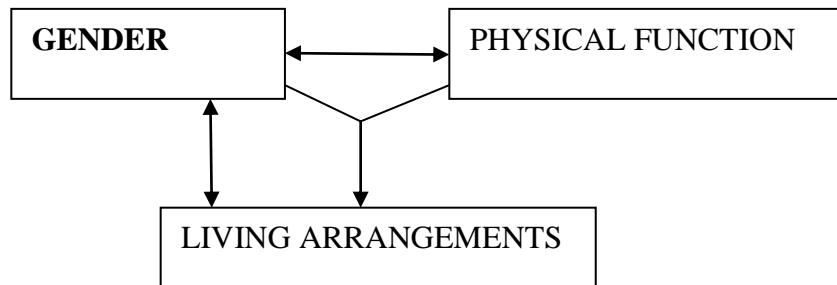
### 4.1. Background and scope, conceptual framework

This study draws on the Vitality 90+ study, a cross sectional study, conducted in Tampere Finland in 2007. The background to this survey is part of surveys continuously undertaken since 1996 and followed up in 1998, 2001, 2003, 2007 and 2010. A postal questionnaire was sent to all nonagenarians living in Tampere. This current study focuses on the latest available data, the Vitality 90+ survey, that was collected in 2007 and includes all Tampere citizens aged 90 and over. This study analyses the data from 2007, builds models on it and draws conclusions. No additional surveys were designed or taken but references and comparisons are made to other, earlier studies where appropriate.

There were two types of postal questionnaires in the Vitality 90+ study; one for those living in the community, and one for those living in institutions. Both questionnaires included a question about the place of residence and five questions about the physical function. The postal questionnaire for the community dwellers included also a question about cohabitation and a question about the rate and need of assistance.

In the current study, three questions on the place of residence, cohabitation, and rate and need of assistance were used to formulate measures for living arrangements, and five questions on physical function to formulate measures for functioning.

The conceptual framework is shown in the following graph:



## 4.2. Measures for living arrangements

The question “Where do you live?” categorized the study participants into two groups, institutionalized and community-dwelling. Participants living in a nursing home or hospital were classified as institutionalized, while participants living in their own house, an apartment or in a service home were classified as community-dwelling.

The question “with whom do you live?” categorized further the community-dwelling participants to those living alone, those living with a spouse, those living with children, those living with grandchildren, those living with someone else, and those living in a service home.

The variable ‘cohabitation’ was created out of this question and includes values alone, children (living with a child or/and grandchild), spouse, somebody else and service home.

In addition, answers to the question “with whom do you live” were also transformed into new variables called ‘alone’, ‘child and grandchild’, ‘spouse’, ‘else’ or ‘service home’. In particular this means that, for example, the ‘alone’ variable can take on two distinct values: a) ‘yes’, for the ones living alone at home and b) ‘no’ for all the other answers such as with a child, with a grandchild, with a spouse, with somebody else, in a service home. Correspondingly the coding went with the variables child (including grandchild), spouse, someone else and service home.

The question “Is somebody helping you at home, for example, with dressing, cleaning or preparing meals?” categorized the community-dwelling participants to those receiving help everyday, those receiving help sometimes, those not receiving help even if they needed it, and to those not needing any help.

Living arrangement is defined as a place of residence such as living in an institution or at home. In addition to that, the status of the ones living in the community, the so-called community dwellers living alone, with a child, grandchild, spouse, somebody else or in a service home without 24 hours of service are also considered as living arrangements. The

variable representing assistance and need issues of the community dwelling participants is a subgroup of living arrangements and goes under living arrangements, as well.

### **4.3. Measures for function**

The five questions about physical function were: (1) “Are you able to get in and out of bed?” (2) “Are you able to dress and undress?” (3) “Are you able to move about indoors?” (4) “Are you able to walk 400 meters?” and (5) “Are you able to use stairs?”. For each of these five questions, the participants could choose between four alternative answers: “Yes, without difficulty,” “Yes, with difficulty,” “Only if someone helps,” or “Not at all”.

Participants able to perform a functional activity without help (i.e. with or without difficulty) were classified as ‘independent’, while participants unable to perform the same activity without help (i.e. only if someone helps/not at all) were labelled as ‘dependent’.

Furthermore, new aggregate physical function variables were defined called ‘independent in five’, ‘dependent in one to four’ and ‘dependent in five’:

1. The first group ‘independent in five’ reflects full independence, that is, that the members of this group answered to all five activities questions ‘Yes, without difficulty’ or ‘Yes, with difficulty’.
2. Then, the next variable includes the ones being ‘dependent in one to four’ who answered one to four activities questions with ‘Only if someone helps’ or ‘Not at all’.
3. Lastly, the rest, the most vulnerable, the ‘dependent in five’. Members of this group answered ‘Only if someone helps’ or ‘Not at all’ to all five activities questions.

Among community dwellers, the group ‘dependent in five’ was small and therefore combined with the group ‘dependent in one to four’ in the logistic regression analysis which is going to be discussed in chapter 4.4.

#### **4.4. Statistical methods: analytical approach and type of analysis**

The data relevant to this study from the main data set was already in SPSS format. Therefore, the first step was to transform the data into the aforementioned variables and tabulated into a readable format where that has not been done yet. The software used was SPSS, versions 13, 16 and 17. To perform binary logistic regression the variables had to be of a binominal nature. As described in sections 4.2. and 4.3 this was accomplished by grouping the answers into the appropriate categories. Multivariate logistic regression would have made the interpretation rather difficult and, however, since binary logistic regression offered all the benefits needed to answer the research question, binary logistic regression was chosen as a method.

The second step was the histogram and frequency distribution analysis to become familiar with the data. To check missing values and to answer the first two research questions (3.1.), cross tabulation analysis was carried out. To identify gender differences, various cross tabulation analyses were performed with the gender factor against the variables physical function and living arrangements. Due to the fact that some questions were only asked from the community dwelling participants, assessing such issues was done by applying a filter considering only the ones living at home followed by investigating gender against factors concerning physical function or living arrangements. This was necessary because cases living in 'institutions' appeared to have values concerning living at 'home', as well.

Thus, a similar situation occurred with information given by the respondents about 'with whom do you live', and therefore the variable 'cohabitation' was created to control better for those cases with multiple answers.

##### 4.4.1. Descriptive part of the study

Due to the fact that the main aim of this study is of a descriptive nature comparing women and men, statistical testing was applied for the descriptive research aims (3.1.), as well.

This gave the opportunity to suggest whether the phenomenon found in this study could serve as evidence for generalization in the whole population. In particular this concerns the analysis (1) place of residence of the whole study population as such and also evaluating gender differences. More, it includes cohabitation, assistance and cohabitation in relation to assistance analysis of the community dwellers, also as such and by gender. Secondly, evaluating (2) physical function of all participants and by gender was also subject to descriptive analysis. Thirdly (3) place of residence and living alone or with others in relation to function was also investigated with cross tabulating the respective variables as such and by gender (numbers in brackets refer to the research questions 3.1.).

The test chosen was Chi Square driven by the sample size. Two sided p-values  $<0.05$ , were considered as significant. Some test results did not meet the two required assumptions, like first, not more than 30% of the expected counts must be smaller than 5 and second, all values should be larger than 1; in these cases Fishers Exact test was additionally applied.

#### 4.4.2. Modelling part of the study

Different logistic regression models (see 4.4.3. and 4.4.4.) were applied to detect interactions and association between physical function and living arrangements (see 3.1.). Apart from age and gender, physical function represented the explanatory variables. In both models age was used as a continuous variable whereas all other explanatory variables were categorical. Furthermore, all outcome measures as place of residence, home or institution, and cohabitation, living alone or with others, were also categorical.

The benefit of the logistic regression method is twofold: first, comparing with cross tabulation we can control for age applying logistic regression models, and second, it provides the advantage of interaction. Interaction means, “the effect of one term depends on the value of the other term”(51). In other words, in addition to the explanatory factors used, another combining two or more explanatory factors are applied, for example gender\*move indoors. In this study gender was interacted with physical function to see whether men and women show a different association between function and living arrangement.

The confounder age has always been included in the model and, therefore, the tests are age adjusted.

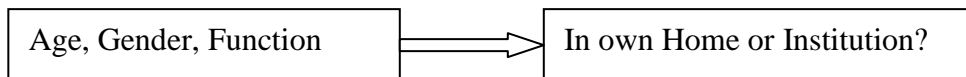
The coding, comparing male to female and independent to dependent, age adjusted, looked as for example as follows: predicting outcome differences by comparing ‘independent in five’ men to women with the same age and independence background. However, for the aggregate physical function variables, the design was comparing the ‘dependent in one to four’ to the ‘dependent in five’ and comparing the ‘independent in five’ to the ‘dependent in five’ ones.

When models did not show statistical significant interactions, then they were as a consequence, remodeled without any interaction to find out whether a general observation can be made.

For logistic regression analysis, p-values  $<0.05$  were considered as significant. Moreover, odds ratios (OR) and 95% confidence intervals (95% CI) were reported. The OR gave the opportunity to express for example, how high the risk for the outcome living arrangement of the exposure independent function compared to its dependent function counterpart is.

