Sarcopenia in the elderly

Comparison of different methods for estimating the prevalence of low muscle mass and low physical function

Master Thesis by
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May 2015
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UNIVERSITY OF OSLO

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Oslo, May 2015

Linn Kristin Lie Øyri
Summary

**Background:** Sarcopenia has been defined by European Working Group on Sarcopenia in Older People (EWGSOP) as “a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength with risk of adverse outcomes such as physical disability, poor quality of life and death”. Different diagnostic criteria of sarcopenia have resulted in widespread estimates of prevalence in the literature. Sarcopenia is most prevalent in elderly - a group increasing in size. Thus the recognition, prevention and treatment of sarcopenia are of major importance to limit its consequences.

**Objectives:** The primary objective of this Thesis was to provide more knowledge about the prevalence of sarcopenia in community-dwelling subjects aged 70 years or older living in the municipality of Skedsmo. Secondary objectives were to describe the prevalence of reduced muscle mass, muscle strength and physical function. Furthermore, the prevalence of sarcopenia in the above mentioned group was described based on the definition created by EWGSOP.

**Subjects and Methods:** After receiving invitations by post, 236 subjects completed study visit. Muscle mass was measured by bioelectrical impedance and estimated by two equations (by Baumgartner et al. and Janssen et al.). Muscle strength was measured by handgrip strength, and physical performance was measured by gait speed. Sarcopenia was defined as the presence of low muscle mass and either low handgrip strength or low gait speed, according to EWGSOP. Other measures of muscle mass and physical function were also conducted, however not included in the definition of sarcopenia.

**Results:** The prevalence of low muscle mass was 10.1 % by using Baumgartner’s method and 88.1 % by using Janssen’s method. Women had a lower prevalence of reduced muscle mass than men when applying both methods for estimating muscle mass. Reduced handgrip strength was present in 37.1 % and 11.8 % of women and men, respectively. In the total sample, 8.9 % had reduced gait speed. The prevalence of sarcopenia was 4.0 % by using Baumgartner’s method and 24.4 % by using Janssen’s method. Sarcopenia was more common in men by using Baumgartner’s method and more common in women by using Janssen’s method. Furthermore, sarcopenia was more prevalent in subjects aged 80 years or older than in subjects between 70 and 80 years old.
**Conclusions:** In this study, the prevalence of sarcopenia according to EWGSOP’s diagnostic criteria was described among community-dwelling subjects aged 70 years or older living in Skedsmo municipality. When comparing two methods, we found a widespread prevalence of sarcopenia ranging from 4.0% to 24.4%. Those aged 80 years or older had a higher prevalence of sarcopenia when compared to those between 70 and 80 years old. The prevalence of sarcopenia seems highly dependent on its diagnostic criteria. A consensus regarding recognition of sarcopenia is highly needed to prevent its burdens in a constantly ageing population.
Contents

1 Introduction .................................................................................................................. 1
  1.1 An ageing population ............................................................................................ 1
  1.2 Definition of sarcopenia ....................................................................................... 2
  1.3 Diagnostic criteria of sarcopenia ......................................................................... 3
    1.3.1 Defining low muscle mass ........................................................................... 3
    1.3.2 Defining low physical function .................................................................... 4
    1.3.3 Other diagnostic criteria .............................................................................. 5
  1.4 Methods to detect sarcopenia .............................................................................. 5
    1.4.1 Muscle mass ............................................................................................... 5
    1.4.2 Muscle strength and physical performance ............................................... 6
  1.5 Prevalence of sarcopenia ..................................................................................... 8
    1.5.1 Prevalence of sarcopenia in studies using DXA to estimate muscle mass ...... 8
    1.5.2 Prevalence of sarcopenia in studies using BIA to estimate muscle mass ..... 9
    1.5.3 Prevalence of sarcopenia in studies using alternative measures to estimate muscle mass .......................................................... 9
  1.6 Sarcopenic obesity ............................................................................................... 13
  1.7 Sarcopenia-related conditions ............................................................................ 13
  1.8 Suggested mechanisms of sarcopenia .................................................................. 14
  1.9 Prevention and treatment .................................................................................... 16

2 Objectives .................................................................................................................. 17

3 Subjects and methods .............................................................................................. 18
  3.1 Recruitment and collection of data ..................................................................... 18
    3.1.1 Study population ......................................................................................... 18
    3.1.2 Study visit .................................................................................................. 18
  3.2 Anthropometric measures .................................................................................. 19
    3.2.1 Height .......................................................................................................... 19
    3.2.2 Waist circumference .................................................................................... 19
    3.2.3 Hip circumference ....................................................................................... 19
    3.2.4 Mid-upper arm circumference (MUAC) ....................................................... 19
    3.2.5 Calf circumference (CC) ............................................................................ 20
  3.3 Measure of muscle mass ..................................................................................... 20
3.4 Measure of physical function ................................................................. 21
   3.4.1 Handgrip strength ................................................................. 21
   3.4.2 Short Physical Performance Battery (SPPB) ............................. 22
   3.4.3 Stair climbing test ................................................................. 23
3.5 Mini Nutritional Assessment (MNA) ................................................. 24
3.6 Mini-Mental State Examination (MMSE) ......................................... 24
3.7 Blood samples .............................................................................. 25
3.8 Subject characteristics .................................................................. 25
3.9 Literature search ........................................................................... 26
3.10 Statistical analysis ......................................................................... 27
   3.10.1 Continuous variables ............................................................ 27
   3.10.2 Categorical variables ............................................................ 27
4 Results ............................................................................................... 28
   4.1 Subject characteristics ................................................................ 28
   4.2 Anthropometric measures ............................................................ 32
   4.3 Muscle mass .............................................................................. 34
   4.4 Physical tests .............................................................................. 37
   4.4.1 Handgrip strength ................................................................. 37
   4.4.2 Gait speed ............................................................................. 37
   4.4.3 Other physical tests ............................................................... 37
   4.5 Correlations between measures of muscle mass and physical function .................................................................................. 41
   4.6 Prevalence of sarcopenia ............................................................... 42
5 Discussion .......................................................................................... 46
   5.1 Subjects and methods ................................................................. 46
   5.1.1 Study population .................................................................. 46
   5.1.2 Study design ........................................................................ 47
   5.1.3 Anthropometric measures ...................................................... 47
   5.1.4 Defining low muscle mass by two methods ............................. 48
   5.1.5 Measure of muscle mass ........................................................ 49
   5.1.6 Strength and limitations of physical tests ............................... 50
   5.1.7 Statistics .............................................................................. 52
   5.2 Discussion of results .................................................................... 52
   5.2.1 Anthropometry .................................................................... 52
5.2.2 Prevalence of low muscle mass by using two methods ........................................ 52
5.2.3 Physical tests ...................................................................................................... 54
5.2.4 Prevalence of sarcopenia .................................................................................. 57
5.2.5 Clinical implications ......................................................................................... 60

