

AGING AND BALANCE

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AGING AND BALANCE

- A quantitative study of four different balance tasks and the Berg Balance scale on a highly functional elderly sample

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“Balance is the key of life”

– Hajra Usman

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Preface

I wanted to write this master thesis based on my own genuine, personal interest in how it is to grow old. Studying Psychology has so far given me valuable insight into how humans think, behave and perceive the world. I have learned much about how we develop and live our everyday lives, yet something has been missing. For me, the missing piece has been how we age. There is something mystical and fascinating about this fact: the inevitability of growing old.

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Abstract

Approximately 30 % of elderly over 65 years old fall each year, causing a decrease in life quality and an increase in mortality. For these reasons numerous studies have focused on frail elderly and balance skills. Few studies have investigated the relationship between physical activity in highly functional elderly and performance on balance tasks. In this study we tested 41 retired, highly functional elderly, ranging from 65-88 years of age, on four different balance tasks and the Berg Balance scale. There were low correlations between all tasks tested, which may provide support to the theory on task specificity. Reporting high or low physical activity during the week had a significant difference on score on the Berg Balance scale, but not on the four other balance tasks measured. Suggestions for future research are to address what kind of physical activity elderly are engaging in, and consider individual differences when creating effective balance exercises as part of their physical activity program.

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1. GENERAL INTRODUCTION

Literature on aging is vast and extensive and there exist many different approaches to the matter: physiological, genetic, cognitive, cultural and environmental (e.g Christensen, Doblhammer, Rau, & Vaupel; Erber, 2011; López-Otín, Blasco, Partridge, Serrano, & Kroemer, 2013; Salthouse, 2009; Taylor, 1962). Grasping it only from one angle seems impossible. Increasing age and the aging process itself has become of major interest to researchers. Advances in technology and medical care are making sure that we are living longer while at the same time having a stronger economy and personal freedom (Myles, 2002). Increasing age puts pressure on the welfare state with people staying longer in the health and social system (Schneider & Guralnik, 1990). We are facing large amounts of people in need of social, political and medical care.

Even though today's elderly are healthier than previous generations, they still experience bodily decline in both muscles and sensory domains (Genton et al., 2011; Li & Lindenberger, 2002). Balance in the elderly is of major interest to researchers. The reason for this is the impact poor balance can have on general function: Ageing and Unit (2008), part of the WHO, states that "approximately 28-35% of people aged of 65 and over fall each year" (p. 1). The same source state that falls in the elderly accounts for 40 % of all injury deaths. These worrisome numbers have gotten much attention from fields like medicine and physiotherapy (e.g Herwaldt & Pottinger, 2003; Huxham, Goldie, & Patla, 2001), but in the field of psychology it seems to have gotten a lower priority (Daatland, 2003). A quick search through psychnet – the American Psychological Association's database, reveals that there are over 20 000 articles mentioning the word "children", but as few as a 1000 articles mentioning the term "elderly".

Seeing that so many elderly fall each year has led researchers to develop various balance tests to predict future fall risk (Berg, 1989; Fabre, Ellis, Kosma, & Wood, 2010; Thorbahn & Newton, 1996), while at the same time promoting exercise programs as prevention strategies (Sherrington et al., 2008). Both balance tests and exercise programs for elderly has had varying success (Herwaldt & Pottinger, 2003; Oddsson, Boissy, & Melzer, 2007), and it still remains an open question to what extent standardized balance tests and exercise programs are effective in reducing falls and increasing the quality of life in the elderly (Overstall, 2003; Trueblood, Hodson-Chennault, McCubbin, & Youngclarke, 2001). Using diverse literature from large fields such as medicine, physiotherapy and psychology, the thesis aims to explore the aging process, individual differences and balance in highly

functional elderly. It may provide an insight into how aging affects performance on balance tasks, which can be valuable for future fall prevention research. The study culminates into four specific research questions stated below:

- 1) *To what extent does four various balance tasks performed by highly functional elderly correlate with each other?*
- 2) *How are the correlations between various balance tasks and scores on the Berg Balance scale?*
- 3) *How are the correlations between physical activity level, four balance tasks and the Berg Balance scale?*
- 4) *How is the difference between two groups of high and low activity and four balance tasks and the Berg Balance scale?*

1.1. Thesis structure

The first part of the thesis consists of a theoretical background on aging and tries to give an explanation of why aging occurs. It aims at giving a picture of how aging affects the body and brain, how this influences balance and the individual differences that can come into play. Much used balance tests for the elderly will be described. In the discussion section, the purpose is to see how high or low correlations are between the test and tasks tested. The thesis looks at theory on physical activity among elderly, to answer the last research questions. The thesis' limitations, conclusions and suggestions for further research will be put forward.

2. THEORETICAL BACKGROUND

2.2. What characterises aging?

Humans have the longest life spans of any other primates (Finch, 2010), and aging is characterised by a progressive, generalized impairment of functions, resulting in an increased vulnerability to environmental challenges, and an increasing risk of disease and death (López-Otín et al., 2013). This coincides with a decline in fertility (Kirkwood, 2005). According to Wilmoth and Ferraro (2013), aging is “any time-dependent changes that occur during the life course of an organism” (p. 19).

2.3. Is aging an evolutionary adaptation or simply a failure?

It is clear that everyone ages, but it is less clear why. The answer might lie in our evolutionary history. Evolutionary perspectives see aging as evolved mechanisms or limitations in somatic maintenance, which results in a build-up of damage (Kirkwood, 2005).

These theories are complex and go into vivid detail of our genes and biological mechanisms. This is not the main focus here, but it might tell the reader how something we see as natural, might not have a natural or obvious explanation. Even evolutionary theorists themselves disagree on the reasons as to why aging occurs. An example of this is the controversial statement by Hayflick (1998) claiming that aging is an evolutionary failure; “after performing the miracles that take us from conception to birth, and then to sexual maturation and adulthood, natural selection was unable to favor the development of a more elementary mechanism that would simply maintain those earlier miracles forever” (p. 639).

According to Kirkwood (2005), aging is not programmed. Genes might account for some of our time on earth, but a lot of it seems to be up to chance; the environments we live in affect our lifespan.

2.4. The complexity of defining old – is age just a concept?

Not even the World’s Health Organization (WHO) has a clear definition of what an old person is (Ageing & Unit, 2008). In the western world, people start retiring around the time they turn 65, but even here there are significant variations. When retiring, that could mean that you are either A) too old or fragile to work, B) just part of a social security system, or C) both. Some parts of the literature states explicitly that they are looking at young-old (ages 65-75), old-old (ages 75-84) or oldest-old (ages 85+) (Erber, 2011).