#### 4.4.3. Model 1: associations between place of residence and physical function

The concept of model 1 is as described below:



As a result the construction of model 1 looks as follows:

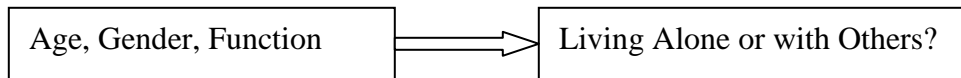
OUTCOME MEASURES:            Living arrangements  
    Place of residence: home or institution

EXPLANATORY MEASURES: *Age*  
*Gender*  
 Physical function  
 Gender\*Physical function

For physical function the five functional activities, ‘move about indoors’, ‘walk 400 meters’, ‘climb stairs’, ‘dress and undress’, and ‘get in and out of bed’ were applied individually and also as aggregate physical function variables.

#### 4.4.4. Model 2: associations between cohabitation and physical function

The concept of model 2 is as described below:



Parallel to model 1 the construction of model 2 looks as follows:

OUTCOME MEASURES: Living arrangements  
 Cohabitation: alone or with others

EXPLANATORY MEASURES: *Age*  
*Gender*  
 Physical function  
 Gender\*Physical function

As a result of the variability of the answers to the question “with whom do you live?” described in 4.2, it seemed that the only accurate and therefore useful measure for regression analysis was living at home alone or with others.

Also here for function, the five functional activities, ‘move about indoors’, ‘walk 400 meters’, ‘climb stairs’, ‘dress and undress’, and ‘get in and out of bed’ were applied individually and also as aggregate physical function variables.

#### **4.5. Ethical consideration and permission**

The data was collected and managed by the Vitality 90+ research team from the University of Tampere, Finland and I have been given the opportunity and permission to analyse the responses from 2007 concerning my research questions. The information was transmitted to me anonymously.



## **5. RESULTS**

This chapter is divided into four main parts. First, socio demographic characteristics and response rate are introduced. In the second section descriptive results concerning living arrangements of the first research question are presented followed by an outline of results of functional status. Finally, the fourth part provides information about the logistic regression analysis of the second research question, namely associations between place of residence / cohabitation and physical function.

As mentioned earlier one main focus of this study is researching gender differences. Therefore, the p-values presented in Tables 1-5 refer to the difference between the genders.

### **5.1. Response rate and socio demographics**

In 2007 1156 (22) persons aged 90 and over lived in Tampere out of which 944 had returned the questionnaires. This gives a resulting response rate of 81.66 %.

The age distribution was highly skewed with ages between 90 and 105. The median age for males was 91, and for females 92, where the latter's age ranged up to 105 and former's age was up to 99 years.

192 (20,4 %) male and 751 (79,6 %) female participated in the study. The balance reflects the allocation of gender from the whole population of that age group in Tampere with 80,45% women and 19,55% men respectively (22).

### **5.2. Living arrangements**

#### 5.2.1. Place of residence

The distribution of individuals living at home or in an institution by gender is presented in Table 1. On the whole, about one out of five of the males lived in institutions and four out of five lived at home, where their counterpart females are more likely to live in institutions:

out of all females, one out of three lived in institutions and two out of three turned out to be living at home. (Table 1.)

**Table 1.** Place of residence in % of the whole study population<sup>1</sup> (total, by gender)

Place of residence	Gender		Total (n=943)	p-value <sup>2</sup>
	Men (n=192)	Women (n=751)		
Community dwelling (n=618)	78	62	66	<b>&lt;0.001</b>
Institution (n=325)	22	38	34	
Total (n=943)	20	80	100	

<sup>1</sup>Study population n=944 including, 1 missing value

<sup>2</sup>Chi Square test. P-value refers to the difference between the genders

### 5.2.2. Cohabitation of the community dwellers

The subgroups of cohabitation by gender stemming from the question ‘with whom do you live?’ are presented in Table 2. While among women there can be found an uneven distribution with 71 % of the women living at home alone and 29 % with others, we can recognize among men a more balanced characteristic of the division and a smaller proportion living alone. In contrast to that are features by gender of living with a spouse. Within gender, only 3 % of the women live with a spouse and 32 % of the men do. Pearson Chi-Square test shows strong significance (Table 2.), investigating these results comparing genders of the ones residing in the community and living alone, with a spouse, with a child or /and grandchild, somebody else or in a service home.

**Table 2.** Cohabitation of the community dwellers<sup>1</sup> in % (total, by gender)

Living Arrangement	Gender		Total (n=611)	p-value <sup>2</sup>
	Men (n=149)	Women (n=462)		
Alone (n=396)	44	71	65	<b>&lt;0.001</b>
Spouse (n=61)	32	3	10	
Child/Grandchild (n=51)	3	10	8	
Somebody else (n=5)	1	<1	<1	
Service home (n=98)	20	15	16	

<sup>1</sup>Total 618, 611 are classified. 1 male and 6 females have not responded to the question ‘WITH WHOM DO YOU LIVE?’ (rest live in service homes with 24 hours service, old people’s homes, health centres or in hospitals)

<sup>2</sup>Chi Square test. P-value refers to the difference between the genders

### 5.2.3. Rate and need of assistance of the community dwellers

The help variable provides information about the frequencies and the nature of demanding assistance concerning, for example, dressing, cleaning up or cooking. Highest frequencies, examining the ones living in a house, apartment or service home with less than 24 hours of service, are observed among these categories in the following order: ‘not needed’, ‘everyday’ and ‘sometimes’ (Table 3). Interestingly, 39 % of the men do not demand help at all, whereas the proportion among women not needing any help is similar with 41 %. The significant gender difference is found in the first two categories where four out of ten of the men need help everyday compared with three out of ten of women requiring help on a daily base. In the distribution within gender studying the ones sometimes needing help, we can discover opposite divergence.

**Table 3.** Rate and need of assistance of the community dwellers in % (total, by gender)

Help <sup>1</sup>	Gender			p-value <sup>2</sup>
	Men (n=145)	Women (n=448)	Total (n=593)	
Everyday (n=186)	40	29	31	<b>0.025</b>
Sometimes n=152)	18	28	26	
Not available (n=13)	3	2	2	
Not needed (n=242)	39	41	41	

<sup>1</sup>n=618, male n=150, female n=468. 25n (4%) did not answer to the question ‘IS SOMEBODY HELPING YOU AT HOME, FOR EXAMPLE WITH DRESSING, CLEANING OR PREPARING MEALS?’

<sup>2</sup>Chi Square test. P-value refers to the difference between the genders

Table 4. describes the men and women in need of help categorized into the subgroups alone, spouse, child and/or grandchild, somebody else and service home. The most important result here is clearly that 48 % of the men living with a spouse require help everyday and 33% do not request assistance at all. This is in comparison with only 8 % of women needing help everyday and 84 % not needing help at all. However, the test results are significant but considering that only 13 women live with a spouse but 48 men do so, indicates that this result should be considered with reservation.

**Table 4.** Cohabitation related to rate and need of assistance among the community dwellers in % (total, by gender)

			Gender			p-value <sup>2</sup>
			Men (n=145)	Women (n=443)	Total (n=588)	
<b>Alone</b> (n=388)	Help <sup>1</sup>	Everyday	33	24	25	0.376
		Sometimes	22	29	28	
		Not available	3	2	3	
		Not needed	42	45	44	
<b>Spouse</b> (n=61)	Help <sup>1</sup>	Everyday	48	8	39	<b>0.007<sup>3</sup></b>
		Sometimes	17	8	15	
		Not available	2	0	2	
		Not needed	33	84	44	
<b>Child/Grandchild</b> (n=51)	Help <sup>1</sup>	Everyday	100	59	63	0.314 <sup>3</sup>
		Sometimes	0	24	21	
		Not available	-	-	-	
		Not needed	0	17	16	
<b>Else</b> (n=5)	Help <sup>1</sup>	Everyday	100	67	80	1.000 <sup>3</sup>
		Sometimes	0	33	20	
		Not available	-	-	-	
		Not needed	-	-	-	
<b>Service Home</b> (n=83)	Help <sup>1</sup>	Everyday	26	36	33	0.090 <sup>3</sup>
		Sometimes	15	32	26	
		Not available	4	2	2	
		Not needed	55	30	39	

<sup>1</sup>n=618, male n=150, female n=468. 25n (4%) did not answer to the question 'IS SOMEBODY HELPING YOU AT HOME, FOR EXAMPLE WITH DRESSING, CLEANING OR PREPARING MEALS?'

<sup>2</sup>Chi Square test. P-values refer to the difference between the genders

<sup>3</sup>Fishers Exact test

### 5.3. Physical function

Looking at the individual physical function tasks solely within gender, women showed in each of them higher dependence than men. For men and women, getting in and out of bed and moving about indoors were most frequently answered as being able to perform with or without difficulty. On the other hand, the most challenging tasks among both genders were walking 400 meters and climbing stairs. (Table 5.)

**Table 5.** Physical function in % (total, by gender)

	Gender			p-value <sup>1</sup>
	Men (n=192)	Women (n=751)	Total (n=943)	
<b>Ability to move about indoors</b>				<b>0.001</b>
independent	93 (176)	82 (618)	84 (794)	
dependent	7 (14)	18 (132)	16 (146)	
<b>Ability to walk 400 meters</b>				<b>&lt;0.001</b>
independent	70 (134)	49 (369)	54 (503)	
dependent	30 (57)	51 (376)	46 (433)	
<b>Ability to climb stairs</b>				<b>&lt;0.001</b>
independent	67 (129)	47 (355)	52 (484)	
dependent	33 (62)	53 (392)	48 (454)	
<b>Ability to dress and undress</b>				<b>0.008</b>
independent	84 (162)	75 (564)	77 (726)	
dependent	16 (30)	25 (185)	23 (215)	
<b>Ability to get in and out of bed</b>				<b>&lt;0.001</b>
independent	93 (178)	82 (616)	84 (794)	
dependent	7 (14)	18 (133)	16 (147)	
<b>Aggregate physical function</b>				<b>&lt;0.001</b>
independent in five	58 (112)	37 (279)	42 (391)	
dependent in one to four	37 (70)	48 (358)	45 (428)	
dependent in five	5 (10)	15 (114)	13 (124)	

<sup>1</sup>Chi Square test. P-values refer to the difference between the genders

Moreover, overall cross tabulation analyses of physical function showed that more than two out of five were independent concerning ability of moving about indoors, walking at least 400 meters, climbing stairs, dressing and undressing and getting in and out of bed (Table 5). The respective distribution among each gender diverges: about three out of five for males, and less than two out of five for females showed independence in all five physical function activities. Nonetheless, looking at the most vulnerable discloses the opposite characteristic: one out of twenty men is dependent in all five activities where among women the result is three times larger. The category with the highest score among men is independent in five activities and among women dependent in one to four physical functioning activities.