6 Conclusion .................................................................................................................. 61

7 Future perspectives .................................................................................................... 62

References ..................................................................................................................... 63

Appendices ................................................................................................................... 79
List of abbreviations

BIA  Bioelectrical impedance analysis
BMI  Body mass index
CC   Calf circumference
CRP  C-reactive protein
CT   Computed tomography
DXA  Dual-energy X-ray absorptiometry
ESPEN European Society for Clinical Nutrition and Metabolism
EWGSOP European Working Group on Sarcopenia in Older People
FNIH  Foundation for the National Institutes of Health
HDL-C High-density lipoprotein cholesterol
IWGS International Working Group on Sarcopenia
LDL-C Low-density lipoprotein cholesterol
MAMC Mid-arm muscle circumference
MMSE Mini-mental state examination
MNA  Mini nutritional assessment
MRI  Magnetic resonance imaging
MUAC Mid-upper arm circumference
SFT  Skinfold thickness
SMI  Skeletal muscle index
SPPB Short Physical Performance Battery
SSCWD Society of Sarcopenia, Cachexia and Wasting Disorders
TC   Total cholesterol
TG   Triglycerides
List of tables

Table 1. Different diagnostic criteria of sarcopenia.

Table 2. Techniques to assess muscle mass, muscle strength and physical performance, as suggested by EWGSOP.

Table 3. Prevalence of sarcopenia in studies using DXA to estimate muscle mass.

Table 4. Prevalence of sarcopenia in studies using BIA to estimate muscle mass.

Table 5. Prevalence of sarcopenia in studies using alternative measures to estimate muscle mass.

Table 6. Cut-offs in measures of muscle mass and physical function.

Table 7. Subject characteristics.

Table 8. Laboratory parameters.

Table 9a-b. Anthropometric measures.

Table 10a-b. Calculations of skeletal muscle index (SMI).

Table 11a-b. Performance on physical tests.

Table 12. Correlations between measures of muscle mass and physical function.

Table 13. Comparison of sarcopenic and non-sarcopenic individuals.
List of figures

Figure 1. Relationship among sarcopenia, frailty and physical function impairment.

Figure 2. Suggested mechanisms of sarcopenia.

Figure 3. Flow chart of inclusion of participants.

Figure 4. Illustration of the three balance positions in SPPB.

Figure 5. Selection of papers in the literature search.

Figure 6. Age distribution among participants.

Figure 7. Age distribution among inhabitants in Skedsmo municipality.

Figure 8. Boxplot of skeletal muscle index (SMI) in Baumgartner’s and Janssen’s method.

Figure 9. Distribution of SMI in women and men in Baumgartner’s and Janssen’s method, respectively.

Figure 10. Portion of participants with reduced handgrip strength, balance, gait speed, rise and sit performance, total SPPB-score and stair climbing performance stratified by age and gender.

Figure 11. Overlap of the prevalence of reduced performance in different physical tests.

Figure 12. EWGSOP-suggested algorithm for sarcopenia case finding applied in the current sample.

Figure 13a. Prevalence of presarcopenia, sarcopenia and severe sarcopenia when Baumgartner’s method was used in the calculation of SMI.

Figure 13b. Prevalence of presarcopenia, sarcopenia and severe sarcopenia when Janssen’s method was used in the calculation of SMI.
List of appendices

Appendix 1. Study invitation and informed consent.

Appendix 2. Approval by REK.

Appendix 3. Protocol for anthropometric measures.

Appendix 4. Handgrip strength protocol.

Appendix 5. SPPB protocol.


Appendix 7. Mini nutritional assessment.

Appendix 8. Mini-mental state examination.

Appendix 9. Data included in the two Master Thesis in the AMARONE-study.
1 Introduction

1.1 An ageing population

In year 1950, eight percent of Norway’s population was 67 years or older. Today, this proportion has increased to 13 %, and it is expected to reach 17 % in year 2030 (1). This development will increase the need for health care services in the future. Prophylactic health promoting actions are crucial. With increasing age, a change in the body composition occur (2). Muscle mass, strength and power have been found to start declining at various ages, ranging from 27 to 60 years (3, 4). In a quantitative review, loss of muscle mass between ages 18 and 80 years ranged from 8-49 %, with an average decline in peak mass per year of 0.37 % in women and 0.47 % in men. After the age of 75 years, the decline is found to be twice as rapid (5). Loss of muscle mass and strength may result in mobility disorders, osteoporosis, falls and fractures, impaired activities of daily living, disabilities, infections, loss of independence, poor quality of life and death (6-13). A decline in muscle mass and strength creates a downward spiral considering health (14). The costs of disability due to low muscle mass and function were in year 2000 estimated to $18.5 billion in the United States. This represented about 1.5 % of the total health care expenditures (15).