Among people over 65 years and older, there is large *interindividual variability* on almost every measure (Erber, 2011). Some people run marathons when they are 75, while others in the same age group are totally dependent on others. A person aged 85 might be driving, while others are no longer authorized to drive when they are 70. Such comprehensive differences are something to keep in mind when studying aging.

2.5. Aging as development

Developmental psychology devotes itself to the study of the individual throughout the lifespan (Shaffer & Kipp, 2013), and it would therefore make sense to look at aging as development. Most theories on development focuses on the time between conception and adolescence (Bronfenbrenner, Kessel, Kessen, & White, 1986). From an ecological perspective, the whole life-course is being viewed as constant development. Life-span developmental psychology studies both constancy and changes throughout the life-span (Baltes, 1987). Here one sees the developmental process humans go through as multi-directional. Some functions might improve, while others are lost. Establishing that both genes

and environments play part in aging, the valuable information is on how this development has an impact on the body and brain.

2.6. How aging affects the body

With increasing age, joints tend to degenerate, while the bone density diminishes (Erber, 2011). *Sarcopenia* is a term first coined by Rosenberg (1989), and explains the decline in muscle mass and strength that happens with what he refers to as healthy aging. Appetite loss is not uncommon, and eating more does not seem to reduce this decline (Thomas, 2007). Genton et al. (2011) found that loss of lean tissues occurs exponentially with aging. During the aging process, mammals lose up to a third of their skeletal muscle mass and strength (Barton-Davis, Shoturma, Musaro, Rosenthal, & Sweeney, 1998). Goodpaster et al. (2006) suggests that loss of muscle strength is not just due to loss of muscle mass, but also to muscle quality. The authors claim that maintaining or gaining muscle mass does not prevent decline in muscle strength associated with aging.

2.7. How aging affects the brain

When reviewing physiological changes it seems inevitable to include cognitive changes. A central issue is to see what occurs in the aging brain. It is hard to make a clear cut distinction between what is common and expected, from abnormal changes in the brain. That is to say, should every old person experience cognitive deficits? It might seem like many elderly experience rapid cognitive decline (Unverzagt et al., 2001), but some researchers argue that it starts much earlier than late life. Salthouse (2009) used longitudinal studies together with estimation of retest effects on a sample of 18 to 60 year olds to see when cognitive decline begins. Some cognitive decline can be seen in healthy educated adults already when they reach their 20s and 30s (Salthouse, 2009).

Functional neuroimaging studies of cognitive aging have given valuable insights into what regions of the brain are most affected by aging (e.g Riecker et al., 2006; Townsend, Adamo, & Haist, 2006). These kinds of studies have shown that elderly has a reduction in occipital activity coupled with increased frontal activity (Davis, Dennis, Daselaar, Fleck, & Cabeza, 2008; Grady et al., 1994) One could question the validity of tests measuring this shift, because they imply that both groups tested (young adults and older adults) see the task as equally challenging. The same cognitive tasks tends to be more demanding for older than younger adults (Davis et al., 2008).

2.8. Why do adult age differences in brain activation occur?

Even though technology has made huge advancements in brain research, it has also created some disputes around why these differences occur. Several theories have been put forward.

The processing-speed theory of adult age differences in cognition proposes that increased age in adulthood is associated with a decrease in speed involved in many processing operations. It also emphasizes that this reduction in speed leads to impairments in cognitive functioning because relevant operations cannot successfully be executed (limited time) and because the products of early processing may no longer be available when the later processing is complete (simultaneity) (Salthouse, 1996).

Seeing that old and young adults differ in their prefrontal activation pattern, the hypotheses of compensation and dedifferentiation has emerged (Cabeza, Anderson, Locantore, & McIntosh, 2002; Davis et al., 2008). *The compensation hypothesis* emphasizes that due to cognitive (and natural) decline, the brain is trying to compensate, activating more areas in the brain during complex tasks than younger individuals. *The dedifferentiation hypothesis* puts an emphasis on specialized neural mechanisms that normally would be involved, but due to age related decline, do not function (Cabeza et al., 2002).

There are still disputes concerning which hypothesis is accounting for these changes in brain activation (Cabeza & Dennis, 2012).

2.9. What structural changes occur in the aging brain and how can they influence balance?

Establishing that cognitive decline happens and that activation patterns in older brains are different than in younger brains, it is also of interest to view what structural changes are contributing to this decline.

2.9.1. The importance of white and grey matter

White matter contains myelin and is present in both the central, as well as the peripheral nervous system. In both systems it is essential for the normal functioning of nerve fibers (van der Knaap & Valk, 2005). Grey matter on the other hand, contains most of the body's neural cell bodies. Grey matter is involved in muscle control, sensory perception and self control (van der Knaap & Valk, 2005).

Sowell et al. (2003) studied a sample of 176 individuals ranging from 7 to 87 years old. The researchers found that grey matter volume decreased from the age of seven to the age of sixty. After sixty, this reduction seemed to end. Many regional differences were observed,

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for instance that the association cortices of the frontal and parietal lobes experiences considerably more grey matter loss than others. This is interesting when considering balance and motor control, since these regions are vital in these kinds of performances (Seidler et al., 2010). White matter had a more curve linear relationship, where it increased until middle age and then declined. White matter volume was similar for both seven year olds and the oldest group (Sowell et al., 2003). The results on white matter could indicate what is observed when children and old adults perform the same motor task. They both tend to do it slower than the middle-aged adults, thus showing the same curve linear pattern (Leversen, Haga, & Sigmundsson, 2012). This means that at some point, elderly and children can perform equally on the same balance tasks.

Resnick, Pham, Kraut, Zonderman, and Davatzikos (2003) used MRI scans to look at structural changes in the brains of non-demented adults ranging from 59 to 85 years of age. A follow up scan just two years after showed grey and white matter tissue loss, even in the very healthy elderly. These results indicate that some structural changes are to be expected and thus may be considered a normal part of the aging process.

Salat et al. (2004) looked at cortical thickness using MRI-scans on a sample of 18 to 93 year olds and found that global thinning was apparent by middle age, with no difference between men and women. Raz et al. (2005) looked at five-year regional volume changes in the brains of 20 to 77 year old adults. Shrinkage was observed in the caudate, the cerebellum, the hippocampus and the association cortices. All regions except the inferior parietal lobe showed individual differences. Burke and Barnes (2006) reviewed the literature on plasticity in the aging brain, debunking some of the myths on this topic. They state that changes in the brain are subtler and more selective than previously believed. It also seems like the hippocampus and the prefrontal cortex are the most vulnerable parts of the aging brain, but that there are major individual differences.