#### **5.4. Association between living arrangements and physical function**

##### **5.4.1. Model 1: physical function predicting place of residence**

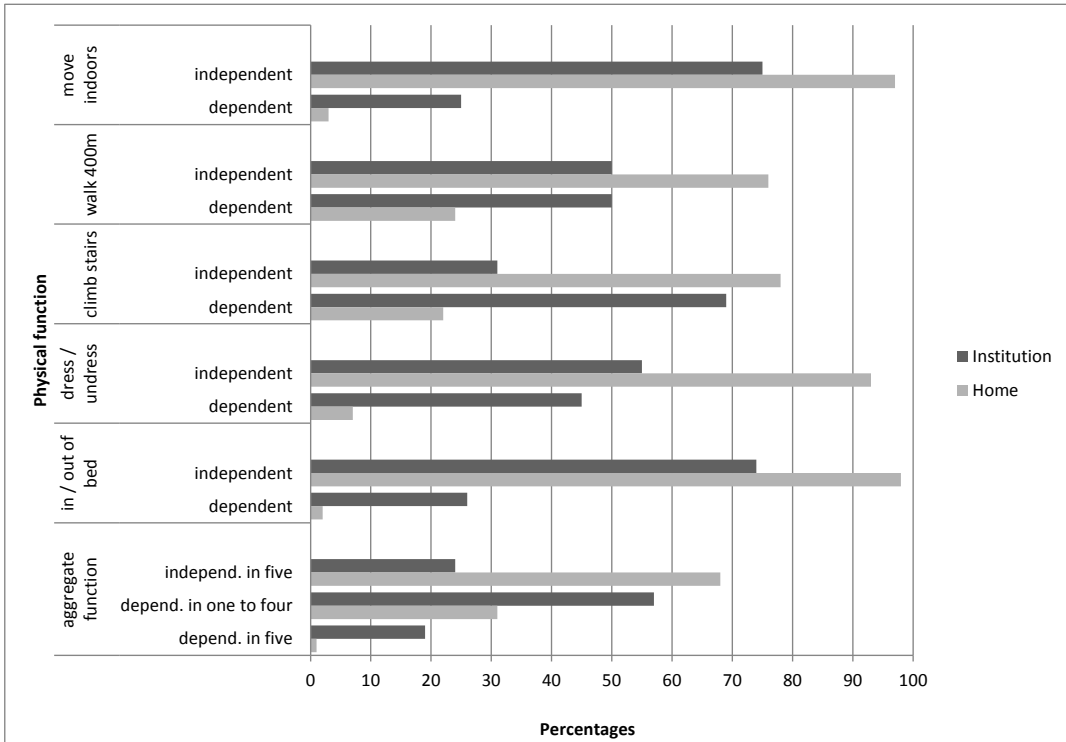
In figures 5a-b, results from model 1 are presented through cross tabulating place of residence and physical function without considering age. This was done for men and

women separately in order to receive percentages to describe the gender differences. The p-values here refer to whether a significant association can be found between place of residence and physical function within men or within women.

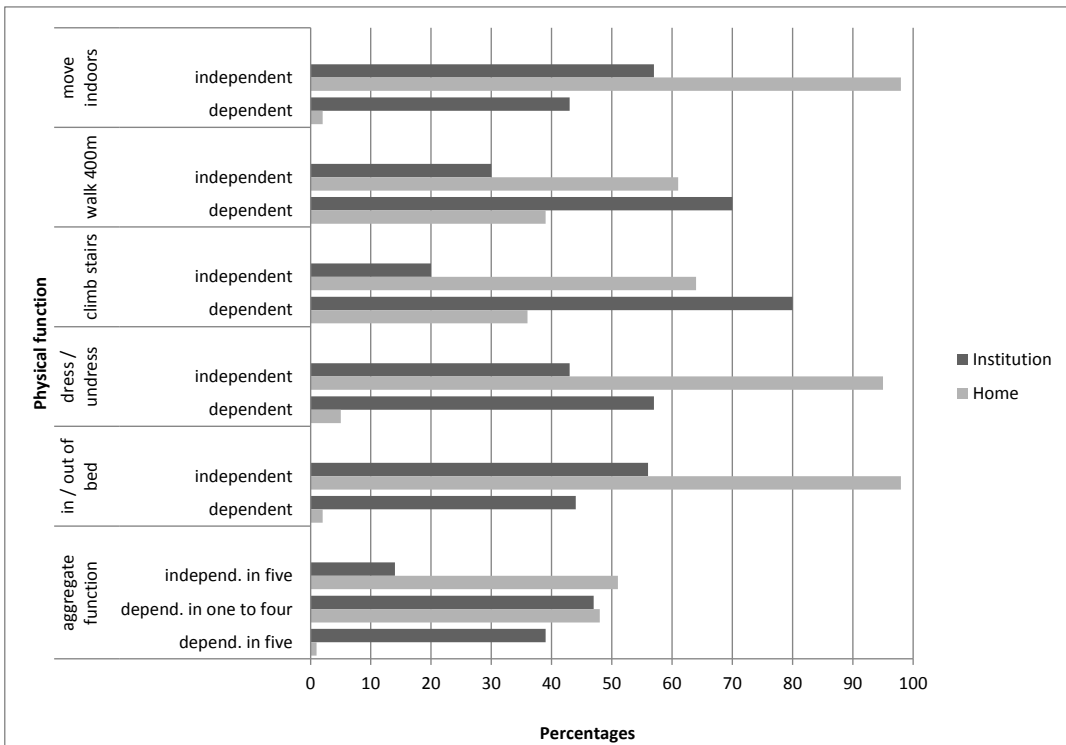
It can be said that most of the men living at home (68%) are 'independent in five' whereas compared to women the proportion is about 50%. About one out of five men living in an institution are 'dependent in five', which stands in contrast with two out of five women 'dependent in five' out of those living in an institution. In other words, place of residence is strongly associated to physical function among men ( $p < 0.001$ ) and among women ( $p < 0.001$ ).

Apart from that and looked at more closely, women and men living in the community show far more independent function in all five tasks assessed compared to those living in an institution (p-values for males: move about indoors  $p < 0.001$ , walk 400 meters  $p = 0.001$ , climb stairs  $p < 0.001$ , dress and undress  $p < 0.001$ , get in and out of bed  $p < 0.001$ . P-values for women: move about indoors  $p < 0.001$ , walk 400 meters  $p < 0.001$ , climb stairs  $p < 0.001$ , dress and undress  $p < 0.001$ , get in and out of bed  $p < 0.001$ ).

**Figure 5a: Place of residence related to physical function among men in %, n=192**



**Figure 5b: Place of residence related to physical function among women in %, n=752**



Subsequently the first round of logistic regression analysis, testing with interaction between the gender and physical function variables, showed no statistical significance (p-values for the gender interactions: independence  $p=0.200$ , move about indoors  $p=0.211$ , walk 400 meters  $p=0.834$ , climb stairs  $p=0.840$ , dress and undress  $p=0.106$ , get in and out of bed  $p=0.275$ ). This insignificance implied that the association is similar for both gender. In consequence the second round showed some general association as explained below:

Testing without interaction (Table 6.) between gender and physical function (aggregate function variables) showed that those who are independent in all five physical function activities are over 100 times more likely to live at home compared with the ones dependent in all five activities (OR=102.26, CI=44.95-232.6). In addition, those who were dependent in one to four physical function activities had higher probability of living at home than those who were dependent in all five (OR=28.33, CI=12.86-62.42). In summary, there is a strong association between place of residence and physical function ( $p<0.001$ ). More, the predictor gender shows also significance (gender p-values: model move about indoors  $p=0.007$ ; model walk 400 meters  $p=0.009$ ; model climb stairs  $p=0.031$ ; model dress and undress  $p=0.003$ ; model get in and out of bed  $p=0.016$ ) implying that no matter what the function background is, men experience a statistically significantly stronger probability of living at home, except for the testing with the aggregate physical function measure.