Lower limb muscle mass has been found to decline faster than upper limb muscle mass (4). Fat-free mass is suggested to decline faster in men than in women (16-18). However, when correcting for peak muscle mass, this distinction vanishes (3, 4). Women, who have a lower peak muscle mass and longer lifespan, may suffer more from the consequences of low muscle mass compared to men (10). Muscle mass is the main determinant for muscle strength, however muscle strength and power have been found to decline more rapid than muscle mass with increasing age (19-21). Maintaining muscle mass does not inhibit loss of muscle strength, implying an age related loss of muscle quality (21). Many suggest that low muscle mass is a predictor of disease and disability. However, some have found that after adjusting for body fat mass, this association is no longer significant (22-24). Several studies have concluded that physical function, and not muscle mass, is associated with mortality (25, 26). Sarcopenia, a syndrome which comprises both low muscle mass and physical function, has been associated with functional decline, disability (10, 24, 27-29), and mortality (30, 31).
1.2 Definition of sarcopenia

The term sarcopenia originates from the Greek words “sarx” and “penia”, which can be translated to flesh and deficiency, respectively. It was first described by Irwin Rosenberg in 1989 (32). In 2009, the European Union Geriatric Medicine Society established the European Working Group on Sarcopenia in Older People (EWGSOP), aimed at creating operational definitions of sarcopenia. EWGSOP agreed that sarcopenia is defined as “a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength with risk of adverse outcomes such as physical disability, poor quality of life and death”. In practice, sarcopenia is present when muscle mass and muscle strength or physical performance are low (33). The syndrome is independent of changes in fat mass (33). Other groups have created similar definitions of sarcopenia. The International Working Group on Sarcopenia (IWGS), the Special Interest Group on Cachexia-Anorexia in Chronic Wasting Diseases created by the European Society for Clinical Nutrition and Metabolism (ESPEN) and the Foundation for the National Institutes of Health (FNIH) all agree that sarcopenia includes both loss of muscle mass and physical function (34-36). The Society of Sarcopenia, Cachexia and Wasting Disorders (SSCWD) describes sarcopenia with limited mobility as “a specific condition, with clear loss of muscle mass and a clear target for intervention” (37). These different definitions of sarcopenia are summarised in table 1.

EWGSOP has proposed a staging system for use in the clinical management of the syndrome. ‘Presarcopenia’ includes low muscle mass without low muscle strength and low physical performance. ‘Sarcopenia’ is the presence of both low muscle mass and either low muscle strength or low physical performance. ‘Severe sarcopenia’ is used when low muscle mass, low muscle strength and low physical performance are present (33). This staging system may be advantageous in treatment and by determining recovery goals. However more clinical inquiries are necessary to support this theoretical staging system. Sarcopenia has been suggested to be a geriatric syndrome, as it is most prevalent in the elderly (27, 38, 39). However, it may also affect young subjects, as it is associated with physical inactivity, malnutrition, neurodegenerative diseases, inflammatory diseases and cachexia, conditions not only seen in the elderly (34, 40). Sarcopenia is suggested by EWGSOP to be classified as primary and secondary. Primary is used when ageing is the only evident cause. Secondary is used when one or more causes are identified, such as sedentary lifestyle, disease-related factors or inadequate nutrition (33).
1.3 Diagnostic criteria of sarcopenia

1.3.1 Defining low muscle mass

Most organizations agree that sarcopenia includes both low muscle mass and physical function (33-36). Muscle mass can be estimated by several methods. In 1998, Baumgartner et al. defined skeletal muscle mass index (SMI) as appendicular skeletal muscle mass divided by height squared (kg/m\(^2\)) (27). Appendicular skeletal muscle mass is the sum of muscle mass in the four limbs. In that study, low muscle mass was defined as two SD below mean SMI measured by dual-energy x-ray absorptiometry (DXA) of healthy American subjects with mean age 29.2 years in the Rosetta study, and it was significantly associated with physical disability (27). Cut-offs for low muscle mass according to Baumgartner et al. were 5.45 kg/m\(^2\) for women and 7.26 kg/m\(^2\) for men (27). This method depends on estimation of muscle mass by DXA or bioelectrical impedance (BIA) (33). Similar cut-offs have been found by others using a different population (24, 44). One of these studies additionally adjusted muscle mass for body fat mass, which was conclusively recommended to be applied in women and overweight or obese individuals (44).

In year 2000, Janssen et al. developed a regression equation for calculating absolute muscle mass measured by BIA based on middle-aged Americans. SMI was then defined as absolute muscle mass divided by height squared (45), which differ from Baumgartner’s method using appendicular muscle mass (27). Cut offs to Janssen’s formula were based on muscle mass values identifying elevated risk for physical disability among Americans with mean age 71 years from the Third National Health and Nutrition Examination Survey (46). In women, moderate sarcopenia was present at 5.76-6.75 kg/m\(^2\) and severe sarcopenia at \(\leq\)8.50 kg/m\(^2\). In men, moderate sarcopenia was present at 8.51-10.75 kg/m\(^2\) and severe sarcopenia at \(\leq\)8.50 kg/m\(^2\) (46). In 2002, Janssen et al. also defined SMI as absolute skeletal muscle mass divided by body mass x 100 with its separate cut-offs (10).

Low muscle mass has frequently been defined as skeletal muscle mass two SD below mean muscle mass of healthy young persons of the same ethnic group (27). EWGSOP, ESPEN and SSCVD all recommend this approach (33, 34, 37). EWGSOP suggest among others using the methods from Baumgartner et al. (27) and Janssen et al. (45). IWGS suggest the use of appendicular fat free mass <20 percentile of healthy young adults (36). Fat free mass includes
all mass except fat mass. FNIH’s criteria for sarcopenia are more restrictive, and were based on developing cut-offs using a variety of large epidemiological studies (35).