Neurological findings like these tells us that there are inevitable structural changes going on in the aging brain, which are highly intertwined with other body systems that are vital for performing everyday tasks, including balance.

2.10. Balance

Balance performance declines when reaching old age (Sturnieks, St George, & Lord, 2008). Structural and plasticity changes in the brain have major implications for balance and postural stability in the elderly. Both losing grey matter in parts of the brain most involved in postural control (Sowell et al., 2003), and activating more areas of the brain trying to

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compensate for neural cell loss (Cabeza & Dennis, 2012), has distinct consequences for the elderly's balance skills. Remembering that 28-35% of elderly over 65 fall each year and that falls account for 40 % of all injury deaths (Ageing & Unit, 2008), there is undoubtedly a need to highlight the importance of balance.

The ability to maintain and restore balance is an invaluable skill for performing activities of daily life. Balance requires complex integration of sensory information, which tells the person the position of the body relative to its surroundings. Balance also relies on the ability to generate appropriate motor responses to control body movements. To do this, it depends on the vestibular system, vision, muscle strength, reaction time and proprioception (Sturnieks et al., 2008). Proprioception refers to the sense of knowing where one's body is in space and is usually comprised of both static and dynamic components (Gandevia, Refshauge, & Collins, 2002). *Static balance* refers to continuance of a certain posture while being in a fixed position. *Dynamic balance* refers to the continuance of an equilibrium during rapid changes of an individual's mobile condition (Tsigilis, Zachopoulou, & Mavdis, 2001). Dynamic balance could be viewed as balance in motion.

Balance control is characterized by maintaining the body's center of mass within manageable limits to the base of support (Winter, 2009). The smaller the base of support, the more balance is challenged. This could be illustrated by the more demanding task of walking on just the toes or heels, instead of the whole foot (Huxham et al., 2001). Humans have a small base of support, standing upright on two feet together with a tall body frame. Both gravitational forces as well as acceleration forces will have an influence on balance. Both could be described as external, where acceleration forces are initiated from within the body by some exterior disturbance like a push (Huxham et al., 2001). The amount of cognitive processing needed for postural control would be influenced by these factors as well.

Balance is a complex skill based on dynamic interaction of sensorimotor processes in the body, not simply a connection of static reflexes. The specific response an individual chooses, depends on both the characteristics of the external environment one is about to pursue, and the expectations one holds as well as prior experiences (Horak & Macpherson, 2011). Having previous experience with a task, or being able to interpret how to maintain the right balance response could be valuable for the elderly. Forseth (2001) sums it up: "we are often unaware of the harmonious interactions among sensors, neural and musculoskeletal elements contributing to postural reactions" (p. 6).

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In an interesting review on how balance is relying on vision by Patla (1997), he describes two major forms of how the body maintains balance. One of the strategies is *proactive* mechanisms that try to reduce or counteract external stresses. The other part is largely *reactive* mechanisms responding to failure of the proactive mechanisms or unexpected events from the external environment. Visual information is key when an appropriate balance response must be made, and serves as continuous feedback for the body and its positioning (Huxham et al., 2001).

2.10.1. Balance decline

Even though there is a decline in many important functions like response time, vision and muscles that have an impact on balance function in the elderly, it is hard to determine just one exact cause for this central issue (Fabre et al., 2010). Research has shown that increased use of medication in the elderly can cause dizziness, which can lead to higher risk of falls (Ziere et al., 2006), but in this particular study, there is a lacking link between balance and medication use. Body weight has a relevant influence on balance skills (Hue et al., 2007). Balance can be improved by training, but the training needs to target specific balance exercises to be effective (Sherrington et al., 2008). A longitudinal prospective study on sixty-six older women aged 65 and over with osteoporosis improved both functional and static balance in a specialized 12-month training program. Falling frequency was also reduced (Madureira et al., 2007). Bohannon, Larkin, Cook, Gear, and Singer (1984) studied a sample of 184 persons ranging from 20 to 79 years old and how age influences the amount of time used on balance tasks. In their study they concluded that all participants were able to balance with both feet together and eyes closed for 30 seconds. There was no significant difference between balancing on the right or left leg. After the age of 60, most people in the sample were unable to balance on one leg, using the same amount of time as younger participants. That is to say, the elderly could not balance on one leg, especially with their eyes closed, for as long as the young participants. This might indicate that elderly will decrease their time on static tasks, such as one leg balance, and might increase their time on dynamic balance tasks like walking in slopes. Elderly tend to have longer movement times and longer path lengths than younger adults (Hageman, Leibowitz, & Blanke, 1995).

2.11. Balance measures

Various balance tests for the elderly have emerged in the field, many for practical reasons, to measure functional level and rating of independence abilities necessary for activities of daily living (ADL) (Fabre et al., 2010). Standing on one leg is a fairly short and

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easy task to conduct and can predict serious consequences: middle-aged adults ability to balance on one leg using less than 30 seconds shows a higher mortality rate than those who are able to do the same task for more than 30 seconds (Cooper, Strand, Hardy, Patel, & Kuh, 2014). Other factors like low income, low education and less healthy lifestyles will also have an influence on mortality rate, and was apparent in the mentioned study.

Vellas et al. (1997) measured 28 healthy elderly and twenty-eight young adults during one leg balance on force plates, accessing ground reaction forces. Elderly had more difficulties in maintaining a static position. The authors indicate that this is due to reduced initial decrease in musculoskeletal components and/or force variability. They claim that the 5 first seconds are crucial when measuring one leg balance. This means that it is not how long you stand on one leg that is important, but how the first five seconds are initiated (Vellas et al., 1997).

The Berg Balance scale (BBS) and the *Timed Up and Go-Test* are often used to establish functional level and predicting fall risk (Fabre et al., 2010; Neuls et al., 2011; Whitney, Poole, & Cass, 1998), while *the Tinetti test* consists of nine different components more focused on gait (Lin et al., 2004). The Berg Balance scale is one of the tests most frequently used to establish fall risk (Neuls et al., 2011). “The Berg Balance Scale has acceptable reliability, although it might not detect modest, clinically important changes in balance in individual subjects.” (Downs, Marquez, & Chiarelli, 2013, p. 93). In a review of Berg Balance scale and its predictability for falls, the authors concluded that it is not useful on its own, and that it should be used in conjunction with other tests (Neuls et al., 2011). The comprehensive nature of the Berg Balance scale might have missed the importance of smaller tests, aiming at predicting the same. Further elaboration of the Berg Balance scale can be found in the methods-section.