**Table 6.** Odds ratios (OR), 95% confidence intervals (95% CI), and p-values for living at home compared to those living in an institution by age, gender and various physical function measures (model 1).<sup>1</sup>

	<b>OR</b>	<b>95% CI</b>	<b>p-value</b>
<b>Age, years</b>	0.92	0.86-0.98	<b>0.016</b>
<b>Gender</b>			0.150
Male	1.37	0.89-2.10	
Female	1		
<b>Aggregate physical function</b>			<b>&lt;0.001</b>
Independent in five	102.26	44.95-232.63	
Dependent in one to four	28.33	12.86-62.42	
Dependent in five	1		
<b>Age, years</b>	0.89	0.84-0.95	<b>0.001</b>
<b>Gender</b>			<b>0.007</b>
Male	1.79	1.17-2.74	
Female	1		
<b>Move about indoors</b>			<b>&lt;0.001</b>
Independent	25.80	14.70-45.30	
Dependent	1		
<b>Age, years</b>	0.91	0.86-0.96	<b>0.002</b>
<b>Gender</b>			<b>0.009</b>
Male	1.67	1.13-2.48	
Female	1		
<b>Walk 400 meters</b>			<b>&lt;0.001</b>
Independent	3.32	2.48-4.44	
Dependent	1		
<b>Age, years</b>	0.93	0.88-0.99	<b>0.025</b>
<b>Gender</b>			<b>0.031</b>
Male	1.57	1.04-2.37	
Female	1		
<b>Climb stairs</b>			<b>&lt;0.001</b>
Independent	7.07	5.14-9.74	
Dependent	1		
<b>Age, years</b>	0.90	0.84-0.96	<b>0.001</b>
<b>Gender</b>			<b>0.003</b>
Male	1.95	1.25-3.06	
Female	1		
<b>Dress/undress</b>			<b>&lt;0.001</b>
Independent	20.06	13.31-30.26	
Dependent	1		
<b>Age, years</b>	0.90	0.84-0.96	<b>0.001</b>
<b>Gender</b>			<b>0.016</b>
Male	1.68	1.10-2.56	
Female	1		
<b>In/out of bed</b>			<b>&lt;0.001</b>
Independent	33.39	18.04-61.81	
Dependent	1		

<sup>1</sup>Model was performed without interaction between gender and physical function

#### 5.4.2. Model 2: physical function predicting cohabitation

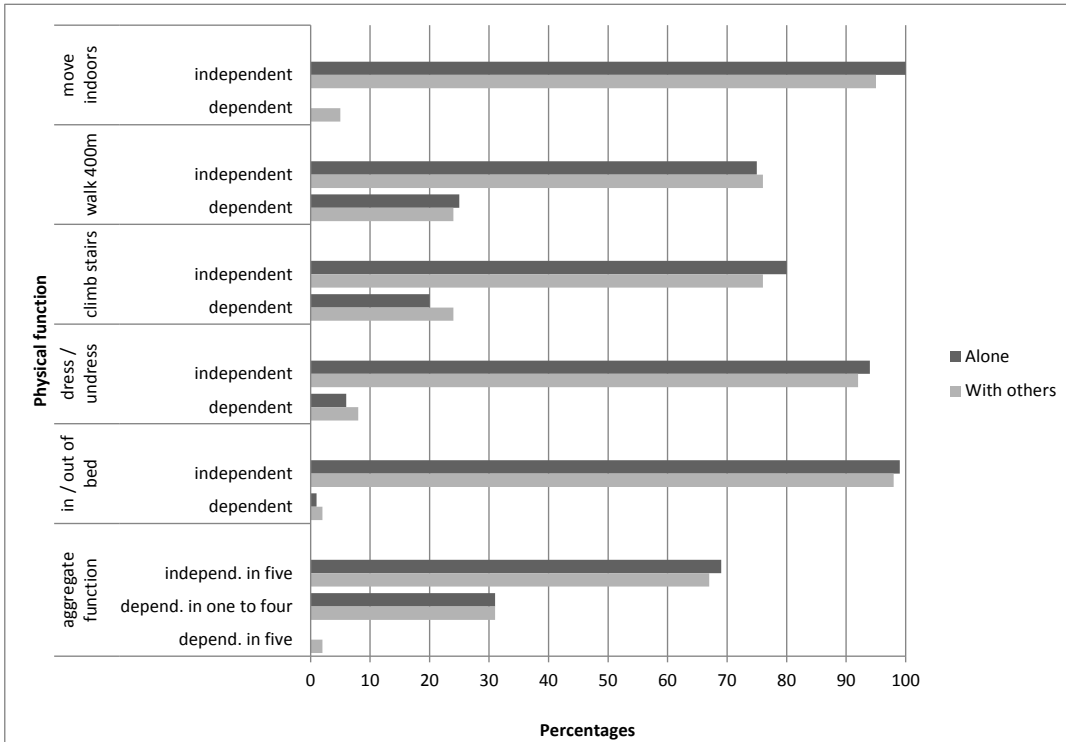
As above for model 1, figures 6a-b present a modified model 2 by cross tabulation analysis applying cohabitation and physical function without considering age. This was also done for men and women separately in order to receive percentages to describe the gender differences. The p-values here refer to whether there can be found a significant association between cohabitation and physical function within men or within women.

Similarly as discovered looking at place of residence it can be stated here as well that almost 70% of the men living alone are 'independent in five' whereas on the other side 55% of the women are. However, the association of living alone or with others to physical function (aggregate physical function measure) shows among men no significance ( $p=0.688$ , Fisher's Exact Test), but significance among women ( $p=0.012$ , Fisher's Exact Test).

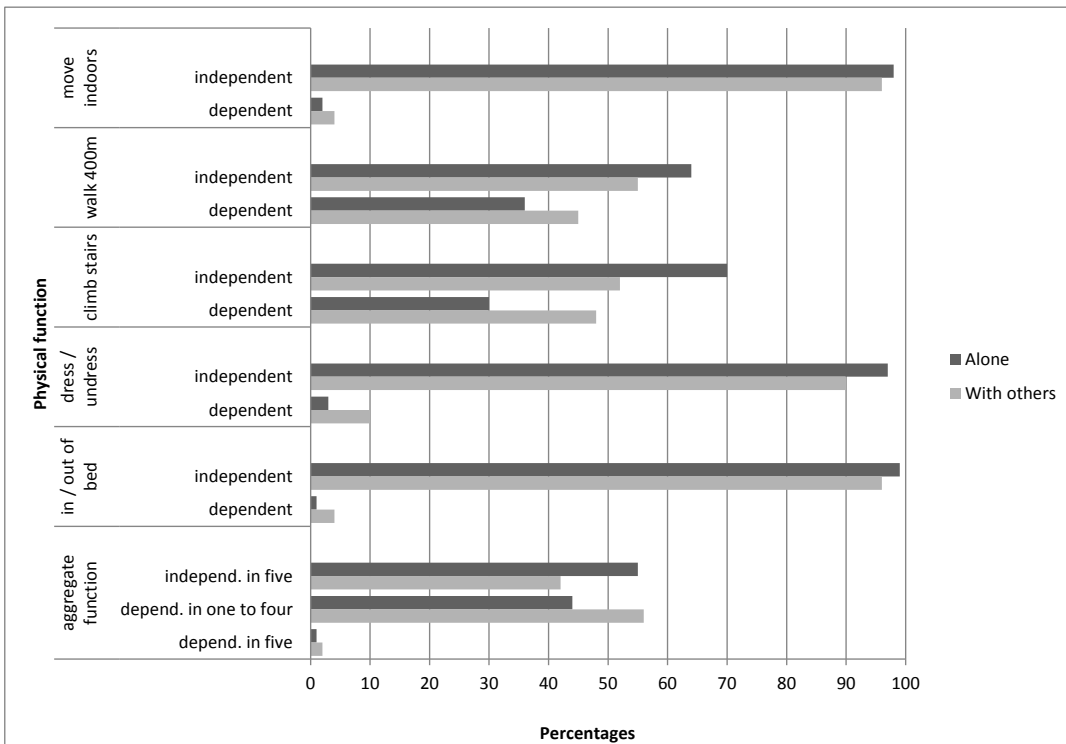
Women and men living alone reported higher independence in all five tasks assessed except walking 400 meters among males, compared to those living with others. Nevertheless, the statistical investigation among men did not show in any test assessed significant results where among women 'climb stairs' and 'dress and undress' turned out significant (p-values for males: move about indoors  $p=0.132$ , Fisher's Exact Test; walk 400 meters  $p=0.942$ ; climb stairs  $p=0.552$ ; dress and undress  $p=0.614$ ; get in and out of bed  $p=1.000$ , Fisher's Exact Test. P-values for women: move about indoors  $p=0.061$ , walk 400 meters  $p=0.089$ , climb stairs  $p<0.001$ , dress and undress  $p=0.001$ , get in and out of bed  $p=0.077$ ).

What is more and worth mentioning in relation to model 1 looking at men is that: the discrepancy of independence in all five physical function tasks including the aggregate physical function measure between living at home or in an institution (Fig.5a) is much larger compared to within community dwellers (Fig.6a). Studying cohabitation (Fig.6a) results show similar proportions for living alone or living with others looking at all physical function tasks and the aggregate physical function measure. Among women (Fig. 5b and 6b) the same tendency is observed but weaker compared to men. In short, it seems that among men physical function impacts stronger on place of residence than cohabitation.

**Figure 6a: Cohabitation related to physical function among men in % n=150**



**Figure 6b: Cohabitation related to physical function among women in %, n=468**



After that, testing with interaction between the gender and physical function variables applying logistic regression showed no statistical significance (p-values for the gender interactions: independence  $p=0.323$ , move about indoors  $p=0.999$ , walk 400 meters  $p=0.396$ , climb stairs  $p=0.249$ , dress and undress  $p=0.214$ , get in and out of bed  $p=0.631$ ). Analogous to model 1 this insignificance implied that the association is similar for both genders.