1.3.2 Defining low physical function

ESPEN suggest a gait-speed <0.8 m/s as a cut-off point for risk of sarcopenia (34). IWGS and the SSCWD recommend a cut-off in gait speed at 1.0 m/s (36, 37), while EWGSOP recommend both 0.8 m/s and 1.0 m/s as cut-offs (33). SSCWD also include a 6 minute walking distance <400 m as cut-off. EWGSOP and ESPEN additionally suggest other well-established functional tests, such as handgrip strength <20kg in women and <30kg in men and total Short Physical Performance Battery (SPPB) score ≤8 (33, 34). FNIH suggest cut-offs for handgrip strength at 16 kg in women and 26 kg in men (35). Table 1 shows diagnostic criteria recommended by different groups. The diagnostic criteria of sarcopenia remain unclear. Furthermore, cut-off values that consider gender and ethnic differences are needed to fit different populations.

Table 1. Different diagnostic criteria of sarcopenia (modified after (47)).

<table>
<thead>
<tr>
<th>Specialist group</th>
<th>Definition</th>
<th>Diagnostic criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Working Group on Sarcopenia in Older People (EWGSOP) (33)</td>
<td>“Sarcopenia is a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength”</td>
<td>Low muscle mass (&gt;2 SD below mean) and low muscle strength (e.g., grip strength) or low physical performance (e.g., gait speed)</td>
</tr>
<tr>
<td>International Working Group on Sarcopenia (IWGS) (36)</td>
<td>“Sarcopenia is defined as the age-associated loss of skeletal muscle mass and function”</td>
<td>Low muscle mass (appendicular mass relative to height squared, i.e., ≤7.23 kg/m² in men and ≤5.67 kg/m² in women) and gait speed ≤1 m/s</td>
</tr>
<tr>
<td>ESPEN Special Interest Groups on Cachexia-anorexia in Chronic Wasting Diseases (34)</td>
<td>“Sarcopenia is a condition characterized by loss of muscle mass and muscle strength”</td>
<td>Low muscle mass (&gt;2 SD below mean) and gait speed &lt;8 m/s or reduced performance on any well-established functional tests</td>
</tr>
<tr>
<td>Society of Sarcopenia, Cachexia and Wasting Disorders (SSCWD) (37)</td>
<td>“Sarcopenia with limited mobility is a specific condition with clear loss of muscle mass and a clear target for intervention”</td>
<td>Low muscle mass (&gt;2 SD below mean) and gait speed ≤1 m/s or 6 minute walking distance &lt;400 m</td>
</tr>
<tr>
<td>Foundation for the National Institute of Health (FNIH) (35)</td>
<td>“Sarcopenia incorporate not only muscle mass but also elements such as strength and function”</td>
<td>Low muscle mass (appendicular lean mass relative to body mass index, i.e., &lt;0.789 in men and &lt;0.512 in women) and grip strength &lt;26 kg in men and &lt;16 kg in women</td>
</tr>
</tbody>
</table>
1.3.3 Other diagnostic criteria

Two questionnaires aimed at predicting sarcopenia without other measurements have been developed (48, 49). One of them is SARC-F, which has been validated in two studies (50, 51). It comprises five questions regarding lifting, walking, stair climbing and falls (49).

Furthermore, biological markers of inflammation and malnutrition, such as C-reactive protein, interleukin-6, tumor necrosis factor-alfa, albumin, haemoglobin, urinary creatinine, vitamin D, testosterone, insulin-like growth factor-1, products of oxidative damage and antioxidants are possible biomarkers of sarcopenia (52).

1.4 Methods to detect sarcopenia

EWGSOP has proposed several different techniques to evaluate the presence of sarcopenia (table 2). Low muscle mass and muscle strength or physical performance are included in the definition of sarcopenia.

1.4.1 Muscle mass

Muscle mass can be estimated by different methods. Computed tomography (CT) and magnetic resonance imaging (MRI) are considered as gold standard methods, which provide estimates for muscle mass that are accurate and reproducible. They separate fat from other soft tissues precisely, but the equipment is expensive and radiation exposure is a safety concern (53, 54). Alternative methods are 4-compartment model (53), air-displacement plethysmography (55), DXA (53), BIA, neutron activation (56), total or partial body potassium per fat free soft tissue (57), urinary excretion of creatinine (58), total body nitrogen (59) and anthropometry. DXA has been found to be highly correlated with MRI, CT and the 4-compartment model (53). It is cheaper, quicker, and emits less radiation than MRI and CT (60). However, different densitometers and software versions in DXA have given different estimates of muscle mass (61, 62).

BIA is a portable alternative to DXA (63). It is cheap, easy to use and it is readily reproducible (64). It has been found to correlate well with MRI and it is validated for multi-ethnic adults (45). BIA has also been found to correlate well with DXA (65-67). Some have found the estimates of fat free mass to be precise (66, 67), and estimates fat mass to be less precise (67). The accuracy and precision of BIA to predict muscle mass is generally
acceptable for population level studies (68) and it is the best option for field measurements (69).

Norman et al. found that BIA resistance and resistance normalized for height were associated with handgrip strength (70). Thus, BIA may be used as a clinically relevant measure of muscle function. With this method, age, gender, height, weight and the electric opposition of body tissues are used in multiple regression relationships to predict body composition (71). Body composition in healthy subjects who have no significant fluid or electrolyte imbalance, no body shape malformations and have BMI within the range of 16-34 kg/m$^2$ can be precisely determined by this method (72).