Seeing that balance tests try to predict future fall risk, one of the goals in this study is to see if there are high or low correlations between various balance tasks and if they correlate with the much-used Berg Balance scale.

Many tests have been able to discriminate between levels of performance and pointing out fallers and non-fallers, but according to Huxham et al. (2001), very few have shown the ability to predict future falls. From the same authors, there is also the notion that no methods to date are including open or moving environments. They argue that until tests include these open environments, clinicians should be aware of the balance assessments they use, and that using them for objective measurements may have limitations. Just as any measure trying to be objective, it might be hard to identify which individual differences influences balance testing.

2.12. Individual differences

Considering that elderly is a very heterogenous group, the interindividual variability, as previously stated, is usually high (Erber, 2011). Aging affects everyone differently, and a lot of this complex picture is painted by individual differences.

Differential Psychology dedicates itself to the study of individual differences (Schmidt, 2008). The goal of the discipline is to differentiate between average behavior and individual differences. The idea that individual differences are more specific than general, comes from the works of Henry (1968), and the focus on motor skill acquisition and its underlying basis (see Keetch, Lee, & Schmidt, 2008 for a review). Motor competence are skills essential to biological functioning, like walking and running (Sigmundsson & Rostoft, 2003). Here one needs to make an important distinction. *Abilities* are often seen as “mostly genetically determined and largely unchanged as a result of practice or experience” (Schmidt, 2008, p.166). While on the other hand one can find the term *skill*: “Skill specificity refers to the uniqueness of basic information processing components underlying task performance or, from an individual-differences perspective, the uniqueness of the ability determinants of individual differences in task performance” (Ackerman, 1990, p.883).

Specificity in motor tasks stands in contrast to the theory on motor skill generality. The generality theory suggests that motor control represented in the neural system can provide a skill to be executed in many different ways (Keetch et al., 2008). One problem is the phenomenon of transfer asymmetry. This is also known as the failure of transference between different procedures that appear to have the same underlying knowledge (Rosenbaum, Carlson, & Gilmore, 2001). In other words, there is disagreement on whether there exists an underlying balance ability that can be transferred between different tasks across situations, or if balance is task specific (see Burton & Rodgerson, 2001, for a review). These authors also argue that a general factor may underlie performances on different tasks, but that they are masked by variations in strategies chosen for the specific task (Burton & Rodgerson, 2001).

Considering that balance is either dynamic or static and not both, suggests that balance is task specific – performance depends on the task, and the skill depends on the person. There is some literature supporting this view (Burton & Rodgerson, 2001; Drowatzky & Zuccato, 1967; Haga, Pedersen, & Sigmundsson, 2008; Tsigilis et al., 2001). However, literature on elderly and specificity in balance tasks are scarce. One example is of Bachman’s studies (as cited in Rosenbaum et al., 2001) from the 60s, where the correlation between time on balancing on a seesaw or a freely standing ladder was less than 0.25. Rosenbaum et al. (2001) argues that such a small value violates the expectation of a general “balancing ability”. “In

general, correlations over participants between different perceptual-motor tasks rarely exceed 0.40” (Rosenbaum et al., 2001, p. 460). Tsigilis et al. (2001) tested this hypothesis using 4 different dynamic balance tests and provided some evidence that balance is indeed specific. One drawback is that the sample only consisted of undergraduate students.

One of the predictions in this study is that the correlations of tasks are low; showing that balance is not a general ability and that functional elderly can perform very differently on simple balance tasks (Leversen et al., 2012). A study on ninety-one 4-year old children showed that they had very low correlations between eight different motor tasks, thus indicating that a particular motor skill is specific to that task (Haga et al., 2008). Leversen et al. (2012) wanted to investigate motor performance across the life span and observe if correlations between motor tasks increased with age. Five different motor tasks were conducted to study the performance of 338 participants, ranging from 7 to 79 years of age. Correlations increased with increasing age between two fine motor tasks and two gross motor tasks. They argue that this is in line with cognitive studies and could offer some support for the theory on Neural Darwinism.

2.13. Neural Darwinism

The idea that balance is both task specific and influenced by individual differences can be offered some explanation by the theory of specificity in learning- the rather complex theory on *Neural Darwinism* (ND) (Edelman, 1987, 1993). The theory states that learning can be seen as an active process of selection that takes place inside the nerve system. The emphasis is on how practice and stimuli increases the connections within specific areas of the brain. With practice, the neural networks being used for the specific task will strengthen (Leversen et al., 2012). Neural Darwinism roots in evolutionary theory and immunology, and stresses the importance of varied and large populations. The theory sees brain development and its dynamics as selectionist in nature as opposed to instructionist, such as computers (Seth & Baars, 2005).

The theory was one of the first trying to fill the gap between psychology and biology. Interestingly, the hallmark of the theory, individual differences, becomes of particular importance. And since it is an ecological approach, Edelman takes the environment and the individuals experience with the world into consideration. Experiencing a specific balance task for the first time will create a firing in a neural circuit in the brain. Practicing the same task over and over again creates a fast response in the same neural network, and a stronger connection every time it gets activated (Edelman, 1993). Neural networks have considerable

variability, just like elderly. It is possible that the elderly's level of physical activity can affect individual differences in neural networks and balance skills, when physical activity has been shown to have impact on cognition (Kramer, Erickson, & Colcombe, 2006).

2. 14. Physical activity in late life

Many have believed that due to bodily decline, elderly should not engage in too much physical activity to preserve what is left (Singh, 2002). Today we know more about the benefits of exercise, not just for young people, but that physical health can be improved in older adulthood (Elward & Larson, 1992; Lexell, Frändin, & Helbostad, 2008). Wilmoth and Ferraro (2013) state that a considerable portion of the decline in muscle strength observed in the elderly is more likely to be related to inactivity and not the aging process per se.

Exciting new research has through cognitive dual training shown gross motor performance benefits (Li et al., 2010). This could prove that motor control, including balance, shows benefits not only from physical exercise, but from mental exercise as well. There are indications that elderly do not need large amounts of physical exercise to improve both cognition and cardiovascular fitness, only 3 hours per week is enough to see improvements (Chapman et al., 2013). Elderly with a current history of physical activity perform better on static and dynamic balance tests, than people who have been active in the past (Bulbulian & Hargan, 2000).