Next, testing without interaction between gender and physical function (aggregate physical function) showed significance (p-value=0.021): individuals ‘independent in five’ are one and a half times significantly more likely to live alone than the ones ‘dependent in one to five’ (OR=1.51, CI=1.06-2.16). The gender covariate showed also significance (p-value<0.001) in this test with the outcome alone: males are much less likely to live alone compared to women (OR=0.29, CI=0.19-0.43). In general, the predictor gender shows significance in all tests (gender p-values: model move about indoors  $p<0.001$ ; model walk 400 meters  $p<0.001$ ; model climb stairs  $p<0.001$ ; model dress and undress  $p<0.001$ ; model get in and out of bed  $p<0.001$ ), implying that no matter what the function background is, men experience a weaker risk of living alone. (Table 7.)

As mentioned earlier (see 4.4.), there are cases with multiple answers concerning cohabitation, such as people living with a child and spouse. Consequently the logistic regression analysis seemed to be only rigorous for living alone or with others because the data is only clear here for either of the answers.

Furthermore, there are only seven persons dependent in all five functional activities among those living at home. Therefore the explanatory variables ‘aggregate physical function’ with the three categories ‘independent in five’, ‘dependent in one to four’ and ‘dependent in five’ activities did not give the impression of being appropriate because the latter mentioned would be negligibly small. As a result, in model 2 the explanatory variable ‘aggregate physical function’ was applied so that it could take on 2 values like ‘independent in five’ and ‘dependent in one to five’ physical function activities (see 4.3.).

Overall, examining model 1 and 2 together, age does not play a statistically significant role

investigating living at home alone or with others but it does indeed stand in strong relation with living in an institution or at home. Finally, ability to walk 400 meters and get in and out of bed do not show significant association with living alone or with others whereas predicting living in an institution or at home shows in all five physical function activities and in the aggregate physical function measure strong association (all six p-values<0.001).

**Table 7.** Odds ratios (OR), 95% confidence intervals (95% CI) and p-values for living alone compared to those living with others by age, gender and various physical function measures (model 2).<sup>1</sup>

	<b>OR</b>	<b>95% CI</b>	<b>p-value</b>
<b>Age, years</b>	0.99	0.92-1.06	0.832
<b>Gender</b>			<b>&lt;0.001</b>
Male	0.29	0.19-0.43	
Female	1		
<b>Aggregate physical function</b>			<b>0.021</b>
Independent in five	1.51	1.06-2.16	
Dependent in one to five	1		
<b>Age, years</b>	0.97	0.90-1.05	0.563
<b>Gender</b>			<b>&lt;0.001</b>
Male	0.31	0.21-0.46	
Female	1		
<b>Move indoors</b>			<b>0.018</b>
Independent	3.83	1.26-11.67	
Dependent	1		
<b>Age, years</b>	0.98	0.91-1.06	0.668
<b>Gender</b>			<b>&lt;0.001</b>
Male	0.30	0.20-0.45	
Female	1		
<b>Walk 400m</b>			0.166
Independent	1.29	0.89-1.86	
Dependent	1		
<b>Age, years</b>	0.99	0.92-1.07	0.888
<b>Gender</b>			<b>&lt;0.001</b>
Male	0.28	0.19-0.42	
Female	1		
<b>Climb stairs</b>			<b>0.001</b>
Independent	1.91	1.32-2.78	
Dependent	1		
<b>Age, years</b>	0.98	0.91-1.05	0.600
<b>Gender</b>			<b>&lt;0.001</b>
Male	0.31	0.21-0.46	
Female	1		
<b>Dress and undress</b>			<b>0.005</b>
Independent	2.79	1.36-5.73	
Dependent	1		
<b>Age, years</b>	0.97	0.90-1.05	0.527
<b>Gender</b>			<b>&lt;0.001</b>
Male	0.31	0.21-0.45	
Female	1		
<b>In and out of bed</b>			0.104
Independent	2.68	0.81-8.82	
Dependent	1		

<sup>1</sup> Model was performed without interaction between gender and physical function

## 6. DISCUSSION

### 6.1. Main Findings

The main aim of this study was to evaluate gender differences of individuals aged 90 years or over, how they live and how their living arrangements are associated with their physical function.

Looking solely at living arrangements, my attention was caught by the fact that compared to men, women have a significantly higher probability of living in institutions than at home. Since there does not appear to be a great deal of material in this area, I was interested to find a focus to broaden research made in gerontological studies. As expected, results showed that living alone is nowadays mostly experienced as the way of life for the oldest old people in Tampere, Finland, where a large share of men also live with a spouse.

Surprisingly the male community dwellers require more frequent assistance, but it can be said that both male and female are equally in need of help. However, men living with a spouse more often demand assistance compared to women living with spouse.

Women show significantly more dependence in mastering all five physical function tasks assessed, like getting in and out of bed or climbing stairs. These results are then also reflected when studying these function activities as a whole. The largest share of men in this study is found in the 'independent in all five' category, whereas most of the women cluster in the category 'dependent in one to four activities' investigating overall physical function.

It can be concluded, therefore, that women seem to be rather more disabled compared to men who enjoy a good physical status.

Crosstabulation analysis showed that place of residence is strongly associated with physical function among men and among women. It revealed no significant association of living alone or with others to physical function among men, but was significant among women. However, regressing with interaction showed no significant gender difference which means

that probably the vulnerable men die before they reach their nineties and the survivor's place of residence / living arrangements at the individual level do not differ from a female in terms of physical function and chronological age. This result is in contrast to my hypothesis that there would be gender differences. The reason for this discrepancy may be first, that the impact of informal help provided by a cohabitant and the higher proportions of married man (see Figure 4) compared to women among nonagenarians is not as relevant as expected. Second, the higher disability rate of women above 90 obviously does not influence in the sense assumed when conducting this study. In spite of this, my finding that men living with a spouse, compared to women living with a spouse, need significantly more frequent assistance, supports my hypothesis.

On account of living arrangements and physical function without the gender focal point, this present study shows strong association between the following two variables: physical independence correlates positively with living at home and living alone.

The results have brought about new insights into ageing by showing that chronological age does not play a statistically significant role in whether a person lives at home alone or with others, but it does, nevertheless, stand in strong relation with living in an institution or at home. The implication here is that age (90+) is a risk factor for living in an institution: The older the person, the higher is the likelihood of living in an institution. In contrast, increasing age does not raise the likelihood of cohabitation. Scrutinizing these findings in more depth, it could be suggested therefore that this is logical. Growing older increases the risk of the spouse dying – rarely do partners die at the same time –which means that we can say that living alone clearly becomes more common with increasing age. However, since age is related to living in an institution, these two aspects might be in direct opposition to each other. As a result, with very advanced age, the probability of living alone or in an institution may be more or less even. In other words, on the one hand the risk of becoming widowed and left alone in the community rises with age. On the other hand, because physical decline is associated with age, the likelihood of moving to an institution due to frailty, also increases. This might be the explanation why age did not show statistical significance when testing association between cohabitation and physical function.



It is worth mentioning, that the sum of diseases (blood pressure, heart failure, vessel calcification, cancer, dementia, brain stroke, brain circulation diseases, diabetes, rheumatism, arthrosis, Parkinson diseases, hip fracture and depression) was included in the logistic regression analysis, but this variable did not have an effect on the significance of the results. Hence, it could be argued that there is no difference in place of residence / cohabitation between nonagenarian male and female with similar function, same amount of chronic diseases and age.

## **6.2. Strength and limitations of the study**

### 6.2.1. Strength, validity and reliability

Most of the studies conducted on similar topics included only community dwellers or comprised old and oldest old together. This data with its rather high response rate gives an extensive insight into the situation of the oldest old of the whole Tampere population. The integral approach of including everybody 90 and above (4.1) makes the study unique and reliable. Thus, this data provides outcomes suggesting new knowledge and can be used as an aid to understanding the circumstances of people in the fourth stage of life more thoroughly. Moreover, the fact that the Vitality 90+ study has been ongoing for two decades and because the results of the applied instruments show consistency I infer high reliability.

In respect of external validity it can be assumed that similar sized cities to Tampere in Finland are comparable in terms of accessibility and availability of institutions and services. Consequently, results concerning place of residence and rate of assistance can be extrapolated to other urban areas in Finland. In rural areas the situation may differ because institutions might not be so widely spread and modes of admission into institutions could be different.

Living arrangements are cultural-bound and therefore differ considerably in different countries, for example, in the west we recognize differences stemming from public provided assistance and institutional care. It is a fact that the social system of a country deeply influences how the oldest old live. In the United States for example old people's homes are mainly privately financed and therefore due to costs not everybody has access. In conclusion, I

would suggest that the living arrangements results from this study can be to some extent extrapolated to Scandinavian countries but only to a very small extent to southern Europe, the United States, or even Japan. Though this study focuses on Finland a certain amount of comparison may be of value since it may set the basis for developing ideas and creating solutions for invigorating elderly people's living arrangements in relation to physical function.

Finally, regarding physical function in the West, culture may not quite as heavily impact the results. Lifestyle may be a major confounding factor since to my knowledge people living in the United States, for instance, are on average less healthy than Finns. On the other hand, looking at the west in contrast to the rest of the world, lifestyles may overlap and health status to some degree may be similar. Briefly, I would think, comments based on this data for physical function are valuable and generalizable information in reference to many Western societies and, as a result, embody a fairly good external validity.