Anthropometry provides another indirect measure of muscle mass (73). Mid-upper arm circumference (MUAC) may give an indication on subjects in risk of having low muscle mass or physical function (74). Mid-arm muscle circumference (MAMC) can be calculated by withdrawing 3.14 times tissue skinfold thickness from MUAC, and it has been found to be strongly correlated to DXA (75). Landi et al. found that physical function was significantly correlated to MAMC. Furthermore, the highest third of MAMC had a lower risk of death when compared to the lowest third of MAMC in that study (76). A high correlation has also been found between DXA and skin-fold thickness (77). Calf circumference (CC) has been found to correlate with muscle mass, and a circumference <31 cm has been associated with disability (78). Anthropometric measures are questionable for individual use and not recommended for routine use in the recognition of sarcopenia (79).

### 1.4.2 Muscle strength and physical performance

EWGSOP suggest several methods to evaluate physical function, including handgrip strength, peak expiratory flow, short physical performance battery, gait speed, timed get-up-and-go test and stair climbing test, as shown in table 2 (33).

Strength in lower limb is more relevant than upper limb regarding gait speed and physical function. However, handgrip strength is often used as it has been correlated to lower extremity muscle strength (29). It may predict mobility and also clinical outcomes better than muscle mass (29). Handgrip strength has been correlated to incident disability for activities of daily living (80, 81), risk of falls (82), quality of life (83), long term disability onset, increased risk of complications, extended hospitalisation (84), and mortality (8, 26, 85, 86).
The method is cheap, valid and reliable (87-94), and it has been shown to decrease linearly between 50 and 85 years of age (95).

SPPB includes three elements. The first part evaluates balance by subjects standing with feet side by side, semi-tandem and tandem. The second part measures time spent walking four meters, and the third part evaluates strength by time used to rise from a chair and return to seated position five times (96). Each of these three elements has been associated with adverse health outcomes and all-cause mortality (85, 97). SPPB is well-validated and has been associated with disability, institutionalization, and mortality (96, 98-100). Gait speed alone has been shown to be valid and reliable (98, 101-105). It has been correlated to SPPB, stair climb, disability, risk of falls and adverse health outcomes (97, 98, 103, 104, 106-111). Cut-off points have been made for SPPB, thus the method is suitable in both clinical studies and the clinic (112, 113). Furthermore, SPPB has been recommended in clinical studies on frail older subjects as a measure of functional outcome (114).

A stair climb power test evaluates the ability to ascend a flight of stairs, as well as lower extremity strength, power and balance (115). The test may be done in several ways, with different number of stairs, different height of stairs, with a limited time or with a certain distance. It has been found to be consistent with other more complex methods for estimating leg power and also SPPB (115).

Table 2. Techniques to assess muscle mass, muscle strength and physical performance, as suggested by EWGSOP (33).

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Clinical practice</th>
<th>Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle mass</td>
<td>Bioelectrical impedance analysis</td>
<td>Computed tomography</td>
</tr>
<tr>
<td></td>
<td>Dual energy X-ray absorptiometry</td>
<td>Magnetic resonance imaging</td>
</tr>
<tr>
<td></td>
<td>Anthropometry</td>
<td>Bioelectrical impedance analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total or partial body potassium</td>
</tr>
<tr>
<td>Muscle strength and physical performance</td>
<td>Handgrip strength</td>
<td>Handgrip strength</td>
</tr>
<tr>
<td></td>
<td>Short physical Performance Battery</td>
<td>Peak expiratory flow Battery</td>
</tr>
<tr>
<td></td>
<td>Usual gait speed</td>
<td>Short physical Performance</td>
</tr>
<tr>
<td></td>
<td>Get-up-and-go test</td>
<td>Usual gait speed</td>
</tr>
<tr>
<td></td>
<td>Stair climb power test</td>
<td>Get-up-and-go test</td>
</tr>
</tbody>
</table>
1.5 Prevalence of sarcopenia

In a systematic review, the prevalence of sarcopenia is indicated to vary between 1% and 29% in community-dwelling populations (116). This large dispersal may be due to real differences, such as age, socio-economic- and anthropometric states, in the populations studied, different definitions of sarcopenia, use of different cut-off values derived from different reference populations, or it may be due to different methods used to estimate muscle mass, muscle strength or physical performance. Many studies have used only low muscle mass as criteria for sarcopenia, which may partly explain the large differences in the prevalence in the literature.

Most papers conclude that sarcopenia increases with age (117-119). Some studies have found that sarcopenia is more prevalent in men than in women (39, 63, 120), while others have found the opposite (10, 77). In most studies, there is no significant difference between genders (30, 121-123). When applying diagnostic criteria of sarcopenia in younger patients, underestimation may occur. The variety in practice regarding the recognition of sarcopenia makes research results difficult to interpret and possibly misleading. EWGSOP recently proposed low muscle mass and low muscle function assessed as low muscle strength and/or low physical performance as diagnostic criteria for sarcopenia (33). In the current Thesis, a systematic literature search was conducted comprising papers using EWGSOP criteria at estimating the prevalence of sarcopenia. Search strategy is described in section 3.8.

1.5.1 Prevalence of sarcopenia in studies using DXA to estimate muscle mass

Most studies using DXA to estimate muscle mass, calculate SMI as appendicular muscle mass divided by height squared (table 3). A few studies have adjusted appendicular muscle mass to weight or body mass index (BMI), and some have used residual methods. Different cut-offs have been derived when applying appendicular muscle mass divided by height. Among articles included in the literature search, cut-off values range from 4.32 to 6.70 kg/m² in women and 6.39 to 8.12 kg/m² in men. The prevalence of sarcopenia varies from 1.3 to 63.3% in total, 0.3 to 58.7% in women and 0.5 to 53.2% in men. Handgrip strength is used in all studies except one. Cut-offs range from 14.3 to 24.4 kg in women and 22.4 to 36.6 kg in men. However, different devices have been used to measure handgrip strength, making comparison between studies difficult. Gait speed is used by many, with cut-off ranging from 0.8 to 1.0
m/s. There is no obvious trend in how assessment methods regarding muscle mass or physical function affect the prevalence of sarcopenia.