New guidelines from the Norwegian Directorate of Health (2014) have provided updated and specific recommendations for people over 65. These recommendations state that this group should be active for at least 150 minutes per week. During these activities the person should become slightly short of breath. If the activity is hard, and making the person "breathe heavily", 75 minutes per week is enough (Helsedirektoratet, 2014). According to research conducted in 2008, only 6-20 % of people in this age group are active for 30 minutes per day, the previous recommendation (Anderssen et al., 2009).

One of the central questions in this study is to elaborate whether it is possible to connect amount of exercise to balance skills. Enormous research literature has shown that physical activity is good for overall health and life quality (Lexell et al., 2008). It has been proven that exercise influences the restoration or maintenance of physical function (Buchman, Boyle, Wilson, Bienias, & Bennett, 2007; Wilmoth & Ferraro, 2013). Even though physical exercise has shown benefits for balance (e.g Bulat et al., 2007; Rinne, Pasanen, Miilunpalo, & Mälkiä, 2010; Steadman, Donaldson, & Kalra, 2003), "what is less clear is whether balance exercises on their own are effective" (Overstall, 2003, p. 156). Herwaldt and Pottinger (2003)

reviewed nine studies that assessed general exercise programs for elderly. For six of them, exercise alone was not effective in improving balance. Three studies with a targeted exercise program, especially designed for each participant proved effective in decreasing the number of elderly who fell.

Elderly can do a lot of the same amount of exercise as younger individuals, but there are often guidelines specifically targeted towards this group. Activity plans are often recommended, including balance and flexibility exercises (Nelson et al., 2007). Seeing that balance can benefit from being physically active, one hypothesis is that there is a significant difference between people who are highly active and people who are less physically active, and how they perform on various balance tasks, as well as the Berg Balance Scale.

3. METHODS AND MATERIALS

3.1. Participants

The sample consisted of 41 participants between 65 and 88 years of age. They were 23 men and 18 women selected from different unions for seniors; dance groups, gymnastic groups and hiking groups. Participation criterions stated that they had to be retired, independent, and living at home. They received a questionnaire asking for gender, age and an estimation of amount of hours per week they are physically active (see Appendix 1.) They were given both verbal and written information about the study, and told that they were guaranteed anonymity, that participating was voluntarily and that they could withdraw at any time. The mean age of the sample was $73(\pm 7.5)$ years.

3.2. Procedure

The participants were tested at the learning lab at the Psychology Department of the Norwegian University of Technology and Science. They were tested once, and the whole testing session consisted of four selected balance tasks and Berg Balance Scale (Berg, 1989). Two static balance tasks were taken from the Movement ABC for children (Sugden & Henderson, 1992), and two dynamic tasks were taken from Leversen et al. (2012). These are described in further detail below. The two static tasks were chosen because of their standardization (Sugden & Henderson, 1992) and their simpleness to administer. The two dynamic tasks were chosen because of their challenging nature and apparent difference with the other two tasks. All of the four tasks were timed with a stopwatch, and all tasks were performed with comfortable shoes for comparable reasons. The whole testing session lasted about 25 minutes.

3.2.1. Dynamic balance tasks

3.2.1. a) Heel to toe-walking (HTT)

Participants were required to walk down a straight, marked line (4,5 m) as fast as they could while their heels touched their toes each step (Leveresen et al., 2012).

3.2.1.b) Walking in slopes (WIS)

This task was inspired by the modified figure of eight test by Jarnlo and Nordell (2003) and the walking/running in slopes- test by Leveresen et al. (2012):

The participant starts at a marked starting point. When a signal is given, the participant starts walking as fast as possible in slopes around two marked lines (line 1 and line 2). The participant can choose which direction they go. If the participant starts to go on the right side of line 1 – the subject will go to the left side of line 2. The participant then turns around and goes back to the right side of line 2 and left side of line 1 – and over the starting point. The time is stopped when the participant arrives back at the starting point. (p. 3)

Illustration of the task can be found in figure 1.

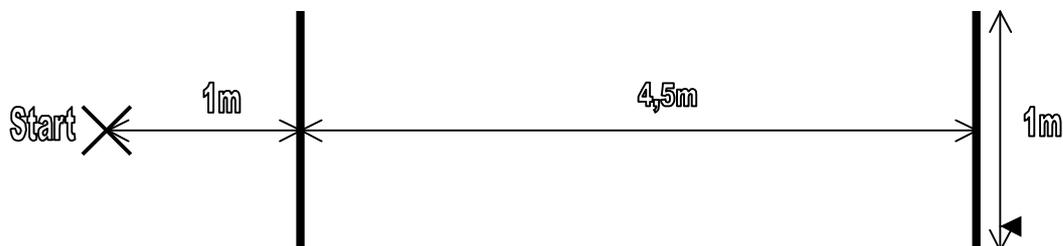


Figure 1.

3.2.2. Static balance tasks

3.2.2. a) One leg balance (OLB)

The participant is asked to stand on a preferred leg for as long as possible. To make it more challenging, the participants were asked to stand with their eyes closed.

3.2.2. b) One-board balance (OBB)

In this task, the person balances on one foot, on a balance board, with hands free to use as necessary, for as long as possible. The participants were allowed one trial on this task, for an understanding on how the board tilts. This task was done on preferred leg with eyes open.

3.2.3. Berg Balance Scale (BBS)

Katherine Berg argued that balance is more of a concept, than an actual and genuine measure. Berg and colleagues designed the Berg Balance scale in the late 1980s. The goal was to create an instrument that would be encompassing and solid enough to predict both static and dynamic balance skills in the elderly in everyday tasks where balance is involved. The main purpose of the scale was to create a comprehensive and clinical tool for measuring balance in the impaired elderly. It is especially important for measuring functional decline, including fall risk, and it is therefore usually administered at least twice on the same patient over a certain time period.

The scale consists of 14 items; most of them are functional assessments, like standing up from a chair, moving from one chair to another, leaning forward and picking up an item. Equipment needed is a chair, a stopwatch, a ruler and a step. Each part of the test consists of a rating system from 0, lowest level of function till 4, highest level of function. A cut off score has been found at 45 points, indicating higher risk of falling (Thorbahn & Newton, 1996).

The Norwegian version of the Berg Balance scale was used (Bergland, Helbostad, & Askim, 2004). This version has proven high internal consistency and interrater reliability when applied to geriatric rehabilitation patients (Halsaa, Brovold, Graver, Sandvik, & Bergland, 2007).