The Finnish population registry is known for its high accuracy. As a result the internal validity is high because this aforementioned accuracy guarantees that all potential candidates of the target population were included. Grounds for systematic error may be a concern due to the small number of male participants. Nevertheless, male participant's ratio displays the allocation of the genders in Tampere, which is an independent confirmation of reliability. (22) Bias might have occurred if proportionally more individuals living in the community, compared to those living in an institution, had answered the question form or vice versa. Both are conceivable in that the ones living at home may be in a better condition with more drive to respond or the ones in institutions have higher chances of receiving help. Studying Fig.3. chapter 2.2. in relation to Table 1. chapter 5.2.1. and considering first, that women are more likely to live in institutions, and second, that living in institutions is associated with age, it can be assumed that there are approximately few differences between community dwellers and individuals living in institutions who had returned the questionnaire.

Examining living arrangements via the questionnaire was not so straightforward. Despite the fact that some questions were only asked from the community dwelling participants, cases classified as living in an institution appeared to have values concerning living at home, as

well. The reason might be, that when these people received the questionnaire they were still living at home but by the time they filled it out they had already moved to an institution. Another reason might be that somebody was in fact a community dweller but at the time of filling out the questionnaire he or she was temporarily in a nursing home to relieve the family at home or the respondent had been ill and taken to hospital. For the three following reasons I would not estimate these issues as weakening factors of the internal validity: First, the design to verify living arrangements with a control question at the end of the questionnaire, 'where are you residing when filling out this questionnaire?' served already as a control for bias. Second, these cases were almost negligible. Third, for analyzing the community dwellers a filter was applied which contributed to the correctness of the community dwellers results.

Finally, the way the questions and answers about physical function were arranged and the resulting definition of being dependent or independent kept the danger of response bias rather low. Similarly, these instruments were largely applied in the past and this gave confidence of their validity. Consequently the questions most likely measured what they were intended to measure and I, therefore, suggest it has a strong accuracy.

Age was identified as the main confounder and was therefore controlled for when testing relationships between living arrangements and physical function.

### 6.2.2. Limitations

To understand the nature and key effects of ageing societies, the dynamics have to be comprehended. A cross-sectional study like this does not give any information of changes or transitions. As a result, suggestions to influence the potential ways a society will evolve in terms of living arrangements and physical function are limited.

In addition, most of the research undertaken in these areas is longitudinal. A survey embodies the boundaries for comparisons.

All factors statistically analyzed are based on self-reported estimations. Equally as in other

research based on questionnaires there is always the risk of response bias.

The applied measurements for function are broadly used and therefore implying strength in terms of comparability. However two issues need to be considered: on one hand many researchers have used similar or modified measurements for function which again may perhaps limit the comparison of results. On the other hand, the questions do not specify tasks in depth and each answer provided may include a range of ability levels. As a result, function in this study is based more on inclusive than on very detailed and specific measurements. Another aspect referred to by Bury and Holme is, that a measurement may not be relevant any more, for example if somebody lives in a one level house, assessing climbing stairs is not meaningful as a factor of disability (13)(p74).

One important point is that in order to be more rigorous, self-rated and cognitive health, both essential aspects of health, should be considered further.

Lastly, socioeconomic elements may confound outcomes of this analysis. Even though most of the women living in the community live alone, a considerable number of women might not be able to afford living and care in a private home and therefore have to move to an institution. Men require assistance more frequently than women, but females are more disabled compared to males. Could it be that women cannot afford help? Due to the fact that they most likely live alone they would have to receive help from outside. However, despite the weaker physical function of the oldest women, social networks or good coping strategies (48) might make it possible for them to live alone in the community.

### **6.3. Comparison to previous studies**

#### 6.3.1. Living arrangements: place of residence, cohabitation and rate and need of assistance

As national statistics indicate that proportionally more women live in institutions and that living in institutions is associated with age is in correlation with findings from this study.

(3,4)

Martikainen et al expressed his finding, which could be in a broader sense understood as corresponding to this current study, as “major determinants of institutional residence”, which are female gender, old age, living alone in the community and having “a low socioeconomic status” (27). The age of the study population was 65+ but looking at the age categories shows the mentioned gender difference about institutionalization clearly in the age category 90+: Men show lower proportion in institutionalization above ninety (38,6%, women:47,0) and of the institutionalized men higher proportions died during follow up compared to women. As a result, women show higher numbers in mean lengths of stay. (27)

Living alone or with others has experienced a slight shift from living alone towards living with others compared to the first Vitality 90+ study done in 1996, which was 71.2% living alone (31) in contrast to 2007 where 65% of the community dwellers living alone. The same development is observed among men: in 1996 47% males uses to live alone (31) where in 2007 there were 44% living alone in the community.

Kinsella and Phillips claim, that in many places in the West living arrangements of older people in the community consisting of two persons is the most common (21). Kinsella’s and Phillips comment is in accordance with studies conducted in Finland including old and oldest old (65+) (16). This study showed that looking at the oldest old only is different in Finland now, namely living alone is the most common practice and this among women and among men. Previous vitality 90+ study results (31) and national statistics presenting the situation of citizens aged 75+ (2) come to the same conclusions. Among ages of this study population, men tend to be married to younger women. In addition, the fact that women live longer than men could result in proportions of marital status as shown in Fig. 4. These two factors could explain why women are more likely to live alone compared to men if we assume that being widowed is associated with living alone. However, marital status as such, as it will be taken up below, is not the key point, what is of more interest is what it embodies: for example cohabitation or living alone.

Interestingly, outcomes of needing assistance have not undergone a shift at all comparing to

the first Vitality 90+ study done in 1996. (31)

Otherwise rate and need of assistance is not largely investigated which means, firstly, that men living in the community needing more frequent assistance compared to women (Table 3), secondly, almost 50% of the men living with a spouse needed help on a daily base (Table 4) and thirdly men living alone needed significantly more frequent assistance compared to women (Table 4) deriving from this study are unique results.

Fujino and Matsuda investigating also younger cohorts in Japan (60+) presented results which may lead to similar conclusions that is a larger proportion of men (most of the men) do live with somebody who is able to offer assistance compared to women. Among women, the largest proportion is found in the same category but rather few do also live with somebody who is unable to deliver enough help stemming from own health challenges or do live alone receiving unofficial help from outside (33).

Considering Fig.4 with the nonexistence of registered partnerships (registered by law as a couple but not married) as a category implies that among oldest old cohorts modern arrangements like cohabitation with a partner are not practiced yet. Therefore, certain age distributions of study populations may rule out the need for the distinction married-cohabitation in a registered partnership because, for example, among the very old, living together without being married might be very rare. As a result it can be suggested to disregard Liang et al's recommendation (19) to distinguish 'married' from 'cohabitation' (cohabiting with a partner) in this study. In conclusion without concern of bias, among the oldest old living with a 'spouse' could be understood as an equivalent to 'married' including cohabitation with a partner.

Taken as a whole, the higher proportions of men and women needing help everyday and living with spouse or child/grandchild from this current study compared to the ones living alone (column 'Total' Table 4.) appear remarkable. The allocation of these proportions could in fact indicate meanings into the same directions as the implication that living with a spouse (19,28) and or children (19) is understood as a source of informal help. Studying the outcomes of interest (Table 4.) in more depth, gender differences are also striking as discussed earlier in this chapter.

Doubtless this chapter has given insight into the complexity of the interlinkages between living arrangements, needing help and marital status. Moreover, these aspects do also stand in direct relation to physical function and were sometimes connectively assessed in previous studies. For that reason, the issues needing help and living arrangements will be looked at again in chapter 6.4.3. taking also physical function into account.

### 6.3.2. Physical function

Comparing physical function is a challenging task as pointed out in 2.3. and discussed in 6.2.2.. However, apart from the wide range of applied measurements presented in the literature for physical function, research chosen to compare and contrast on this present study is considered as comparable. The reason why is that the Katz index (11,12,15,26) or the combined ADL measures (13,14) applied by those authors embody similarities to the extent that allows consideration for comparison.

Outcomes found in this study of physical function are not new; on the contrary, they are in line with conclusions from many other studies, which underlines the importance of confirming existing data: results of dependence of physical function among nonagenarians from this present study (58%, Table 4.) are comparable with findings (about 60%) from Sweden dated over 15 years back.(26)

Gender difference found in this study among oldest old populations studying physical function is supported by some other scholars who researched similar areas in the Western world. (11-15) In other words, it can be said that women's weaker function found in this current study measured on a scale of independence/dependence for mastering ADLs correlates with earlier findings stating that women are more disabled compared to men among the oldest old populations.

### 6.3.3. Relationships between living arrangements and physical function

The assumption, also of this analysis, that there is a strong relationship between living arrangements and physical function is well accepted in the academic world (13,16-19).

Researchers in England (age 90+) and in Sweden (age 84-90) found about 20 and 15 years ago respectively, the same results: first, that people living in an institution show weaker physical function (13)(p156) in the English study, and second, found the association of resident status and ADLs (17) in the Swedish study.

As mentioned before, among oldest old women are more disabled than men are. This could serve as an explanation why women are more likely to live in an institution than men. However, research suggesting that other factors such as socio economics, could also influence the fact that women are at a higher risk of having to live in institutions than men, makes the issue a bit more complex:

on the one hand Nihtilä and Martikainen suggest that the possibility of moving to an institution is rather high right after the spouse has died (study population 65+) (29) or rather the fact of not having a spouse is central to the risk of being institutionalized (30). They explain their outcome might be driven by the fact that a spouse is a source of informal help overcoming difficulties in physical function (IADL and PADL). When the spouse dies, ability to cope with living at home is no longer guaranteed because of the missing assistance (29). Considering the influence of socio economic issues assessed by Nihtilä and Martikainen (30) and national statistics that almost 80% of the women aged 90 and over are widowed (49), marital status could be in a way a predictor, a possible explanation and risk factor for the result of this study (women are more likely to live in an institution).