1.5.2 Prevalence of sarcopenia in studies using BIA to estimate muscle mass

When BIA is used to estimate muscle mass, height adjusted appendicular mass or height adjusted absolute muscle mass are used most frequently (table 4). Absolute muscle mass is calculated by the formula created by Janssen et al (46). One study adjusted absolute muscle mass to weight, while three studies used height adjusted fat free mass. Different cut-offs have been derived when applying appendicular muscle mass divided by height. Among articles included in the literature search, cut-off values range from 5.07 to 6.42 kg/m² in women and 6.75 to 8.87 kg/m² in men. The resulting prevalence of sarcopenia ranges from 2.5 to 22.1 % in women and 5.4 to 21.8 % in men. When using height adjusted absolute muscle mass, cut-off values range from 5.67 to 7.0 kg/m² in women and 7.7 to 10.75 kg/m² in men. When this method to estimate muscle mass is applied, the prevalence of sarcopenia ranges from 3.7 to 34.2 % in women and 5.6 to 25.0 % in men. Handgrip strength is used in all studies. Cut-offs range from 14.6 to 21.0 kg in women and 25.0 to 36.6 kg in men. Gait speed is used by many, with cut-offs ranging from 0.57 to 1.26 m/s.

1.5.3 Prevalence of sarcopenia in studies using alternative measures to estimate muscle mass

Table 5 demonstrates the prevalence of sarcopenia in studies using alternative measures to estimate muscle mass. Studies using CC have set 31 cm as cut-off for predicting low muscle mass. Different cut-offs are set in studies using skinfold thickness, MUAC, or a mathematical formula estimating appendicular muscle mass. The prevalence of sarcopenia ranges from 6.1 to 33.6, 3.9 to 37.3 and 21.8 to 31.4 by using CC, SFT and MAMC, respectively. Handgrip strength is used in all studies, with cut-offs at 20 to 20.7 kg in women and 30 to 36.6 kg in men. Many have also included gait speed at 0.8 m/s as cut-off for low physical function.
<table>
<thead>
<tr>
<th>Reference</th>
<th>Publication year</th>
<th>Country</th>
<th>n (% female)</th>
<th>Age, years</th>
<th>Assessment method</th>
<th>Physical test (cut-off)</th>
<th>Total</th>
<th>Sarcopenia prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>(124)</td>
<td>2014</td>
<td>France</td>
<td>1421 (61)</td>
<td>63.1 (10.2)</td>
<td>1 (5.457/26)</td>
<td>HS (20/30)</td>
<td>15.6</td>
<td>15.6</td>
</tr>
<tr>
<td>(125)</td>
<td>2015</td>
<td>Belgium</td>
<td>250 (63)</td>
<td>74.1 (6.4)</td>
<td>1 (5.5/26)</td>
<td>HS (20/30)</td>
<td>14.0-27.6</td>
<td>-</td>
</tr>
<tr>
<td>(126)</td>
<td>2014</td>
<td>Australia</td>
<td>680 (65)</td>
<td>79 (-)</td>
<td>1 (5.5/26)</td>
<td>HS (20/30)</td>
<td>50.8</td>
<td>58.7</td>
</tr>
<tr>
<td>(31)</td>
<td>2013</td>
<td>USA</td>
<td>319 (61)</td>
<td>59.2 (4.4)</td>
<td>1 (5.5/6.4)</td>
<td>GS (0.8)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(127)</td>
<td>2013</td>
<td>France</td>
<td>3025 (100)</td>
<td>80.5 (3.9)</td>
<td>1 (5.6)</td>
<td>HS (-)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(128)</td>
<td>2013</td>
<td>Finland</td>
<td>409 (100)</td>
<td>74.2 (3.0)</td>
<td>1 (5.5)</td>
<td>HS (0.8/1.0)</td>
<td>3.3-5.2</td>
<td>-</td>
</tr>
<tr>
<td>(129)</td>
<td>2014</td>
<td>Belgium</td>
<td>400 (61)</td>
<td>73.9 (-)</td>
<td>1 (5.5/7.26)</td>
<td>GS (0.8)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(130)</td>
<td>2014</td>
<td>Brazil</td>
<td>132 (61)</td>
<td>70.2 (6.6)</td>
<td>1 (5.5/7.26)</td>
<td>HS (20/30)</td>
<td>9.3-18.0</td>
<td>6.6</td>
</tr>
<tr>
<td>(131)</td>
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<td>Taiwan</td>
<td>1008 (49)</td>
<td>65.2 (9.3)</td>
<td>1 (5.9/0.7)</td>
<td>HS (16/25)</td>
<td>9.6</td>
<td>9.8</td>
</tr>
<tr>
<td>(132)</td>
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<td>Japan</td>
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<td>1 (6.70)</td>
<td>HS (24/4)</td>
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<td>2013</td>
<td>England</td>
<td>679 (0)</td>
<td>59.6 (10.7)</td>
<td>1 (7.26)</td>
<td>HS (29-32)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(133)</td>
<td>2013</td>
<td>Taiwan</td>
<td>681 (48)</td>
<td>61.4 (7.0)</td>
<td>1 (-)</td>
<td>HS (-)</td>
<td>5.0</td>
<td>-</td>
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<td>(134)</td>
<td>2014</td>
<td>Iceland</td>
<td>10063 (29)</td>
<td>-</td>
<td>1 (5.67/7.23)</td>
<td>GS (-)</td>
<td>13.0</td>
<td>13.3</td>
</tr>
<tr>
<td>(135)</td>
<td>2014</td>
<td>Britain</td>
<td>1566 (52)</td>
<td>-</td>
<td>1 (5.67/7.23)</td>
<td>HS (16/26/20/30)</td>
<td>11.8</td>
<td>13.3</td>
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<td>(136)</td>
<td>2015</td>
<td>Taiwan</td>
<td>771 (47)</td>
<td>74.0 (-)</td>
<td>1 (4.84/6.39)</td>
<td>HS (20/30)</td>
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<td>2.6</td>
</tr>