3.2.4. Hours of physical activity

The participants were asked to estimate how many hours per week they are physically active. Physical activity was defined as arranged fitness activities, but any other activities that demands energy, such as going for a walk and household duties were also included (in line with the new Norwegian Directorate of Health's recommendations from 2014).

3.3. Data analysis

To see how the relationships are between performances on the tasks, correlation analysis was performed. To see if hours of physical activity influence the results on the five tests, the dataset was divided into two groups: the 9 highest and 10 lowest reported hours of physical activity. The reason for different group sizes was in order to appropriately implement

the analysis, a criterion of at least six scores in each group had to be met. This made the cut off scores for the high group 15 hours a week, and the cut off score for the lowest group 4,5 hours per week. Here the goal is to see if there is a significant difference between people in the high or low activity group and scores on the tasks and the Berg Balance Scale.

Inspections of histograms and Q-Q plots indicated that normality distribution could not be assumed for all of the four tasks. Both WIS and HTT were close to normally distributed, while OLB and OBB were severely skewed. Non-parametric statistic was therefore applied for further analysis (Field, 2013).

It is important to note the difference between the four tasks. The heel to toe task and walking in slopes task measure aspects of dynamic balance and here it is the fastest times that reflect the best performance. The two static balance tasks measure how long a person can perform the task. We would therefore expect shorter times on the HTT and WIS, and longer times on the OLB and OBB.

3.4. Results

Data were analyzed using SPSS 21. Descriptive statistics of the means and standard deviations of estimated hours of physical activity, four balance tasks and Berg Balance scale are found in Table 1.

Table 1. Descriptive statistics. The table shows the mean and standard deviations (SD) of estimated hours of physical activity, four different balance tasks and the BBS.

N = 41 (23 men, 18 women)

Mean age 73(5.7)

	Mean (SD)
EHPA	8.79 (5.85)
HTT	16.46 (8.91)
WIS	9.11 (1.88)
OLB	12.00 (14.61)
OBB	13.08 (16.02)
BBS	54.66 (1.65)

EHPA, estimated hours of physical activity; HTT, heel to toe walking; WIS, walking in slopes; OLB, one leg balance; OBB; one board balance; BBS, Berg Balance scale.

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The data analysis reveals some variation between the tests, but also within the tests themselves. Both OLB and OBB have fairly large standard deviations, 14.61 and 16.02 seconds respectively. The lowest amount of hours of physical activity reported is 2 hours per week, the highest reported is 24 hours per week. Correlations (Spearman's rho, two tailed) between the four tasks, hours of physical activity and score on the BBS are summarized in table 2 below.

Table 2. The table shows correlations of estimated hours of physical activity (EHPA), heel to toe walking (HTT), walking in slopes (WIS), one leg balance (OLB), one board balance (OBB), Berg Balance scale (BBS) (n = 41).

	EHPA	HTT	WIS	OLB	OBB	BBS
EHPA	1	-.040	-.156	.035	.242	.231
HTT		1	.014	-.079	.325*	.041
WIS			1	.073	-.128	-.105
OLB				1	.368*	.044
OBB					1	.328*
BBS						1

*. Correlation is significant at the 0.05 level (2-tailed).

There are low to moderate correlations between the four different balance tasks, BBS score and estimated hours of physical activity. According to Cohen (2013) a correlation of .10 equals a low correlation, a correlation of .30 equals a moderate correlation, and a correlation of .50 and over, is a large correlation.

The Spearman's rho reveals a statistically significant relationship ($p < .05$) between heel to toe walking and one board balance, $r = .325$, one leg balance and one board balance, $r = .368$, and one board balance and Berg Balance scale, $r = .328$.

The results from dividing the physical activity group into high PA (15-24 hours) and low PA (2-4.5 hours) analyzed by a Mann Whitney test are summarized in table 3 below. Assuming that amount of physical activity would influence the results (Bulat et al., 2007; Rinne et al., 2010), a one-tailed analysis was used.

Table 3. The table shows the means and standard deviation difference between high and low activity groups separately for the four different balance tasks and the BBS.

Groups

	HIGH PA	LOW PA	P
	MEAN (SD)	MEAN (SD)	
	(N=9)	(N=10)	
HTT	14.24 (7.66)	12.52 (8.76)	ns
WIS	8.85 (2.06)	9.65 (2.60)	ns
OLB	10.21 (7.28)	12.76 (13.56)	ns
OBB	17.84 (18.15)	7.40 (6.07)	ns
BBS	55.33 (1.11)	53.90 (1.96)	0.03*

Table 3. Notes: * $p < 0.05$ (one-tailed), ns = not significant

There is no significant difference between groups with high or low physical activity and time used on the four balance tasks. A significant difference is found between groups with high or low physical activity and score on the BBS ($p = 0.03$, one-tailed).

4. DISCUSSION

The aim of the study is to look at several aspects of aging, where the main focus is on how independent, living at home-elderly perform on four different balance tasks and the Berg Balance scale. It is also interesting to view how elderly perform on these tasks together with how physically active they are, indicated by self-reporting. The following section tries to answer the four research questions raised in the beginning of the thesis.

4.1. To what extent does four various balance tasks performed by highly functional elderly correlate with each other?

One aim of the study was to analyze the correlation between four balance tasks; heel to toe walking, walking in slopes, one leg balance and one board balance. If highly correlated, it may suggest a general balance ability in the elderly (Burton & Rodgeron, 2001), which means that performance should be quite similar on these tasks. Abilities are often inferred

from correlations on certain kinds of tasks and described as a general trait of the individual. Skill often refers to proficiency on a specific task (Fleishman, 1966, as cited in Haga et al., 2008). The results display low correlations among the tasks tested, ranging from of .014 to .368, with a few moderate correlations (see table 2.), which suggest that performance on these tasks may be regarded as specific. The theory on Neural Darwinism could offer some explanation for this. To perform a balance task, practice of the skill for the task becomes vital (Edelman, 1987; Kleim & Jones, 2008). This is also supported by previous research stating that correlations between motor tasks are usually low, even in different age groups (Drowatzky & Zuccato, 1967; Haga et al., 2008; Leversen et al., 2012; Rosenbaum et al., 2001).