If we turn the results from Nihtilä and Martikainen into a slightly different direction another conclusion in relation to this present study could be made:

most of the men living with others do live with a spouse (Table 2.) and it can be seen in Table 4. that almost 50% of them need everyday assistance in physical function, cleaning or preparing meals, whereas among the ones living alone only 33% actually need as frequent assistance. One would therefore expect significant differences of dependence in physical function between the ones living alone and those living with others including living with a spouse (Figure 6a.), which apparently cannot be observed. Even more, figure 5a. presents rather high independence among males living at home as a whole. An explanation for this



phenomenon could be, that men function physically well in terms of for example moving about indoors or getting in and out bed, but do indeed need help for preparing meals, shopping and cleaning coming from a spouse. If we then contemplate needing assistance in physical function, cleaning or preparing meals used in this study as comparable to difficulties in IADLs applied by Nihtilä and Martikainen we can suggest, even they had included much younger populations, as well, that: the exercise for males made in this paragraph based on this present study may correlate with the conclusion made by these authors, that is, the spouse is a resource of help for IADLs. (29)

Li et al studying the Chinese (age range 77-122), did not find any “significant interaction effects of living arrangements and gender” when testing relationships of living arrangements and six disability measures like bathing, dressing, toileting or moving indoors (18). This article has only been mentioned but not broadly discussed in the literature review because the differences between China and the West are rather large and, therefore, it is not necessarily relevant in comparison to this study. Nevertheless, it is indeed still interesting to look at, because the conceptual framework and outcomes are similar to this present study. However, in the case of China, in contrast to this study, explanations of results may be found in the environment where cultural norms are still more traditional than in the West.

At first sight Kharichas et al findings from the UK that is, living alone is associated with poorer mobility and challenges in IADL’s, may contradict the findings of this study. Assuming, that the susceptible old die and the healthier ones manage in rather good functional condition up to old age, suggest that the age range for the study population explains the diverging results: Kharicha et al included people aged 65+. (39)

Nevertheless, looking only at women my results, can be understood as being in correlation with Michael et al proposal

that older women who live alone are not at increased risk of decline in physical function compared with women who live with their spouses after controlling for physical function at baseline. (45)

Interestingly, these results are based on an American female study population aged 60+

which again is controversial to Kharicha et al. Unfortunately, the measures used to determine physical function deviate largely from this study which defies a rigorous comparison.

Finally, studies about the oldest populations tend to include old and oldest old people. The small sample sizes of the oldest old in relation to the old might not bring to light well enough the 'true situation' of the oldest old. Ultimately, conclusions based on cohorts studied in the eighties and nineties in the last century of the very old might not be generalized for the oldest old today since various influencing factors such as social and medical not to mention experienced childhood environments have changed considerably since then (24). However, this study has focused on the oldest old only and the data is fairly recent. Additionally, the high response rates among both genders suggest revealing the 'true situation' to the extent discussed in chapter 6.2.

#### **6.4. Public health implementations**

Information found in this study may impact the daily work of health professionals aiming to improve preeminently female physical health, because first, proportionally there are so many and second they seem to be at risk of being frail. The intent should be to keep them mobile at home and in institutions due to the fact that most of the women live at home alone and women are more likely to live in institutions than men.

Generally, it seems there is no need for the provision of diverging services endeavoring to improve physical function among oldest old for women and men nor individuals living alone or with others. The main effort needs to be on keeping the community dwellers healthy and active as long as possible. In addition to that providing assistance for the ones in need stemming from various sources to enable the oldest old to live at home is also crucial.

## 6.5. Further research proposals

A substantial number of findings indicate the same direction as these results. Yet, little is still known about the condition of the oldest old and methods and methodologies diverge. This implies the necessity for more comparable research.

As mentioned in the limitation section, due to the dynamics of ageing societies, longitudinal studies may open a greater perspective for implementations. Clearly, more research considering the oldest old and to include individuals in institutions is required. Investigating a larger population to receive solid and conclusive data also about males is needed.

Moreover, I would suggest expanding the focus towards the concept of health, which would also include other aspects such as self-rated health and cognitive health variables.

Obviously there is a linkage between cohabitation and need of assistance. In addition to that, there is the impression that these again are related to physical function. The data used for this study contains this information and therefore has the potential to describe living arrangements, physical function and independence/dependence from the need of assistance perception in more depth. This could impart more precisely where the target population in greatest need lies and where resources should be allocated. Gains in quality of life, inhibiting the down slope of physical ability and manifesting independence could be outcomes on the individual level. From the society point of view, sustainable health up to old age and economical distribution of commodities could be the prospect.

## 7. CONCLUSIONS AND RECOMMENDATIONS

In this Master thesis I examined the relationships between living arrangements and physical function by gender amongst the oldest olds living in Tampere, Finland. Whereas I have found both, a) relationships between living arrangements and physical function and b) gender differences among each variable, I did not find any evidence for a causal relationship nor differences in outcome when including all factors. Therefore, I conclude that probably frail men die before reaching 90 years of age and the place of residence / living arrangements of the surviving males do not differ from the females in regard to their physical function and chronological age. This conclusion follows the fact that men are more likely to suffer an illness that leads to their death. Although, women show higher probability in becoming physically disabled, it would appear that amongst the oldest old today, physical function, gender, or age as *such* are relevant factors in relation to place of residence, gender or physical function respectively for living alone or with others.

Specifically, on account of the outstandingly high odds ratios of function and physical function tasks, I recommend first, to enhance health promotion for a physically active lifestyle not only throughout the younger and mid-age years, but also up to very old age. Principally, this is essential for the entire oldest old population but in particular to sustain living in the community or home alone. Second, for the purpose of reaching the largest vulnerable section of the community dwellers in potential need, I suggest promoting health professionals' tools and individuals' knowledge and experience linked to target the oldest old women living alone in the community. These instruments and awareness would reinforce self-determining living and physical independence especially among women above ninety.

Finally, in accordance with the foreseeable demographic changes and longevity, the prospect of increasing numbers of the oldest old age groups in the near and distant future will inevitably take place. To ensure, therefore, the best possible life quality in terms of

living arrangements and physical function for everybody, building structures to respond to developments and improvements in health are fundamental agendas for ageing societies.

## ACKNOWLEDGEMENTS

My sincere thanks go to Leena Nikkari and Catharina Ståhle-Nieminen who supported and advised me from the initial moments throughout all stages of my studies. Further, I would like to express my gratitude to Professor Clas-Håkan Nygård and to the teachers of the MHS program. Their inspiring way of teaching created the most joyful learning environment.

Above all I am indebted to my supervisor, Tytti Sarkela, who embodies the entire characteristics one could wish for in a supervisor. Her patience and encouragement were always provided in times of need. To Professor Marja Jylhä, I am very grateful, too, for the use of the Vitality 90+ data. Professor Riitta Luoto has given me very valuable advice when I was at a key junction of my studies so that without her counselling, the process would have been seriously decelerated. Anna Maija Koivisto's introduction and guidance to statistical challenges never failed to help me to find the results. To all of them I wish to express my deep gratitude for their instruction, inspiration, and encouragement at every stage.

Stimulating discussions and mutual support in both informal settings and the formal environment of seminars with all my fellow-students, especially Chioma, Adela, Kirsi and Tomomi have enriched my studies and I feel privileged to have worked with them.

Special thanks also go to my mother-in-law, Yvonne, and brother, Markus, who assisted me with their expertise whenever the obstacles seemed impossible to overcome.

My dear husband, Mika, who has encouraged me from the very beginning to the last moment, never pressuring me, but always giving me room to make my long held dream come true, deserves my deepest thanks. And last, but not least, I cannot exclude my lovely sons, Ilmari and Lauri, who never failed to raise my spirits during this time.

## REFERENCES

- (1) Crimmins EM. Trends in the health of the elderly. *Annu Rev Public Health* 2004;25:79-98.
  
- (2) Statistics Finland. Dwellings and housing conditions. 26.05.2009; Available at: [http://www.stat.fi/til/asas/index\\_en.html](http://www.stat.fi/til/asas/index_en.html). Accessed 01/25, 2010.
  
- (3) Statistics Finland. Tallella ikä eletty.....Ikääntyminen tilastoissa. 9.2.2004; Available at: [http://www.stat.fi/ajk/tapahtumia/2005-05-11\\_sosiaalitulastoseminaari\\_myrskylä.pdf](http://www.stat.fi/ajk/tapahtumia/2005-05-11_sosiaalitulastoseminaari_myrskylä.pdf). Accessed 10/11, 2010.
  
- (4) National Institute for Health and Welfare. Social welfare, health care and population data. Available at: <http://uusi.sotkanet.fi/portal/page/portal/etusivu>. Accessed 10/11, 2010.
  
- (5) Parker MG, Schön P, Lagergren M, Thorslund M. Functional ability in the elderly Swedish population from 1980 to 2005. *Eur J Ageing* 2008;5(4):299-309.
  
- (6) Romoren TI, Blekeseaune M. Trajectories of disability among the oldest old. *J Aging Health* 2003;15(3):548-566.
  
- (7) Martelin T, Koskinen S, Kattainen A, Sainio P, Reunanen A, Aromaa A. Changes and differentials in the prevalence of activity limitations among Finns aged 65–74: comparison of the Mini-Finland Health Examination Survey (1978–80) and the FINRISK-97 Senior Survey (1997). *Yearbook Popul Res Finland* 2002;38:55-75.
  