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<td>(137)</td>
<td>2014</td>
<td>China</td>
<td>101 (0)</td>
<td>88.8 (3.7)</td>
<td>1 (6.85)</td>
<td>HS (0.8/1.0)</td>
<td>9.7</td>
<td>12.5</td>
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<td>(138)</td>
<td>2013</td>
<td>Taiwan</td>
<td>408 (42)</td>
<td>73.7 (5.6)</td>
<td>1 (4.47/7.27)</td>
<td>HS (22.4)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(139)</td>
<td>2014</td>
<td>Australia</td>
<td>986 (38)</td>
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<td>1 (4.32/6.89)</td>
<td>HS (20/30)</td>
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<td>0.3</td>
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<tr>
<td>(140)</td>
<td>2013</td>
<td>USA</td>
<td>2176 (57)</td>
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<td>5 (-1.4/2-2.15)</td>
<td>HS (20/30)</td>
<td>7.2</td>
<td>8.5</td>
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<tr>
<td>(77)</td>
<td>2013</td>
<td>England</td>
<td>103 (0)</td>
<td>72.5 (2.5)</td>
<td>6 (-)</td>
<td>HS (20/30)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Age, mean (SD); sarcopenia prevalence, %; HS, handgrip strength; GS, gait speed; SPPB, Short Physical Performance Battery. Formula (cut-off), women/men. Physical test (cut-off), HS, kg; GS, m/s; SPPB, total score. 1, appendicular muscle mass/height² (kg/m²); 2, appendicular muscle mass/BMI; 3, appendicular muscle mass/weight*100; 4, absolute muscle mass/weight*100; 5, residual method; 6 lowest third of lean mass.
Table 4. Prevalence of sarcopenia in studies using BIA to estimate muscle mass.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Publication year</th>
<th>Country</th>
<th>n (% female)</th>
<th>Age, years</th>
<th>Assessment method</th>
<th>Sarcopenia prevalence</th>
</tr>
</thead>
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<tr>
<td>(41)</td>
<td>2013</td>
<td>Japan</td>
<td>1882 (70)</td>
<td>74 (5.5)</td>
<td>1 (5.5/0.75)</td>
<td>HS (20/30)</td>
</tr>
<tr>
<td>(141)</td>
<td>2014</td>
<td>Taiwan</td>
<td>2867 (50)</td>
<td>74 (6)</td>
<td>1 (5.9/6.76)</td>
<td>HS (14.6-15.0/0.7-2.6)</td>
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<tr>
<td>(123)</td>
<td>2014</td>
<td>Japan</td>
<td>1110 (66)</td>
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<td>1 (5.8/7.0)</td>
<td>HS (14.6-15.0/0.7-2.6)</td>
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<tr>
<td>(142, 143)</td>
<td>2014</td>
<td>Japan</td>
<td>1971 (50)</td>
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<td>1 (5.8/7.0)</td>
<td>HS (14.6-15.0/0.7-2.6)</td>
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<tr>
<td>(144)</td>
<td>2014</td>
<td>Japan</td>
<td>1000 (65)</td>
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<td>1 (5.8/7.0)</td>
<td>HS (14.6-15.0/0.7-2.6)</td>
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<td>(145)</td>
<td>2014</td>
<td>Japan</td>
<td>1158 (69)</td>
<td>74.1 (-)</td>
<td>1 (5.8/7.0)</td>
<td>G (16.0-15.0/0.7-2.6)</td>
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<tr>
<td>(146)</td>
<td>2014</td>
<td>Japan</td>
<td>4811 (51)</td>
<td>72.1 (-)</td>
<td>1 (5.9/7/0.9)</td>
<td>HS (18-22/8.8)</td>
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<td>Belgium</td>
<td>250 (63)</td>
<td>74.1 (6.4)</td>
<td>1 (6.4/8.8)</td>
<td>G (16.0-15.0/0.7-2.6)</td>
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<tr>
<td>(119)</td>
<td>2014</td>
<td>Taiwan</td>
<td>549 (48)</td>
<td>76.0 (6.2)</td>
<td>7 (5.6/7.7)</td>
<td>HS (17-21/29-32)</td>
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<td>Italy</td>
<td>730 (54)</td>
<td>77.1 (5.5)</td>
<td>7 (6.4/8.8)</td>
<td>HS (17-21/29-32)</td>
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<tr>
<td>(147)</td>
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<td>Belgium</td>
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<td>84.8 (3.6)</td>
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<td>HS (20/30)</td>
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<tr>
<td>(74)</td>
<td>2014</td>
<td>USA</td>
<td>80 (34)</td>
<td>54.0 (-)</td>
<td>7 (6.7/10.7)</td>
<td>HS (17-21/29-32)</td>
</tr>
<tr>
<td>(130)</td>
<td>2014</td>
<td>Brazil</td>
<td>132 (61)</td>
<td>70.2 (6.6)</td>
<td>7 (5.7/8.50)</td>
<td>HS (20/30)</td>
</tr>
<tr>
<td>(42)</td>
<td>2014</td>
<td>Brazil</td>
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<td>70.7 (7.0)</td>
<td>8 (14/6/18.1)</td>
<td>HS (20/30)</td>
</tr>
<tr>
<td>(148)</td>
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<td>Korea</td>
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<td>8 (-)</td>
<td>HS (20/30)</td>
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<tr>
<td>(122)</td>
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<td>Canada</td>
<td>85 (51)</td>
<td>75.2 (5.7)</td>
<td>8 (-)</td>
<td>HS (20/30)</td>
</tr>
</tbody>
</table>