There is a significant moderate correlation between the heel to toe walking task and one board balance ($r = .325$), while the one leg balance and one board balance have a significant moderate correlation of .368. One would not expect heel to toe walking task and one board balance task to have a significant correlation as it is likely that these tasks rely on experience and different responses (Edelman, 1987, 1993), especially considering their static/dynamic difference. It may be that the significant correlation is due to the cognitively demanding nature of both tasks, acquiring much attention from the participant (Shumway-Cook, Woollacott, Kerns, & Baldwin, 1997). However, both correlations are low and do not offer further support for a general balance ability on their own. Correlations tend to increase between motor tasks the older the participants get (Leversen et al., 2012). This might be why some tasks show significant, yet moderate correlations.

4.2. How are the correlations between various balance tasks and scores on the Berg Balance scale?

The Berg Balance Scale (BBS) consists of 14 items intended to measure most aspects of balance (Berg, 1989). If this is the case, it should have high correlations with the other four tasks measured.

Three of the tasks tested do not have any significant correlations with the scale; the heel to toe task, the one leg balance and walking in slopes. There is a significant low correlation between time on the one board balance task and score on the BBS ($r = .328$). These were the items with the highest correlation. The one board balance task might be the most challenging task tested, and doing well on this task could mean that elderly perform well on the BBS as well. Highly functional elderly, as indicated by a high score on the BBS, could be better at very demanding tasks like the one board balance task. Since we are only looking

at correlations, a direction of causality is hard to determine. We cannot tell if being able to perform well on the one board balance task predicts a high score on the BBS.

Some elderly are so afraid of falling that it restricts them in balance tasks (Jung, 2008; Zijlstra et al., 2007). It is plausible that our sample with a high score on the BBS, which indicates less fall risk, is not afraid of trying a complex task, such as the one board balance.

Standing on one leg is another item in the BBS. The one leg balance task is easy to administer and it has been shown to be a good predictor of future fall risk (Berg, 1989). Being able to stand on one leg, with eyes open for more than ten seconds indicates high ability on daily functioning and is given a full score on the BBS. The BBS also consists of items like leaning forward, sitting down on a chair and shifting weight between legs on a step. One could argue that these are more functional tasks as they replicate typical daily activities, than the study's other four selected tasks.

The BBS was developed to predict fall risk and evaluate level of independence among frail elderly. Testing a group of highly functional elderly on a scale developed for a low functioning group is not according to the test's intentions, but confirms that it is a good measure for frail elderly. A highly functional sample should be able to receive a score of more than 45 points (Berg, 1989). Our sample scored 54 points on average, indicating high functionality. Being consistent when giving test instructions is very important:

Simultaneous testing of the Berg Balance Scale to measure inter-rater reliability has different disadvantages. The Berg Balance Scale instructions may be interpreted and delivered in slightly different ways by different assessors. Non-verbal components such as demonstrating how to perform balance tests may vary between assessor (Downs et al., 2013, p. 94).

Since there was only one assessor, it was crucial that the same instructions, in the same way, were given to all of the participants.

In sum, the BBS seems able to distinguish between highly functional and frail elderly, indicated by the high mean score. The BBS consist of as many as 14 items to measure balance, but it is not correlated with the other four balance tasks. This finding offers further support that balance might be task specific (Haga et al., 2008; Leversen et al., 2012).

The BBS may not be comprehensive enough or useful on its own. One suggestion is that the BBS could be used in conjunction with other balance tasks to get a more accurate picture of the elderly's balance skills (Neuls et al., 2011).

4.3. How are the correlations between physical activity level, four balance tasks and the Berg Balance scale?

We added physical activity to see if it has high or low correlations with the four tasks or the BBS. The analysis reveals that hours of physical activity have low non-significant correlations with the four balance tasks or the BBS (see table 2). Physical activity has been shown to improve functionality and overall health (Buchman et al., 2007), so one would at least expect a higher correlation between physical activity level and score on the BBS ($r=.231$). In this functional sample, these results are unexpected.

Overstall (2003) questioned whether balance exercises are effective on their own. It might be that a combination of physical activity and targeted balance exercises are the most effective in improving balance tasks in the elderly – not general exercise programs alone (Herwaldt & Pottinger, 2003). The elderly are a heterogeneous group and might profit on individually made balance exercise- and activity programs. Specifically tailored tasks rely on the principals of specificity (Ackerman, 1990). To perform a task successfully, one needs to have experience with the task (Leversen et al., 2012). Even though our sample is physically active, they may not have experience with the four balance tasks chosen. This lack of experience may provide an explanation as to why there is a low correlation with physical activity.

According to Bulbulian and Hargan (2000) elderly with a current history of physical activity should perform better on static and dynamic balance tests than people who have been active in the past. It was evident during testing, but also through analysis of histograms, that the sample tested seemed to have good overall function. This evaluation is made problematic by its subjective nature and the lack of a definition of good functioning. Most studies assess how elderly perform on Activities of Daily Living, or ADLs (Fillenbaum, 1985). These include tasks that are related to self-care, such as bathing, feeding and basic mobility (Fillenbaum, 1985). Highly functional are in this study juxtaposed to highly active. On average, the participants report that they are physically active for over 8,5 hours per week. This is more than an hour per day. Even though variations are high (SD 5.8), there is reason to believe that this group has a higher functional level than the average elderly population. Especially considering that under 20 % of Norwegian elderly are active for 30 minutes per day (Anderssen et al., 2009).

Most studies are performed on frail elderly (Clegg, Young, Iliffe, Rikkert, & Rockwood, 2013). Given the small and narrow samples, balance tests using highly active participants are needed to help increase outer validity/generalizability to the group as a whole.

This study shows that even highly functional elderly have low correlations between balance tasks performance and score on the BBS.

4.4. How is the difference between two groups of high and low activity and four balance tasks and the Berg Balance scale?

Surprisingly, there is no high, significant correlation between hours of physical activity and the four tasks or the BBS. One's balance can benefit from being physically active (Bulat et al., 2007; Rinne et al., 2010), and one hypothesis proposes a significant difference between people who are highly active and people who are less physically active. In an attempt to see whether being very or less physically active during the week has an impact on the scores, the dataset were split into two groups; high and low activity. As shown in table 3, there are no significant differences between the two dynamic and the two static balance tasks. Exercising often (over 15 hours per week) or rarely (under 4,5 hours a week) does not seem to influence results on the four balance tasks. As little as 3 hours per week of being physically active is enough to see improvements in functioning (Chapman et al., 2013), but we cannot control whether the participants are performing better or worse than they would if they were less physically active. We do not know what they see as being physically active. Being physically active could mean better overall function. The participants may engage in activities that are making them more flexible, persistent and physically stronger (Wilmoth & Ferraro, 2013). We do not know the degree of intensity of the activities (Lexell et al., 2008). This could mean that it is possible to receive a high score on the BBS and vary on other balance tasks. This could offer an explanation to the finding that there is a significant difference between groups with high or low physical activity and their score on the BBS ($p=0.03$, one-tailed).