- (8) Oman D, Reed D, Ferrara A. Do elderly women have more physical disability than men do?. *Am J Epidemiol* 1999;150(8):834-842.
  
- (9) Nakamura E, Miyao K. Sex differences in human biological aging. *J Gerontol A Biol Sci Med Sci* 2008;63(9):936-944.

- (10) Verbrugge LM. The Twain Meet: Empirical explanation of sex differences in health and mortality. *Journal of health and social behavior* 1989;30(3):282-304.
- (11) Berlau DJ, Corrada MM, Kawas C. The prevalence of disability in the oldest-old is high and continues to increase with age: findings from the 90+ study. *Int J Geriatr Psychiatry* 2009;24(5):1217-1225.
- (12) Engberg H, Christensen K, Andersen-Ranberg K, Vaupel JW, Jeune B. Improving activities of daily living in Danish centenarians- but only in women: a comparative study of two birth cohorts born in 1895 and 1905. *J Gerontol A Biol Sci Med Sci* 2008;63(11):1186-1192.
- (13) Bury M, Holme A editors. *Life after ninety*. 1st Edition ed. London: Routledge; 1991.
- (14) Freeman S, Kurosawa H, Ebihara S, Kohzuki M. Understanding the oldest old in northern Japan: an overview of the functional ability and characteristics of centenarians. *Geriatrics & Gerontology International* 2010;10(1):78-84.
- (15) Nybo H, Gaist D, Jeune B, McGue M, Vaupel JW, Christensen K. Functional status and self-rated health in 2,262 nonagenarians: the Danish 1905 Cohort Survey. *J Am Geriatr Soc* 2001;49(5):601-609.
- (16) Martikainen P, Nihtila E, Moustgaard H. The effects of socioeconomic status and health on transitions in living arrangements and mortality: a longitudinal analysis of elderly Finnish men and women from 1997 to 2002. *J Gerontol B Psychol Sci Soc Sci* 2008;63(2):99-109.



- (17) Femia EE, Zarit SH, Johansson B. Predicting change in activities of daily living: a longitudinal study of the oldest old in Sweden. *J Gerontol B Psychol Sci Soc Sci* 1997;52(6):294-302.
- (18) Li LW, Zhang J, Liang J. Health among the oldest-old in China: which living arrangements make a difference?. *Soc Sci Med* 2009;68(2):220-227.
- (19) Liang J, Brown JW, Krause NM, Ofstedal MB, Bennett J. Health and living arrangements among older Americans: does marriage matter?. *J Aging Health* 2005;17(3):305-335.
- (20) Harper S. Ageing societies. 1st Edition ed. London: Hodder Education; 2006.
- (21) Kinsella K, Phillips DR. Global aging: the challenge of success. 2005;60(1):5-42.
- (22) Statistics Finland. Tables on the subject area of: Population Structure. 27.03.2009; Available at: [http://pxweb2.stat.fi/database/StatFin/vrm/vaerak/vaerak\\_en.asp](http://pxweb2.stat.fi/database/StatFin/vrm/vaerak/vaerak_en.asp). Accessed 10/11, 2010.
- (23) Statistics Finland. The population of Finland in 2007. 2008; Available at: [http://www.stat.fi/til/vaerak/2007/vaerak\\_2007\\_2008-03-28\\_tie\\_001\\_en.html](http://www.stat.fi/til/vaerak/2007/vaerak_2007_2008-03-28_tie_001_en.html). Accessed 10/21, 2010.
- (24) Christensen K, Doblhammer G, Rau R, Vaupel JW. Ageing populations: the challenges ahead. *Lancet* 2009;374(9696):1196-1208.
- (25) Statistics Finland. Population. Available at: [http://www.tilastokeskus.fi/tup/kvportaali/kuviot\\_vrm\\_8\\_en.html](http://www.tilastokeskus.fi/tup/kvportaali/kuviot_vrm_8_en.html). Accessed 10/21, 2010.

(26) Holmén K, Ericsson K, Winblad B. Loneliness and living conditions of the oldest-old. *Scand.J.Soc.Med.* 1994;22(1):15-19.

(27) Martikainen P, Moustgaard H, Murphy M, Einiö EK, Koskinen S, Martelin T, et al. Gender, living arrangements, and social circumstances as determinants of entry into and exit from long-term institutional care at older ages: a 6-year follow-up study of older Fins. *The Gerontologist* 2009;49(1):34-45.

(28) Hallberg D, Lagergren M. Moving in and out of public old age care among the very old in Sweden. *Eur J Ageing* 2009;6(2):137-145.

(29) Nihtilä E, Martikainen P. Institutionalization of older adults after the death of a spouse. *American Journal of Public Health* 2008;98(7):1228-1234.

(30) Nihtilä E, Martikainen P. Why older people living with a spouse are less likely to be institutionalized: the role of socioeconomic factors and health characteristics. *Scandinavian Journal of Public Health* 2008;36(1):35-43.

(31) Jylhä M, Hervonen A. Functional status and need of help among people aged 90 or over: a mailed survey with a total home-dwelling population. *Scand J Public Health* 1999;27(2):106-111.

(32) Sarma S, Hawley G, Basu K. Transitions in living arrangements of Canadian seniors: findings from the NPHS longitudinal data. *Soc Sci Med* 2009;68(6):1106-1113.

(33) Fujino Y, Matsuda S. Prospective study of living arrangements by the ability to receive informal care and survival among Japanese elderly. *Preventive Medicine* 2009;48:79-85.

- (34) Ilmarinen J, Prof. Ageing and Work. 27.9.10-28.9.10; Course at Tampere School of Public Health, Lecture 3 on the 28th of September 2010.
- (35) Stessman J, MD, Hammerman R, MD, Cohen A, MD, Ein-Mor E, MA, Jacobs JM, MBBS. Physical activity, function, and longevity among the very old. *Arch Intern Med* 2009;169(16):1476-1483.
- (36) Katz S, MD, Ford AB, MD, Moskowitz RW, MD, Jackson BA, BS, Jaffe MW, MA. The index of ADL: A standardized measure of biological and psychosocial function. *JAMA* 1963;185(12):914-919.
- (37) Ferrucci L, Turchi A, Fumagalli S, Di Bari M, Silvestrini G, Zacchei S, et al. Sex-related differences in the length of disability prior to death in older persons. *Aging Clin Exp Res* 2003;15(4):310-314.
- (38) Parker MG, Ahacic K, Thorslund M. Health changes among Swedish oldest old: prevalence rates from 1992 and 2002 show increasing health problems. *J Gerontol A Biol Sci Med Sci* 2005;60A(10):1351-1355.
- (39) Kharicha K, Iliffe S, Harari D, Swift C, Gillmann G, Stuck A. Health risk appraisal in older people: are older people living alone an 'at-risk' group? *British Journal of General Practice* 2007;537(57):271-276.
- (40) Sulander T, Martelin T, Sainio P, Rahkonen O, Nissinen A, Uutela A. Trends and educational disparities in functional capacity among people aged 65-84 years. 2006;35:1255-1261.
- (41) Jylhä M, Vuorisalmi M, Luukkaala T, Sarkeala T, Hervonen A. Elinikä pitenee nopeammin kuin toimintakyky paranee. 2009;25(64):2285-2290.

(42) Davey A, Femia EE, Zarit SH, Shea DG, Sundström G, Berg S, et al. Life on the edge: patterns of formal and informal help to older adults in the United States and Sweden. *J Gerontol B Psychol Sci Soc Sci* 2005;60(5):281-288.

(43) Zunzunegui MV, Nunez O, Durban M, García de Yébenes.M.J.:Otero A. Decreasing prevalence of disability in activities of daily living, functional limitations and poor self-rated health: a 6-year follow-up study in Spain. *Aging Clin Exp Res* 2006;18(5):349-351.

(44) Christensen K, McGue M, Petersen I, Jeune B, Vaupel JW. Exceptional longevity does not result in excessive levels of disability. *Proc Natl Acad Sci USA* 2008;105(36):13274-13279.

(45) Michael Y, Berkman LF, Colditz GA, Kawachi I. Living arrangements, social integration, and change in functional health status. *American Journal of Epidemiology* 2001;153(2):123-131.

(46) Fänge A, Ivanoff SD. The home is the hub of health in very old age: findings from the ENABLE-AGE project. *Archives of Gerontology and Geriatrics* 2009;48:340-345.

(47) Linnanmäki E. Terveyserojen kaventaminen terveyden edistämisen osana. 2008; Available at: <http://www.thl.fi/thl-client/pdfs/1eb45b52-8321-42f7-865e-e23a8e3fbda4>. Accessed 11/03, 2010.

(48) Jylhä, M, Prof. Course 'Aging of the Population'. Autumn 2009 at Tampere School of Public Health, University of Tampere Finland.

(49) Statistics Finland. Population according to age (1-year), marital status and gender 1990 - 2008. 2009; Available at: [http://pxweb2.stat.fi/database/StatFin/vrm/vaerak/vaerak\\_en.asp](http://pxweb2.stat.fi/database/StatFin/vrm/vaerak/vaerak_en.asp). Accessed 02/22, 2010.

(50) Auvinen A, Prof. Course 'Basic Epidemiology', Lecture 2, Occurrence Measures.  
Autumn 2009 at Tampere School of Public Health, University of Tampere Finland.  
Lecture notes pages12-18.

(51) Walter S, Prof. Course 'Logistic Regression' March 2010 at Tampere School of Public  
Health, University of Tampere Finland. Course material: Textbook logistic regression p82.