4.5. What does the study provide?

In sum, this study provides insights into how highly functional elderly perform on two static and two dynamic balance tasks and the BBS. Self-reports indicate that this sample of elderly is very physically active. The results display low correlations between the heel to toe task, the walking in slopes task, the one leg balance task and the one board balance task. There are also low correlations between the four tasks, the BBS and the amount of hours of physical activity performed per week. In accordance with Neural Darwinism, it may be considered that elderly's performance on a variety of balance tasks depend on skill specificity. This may have implications for fall risk assessment as balance-training programs might target specific exercises to better improve balance skills. It is especially important to identify which

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balance tasks are more difficult for the elderly and then practice these tasks more. This assigns responsibility on to the elderly themselves to identify individual differences in balance skills and how to improve them. Variation of different tasks may be vital. It seems as though being physically active is too general to be able to influence performance on balance tasks. Being highly or less physically active has an impact on the BBS score, a measurement of functionality and fall risk evaluation, but no significant difference on the four other tasks.

The definition of a “good” balance scale or “good” balance skills becomes especially problematic if balance is task specific and not a general ability. This study has provided some insights into how highly functional elderly perform on the BBS where a significant difference is found between high and low activity levels. The correlations are low and vary greatly on the four other tasks. These findings raise questions as to whether the BBS measures all aspects of balance in the elderly.

The low correlations among the tasks could be a result of physiological changes in the brain, like grey matter loss (Sowell et al., 2003), but this connection is hard to prove in this study. Frontal and parietal lobes are areas prone to more grey matter loss than other parts of the brain, known to be vital for balance performance (Seidler et al., 2010).

How can this study contribute to fall prevention research? Elderly living at home may be doing well on functional tasks, but not when meeting new, challenging, and very specific balance tasks such as the one board balance. Seeing that many programs are focusing on being physically active, this study argues that physical activity programs need to target specific exercises to be effective at improving balance. Being active does not automatically imply good balance skills. It might be that fall prevention research needs to relocate its focus:

Falls programmes need to be evidence based, and that means abandoning ineffective interventions. Secondly, physical activity programmes need to measure falls as a measure of potential harm. Programmes to enhance everyday physical activity levels, especially in the oldest, most frail population, need to incorporate strength and balance training, preferably as an integral part of everyday functional activities that are most meaningful to the person. (Clarke, McMurdo, & Witham, 2015, p. 2).

The future of balance training is the possibility of combining it with both physical as well as cognitive dual training (Clarke et al., 2015). This form of cognitive exercise have shown some promising results in improving gross motor performance based on executive control (Li et al., 2010).

There is a lack of consensus in the literature as to what balance performance entails

(Pollock, Durward, Rowe, & Paul, 2000). It might be easier when having a standardized scale like the BBS, where the score tells something about the elderly's functional level. Timing balance tasks calls for more comparison studies to get a reference point as to what good balance performance is.

This study tells us that the balance term is complex and might not be a general ability that is transferable to different tasks. It provides us with the notion that four different balance tasks do not correlate, indicating that elderly can perform better on one task than another. This supports the theory behind specificity in learning (Henry, 1968). Based on mean score on the BBS, the sample has good balance skills for activities of daily living.

4.6. Limitations

This study has several limitations. It is looking at correlations between balance tasks and the BBS, but it does not address the possible direction of these correlations.

A trained professional should administer the BBS, preferably with more than one assessor, and more than once to see a change in function. The BBS is also a test for elderly with lower functioning, and may not be sensitive enough to distinguish really functional elderly from those who are just functional and what separates these groups.

Many of the participants were conscious of the fact that they were being tested, and may have performed differently if given practice. Then again, this study was not aiming for learning effects. The one leg balance was only performed with eyes closed. For better comparisons, it should have been performed with eyes open, even though it is an item in the BBS. The task of standing on one leg is probably more transferable to everyday living with eyes open than closed.

It may be hard to generalize these results to the entire elderly population, but they provide an insight into how highly functional Norwegian elderly perform on balance tasks and the BBS. Further research is suggested to investigate what kinds of physical activity elderly perform and if this influences their performance on various balance tasks. One participant used to ice skate, and he performed well on the one board balance task, which can be quite similar to ice-skating, which is balancing on a thin edge.

Self-reporting is always an issue in this kind of research (Clarke et al., 2015; Downs et al., 2013). Participants were asked to estimate how many hours per week they are physically active. This may be interpreted as hours spent at the gym, or as hours at the gym together with hours doing house chores, going for walks and so on. The questionnaire wanted to explicitly state that hours of physical activity are not just arranged fitness activities, but also any other

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activity that demands energy, such as going for a walk, cleaning and so on. One issue is that elderly tend to report by comparing to others in their same group. They could be over-estimating amounts of hours of physical exercise, comparing to more frail adults in the same age group (Downs et al., 2013).

Remembering that elderly is one of the groups with highest variation, the sample ranges from 65 till 88 years of age. This means that there is an age difference of 23 years between the youngest and the oldest participant tested. It is likely influencing the results, but it might be that the 65 year old is in worse shape than the 88 year old. One can question what is natural and expected. It is likely that most elderly will experience some decline in body functions and variations in the brain that will influence balance skills and performance.

5. CONCLUSION

41 highly functional elderly, ranging from 65-88 years of age, performed very differently on four different balance tasks and the Berg Balance scale. There were low correlations between all the tasks tested. These results support the idea of task specificity; that balance performance depends on the task tested. Being very or less physically active during the week revealed a significant difference in the score on the Berg Balance scale, but not on the other four tasks measured. Further suggestions are made to ensure that elderly identify what balance exercises they need to practice, and make them a part of their weekly activity plans.

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Appendices

Appendix 1.

Deltakernr

Spørreskjema - Balanseøvelser hos eldre

Nedenfor finner du noen korte spørsmål jeg trenger svar på før gjennomførelse av studien.

Alder:år

Kjønn: mann kvinne (sett ring/kryss)

Jeg trenger et estimat på hvor ofte du er i fysisk aktivitet, gitt i timer per uke. Dette innebærer enhver aktivitet som øker energiforbruket. Dette kan være å gå tur, sykle, danse, hogge ved osv.

Antall timer med fysisk aktivitet i uken:

Fylles ut av test-ansvarlig

HtT	WiS	OIB	ObB	BBS