Age, mean (SD); sarcopenia prevalence, %; HS, handgrip strength; GS, gait speed; SPPB, short physical performance battery. Formula (cut-off), women/men. Physical test (cut-off): HS, kg; GS, m/s; SPPB, total score. 1, appendicular muscle mass/height²; 4, absolute muscle mass/weight*100; 7, absolute muscle mass/height²; 8, fat free mass/height².
Table 5. Prevalence of sarcopenia in studies using alternative measures to estimate muscle mass.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Publication year</th>
<th>Country</th>
<th>n (% female)</th>
<th>Age, years</th>
<th>Assessment method</th>
<th>Physical test (cut-off)</th>
<th>Sarcopenia prevalence</th>
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<tr>
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<td>Estimate on muscle mass (cut-off)</td>
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<td>Female</td>
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<tr>
<td>(130)</td>
<td>2014</td>
<td>Brazil</td>
<td>132 (61)</td>
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<td>CC (31)</td>
<td>6.1</td>
<td>7.5</td>
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<tr>
<td>(149)</td>
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<td>Mexico</td>
<td>345 (53)</td>
<td>78.5 (7.0)</td>
<td>CC (31)</td>
<td>33.6</td>
<td>-</td>
</tr>
<tr>
<td>(150)</td>
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<td>Netherlands</td>
<td>635 (46)</td>
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<td>CC (31)</td>
<td>12.9</td>
<td>-</td>
</tr>
<tr>
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<td>Netherlands</td>
<td>884 (49)</td>
<td>-</td>
<td>CC (31)</td>
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<td>-</td>
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<td>Brazil</td>
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<td>SKF-LBMI (14.6/18.1)</td>
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<td>1787 (57)</td>
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<td>GS (0.8)</td>
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<tr>
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<td>Equation (6.37/8.90)</td>
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<td>-</td>
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<tr>
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<td>2014</td>
<td>Brazil</td>
<td>1149 (60)</td>
<td>69.6 (0.6)</td>
<td>MAMC (20.1-20.7/34.7-36.6)</td>
<td>15.4</td>
<td>16.1</td>
</tr>
</tbody>
</table>

Age, mean (SD); sarcopenia prevalence, %; HS, handgrip strength; GS, gait speed. Estimate on muscle mass (cut-off), women/men. Physical test (cut-off): HS, kg; GS, m/s; SPPB, total score. CC, calf circumference in cm; SKF-LBMI, skinfold thickness-lean body mass index; MAMC, mid-upper arm circumference - (3.14 * triceps skinfold thickness); equation, equation for appendicular muscle mass divided by height$^2$. 
1.6 Sarcopenic obesity

Age-related reduction of muscle mass and strength may be independent of changes in body weight. Fat mass may be preserved or increased simultaneous as muscle is degraded (154), which is the case in sarcopenic obesity (155). An average adult may expect to gain 0.45 kg of fat mass and loose about 0.23 kg of muscle mass each year between age 30 and 60 (156). The state in which fat infiltrates muscle cells is called myosteatosis. This results in lower muscle quality and reduced physical strength and performance (157, 158). Myosteatosis increases with body fatness, and it has been shown to increase with age regardless of changes in body weight (159). In a study including older subjects, strength training decreased intramuscular fat accumulation (160).

Sarcopenic obesity has been associated with disability, gait problems and falls more strongly than ordinary sarcopenia (24, 161-164). Additionally, myosteatosis has been shown to increase all-cause mortality (165). A positive relationship between BMI and functional disability and limitation has been described (166). Sarcopenic obesity has been reported to affect 8.4 % of women and 17.5 % of men aged 80 years or older (167). However, the prevalence varies considerably between studies. When muscle mass is considered as a fraction of body weight compared to height, fat mass is of importance. Fat mass should be taken into account when recognizing sarcopenia in overweight or obese subjects (44).

1.7 Sarcopenia-related conditions

Sarcopenia may overlap with other syndromes associated with muscle wasting, such as frailty and cachexia. Frailty is a common syndrome among elderly. It includes unintended weight loss, exhaustion, weakness, slow gait speed, and low physical activity (168). Frailty also involves psychological and social factors. In a systematic review on community-dwelling individuals ≥65 years, the prevalence of frailty was estimated to 10.7 % (169). Sarcopenia is prevalent in frail individuals, but not all sarcopenic individuals are frail (33, 170). The overlap between sarcopenia and frailty is demonstrated in figure 1.
There are many definitions of cachexia. One of them expresses that cachexia is a “multifactorial syndrome defined by an ongoing loss of skeletal muscle mass (with or without loss of fat mass) that cannot be fully reversed by conventional nutritional support and leads to progressive functional impairment” (172). Sarcopenia is a part of cachexia, but most sarcopenic persons do not have cachexia (33, 173). Furthermore, dynapenia and muscle fatigue are terms related to muscle function. Dynapenia has been referred to as age-related loss of muscle strength (174), and muscle fatigue can be defined as “an inability of a muscle or a group of muscles to sustain the required or expected force” (175).

1.8 Suggested mechanisms of sarcopenia

Several mechanisms may be involved in the onset and progression of sarcopenia both within individuals and between individuals, as shown in Figure 2. In healthy muscle there is an equilibrium between protein synthesis and breakdown (176). This is not the case in sarcopenia. Physical inactivity is suggested as a major underlying cause to sarcopenia (177). This is reflected in several possible molecular mechanisms. Muscle fiber size and muscle fiber number have been found to decline, while myosteatosis has been reported to increase with age (34, 36, 47, 178, 179). A reduction in intensity of activity with increasing age, has been shown to result in a decline in type II muscle fibers and preservation of type I muscle fibers (180-182), thus affecting physical performance.
Loss of muscle mass may also be a result of anorexia of ageing (121, 183, 184). Another age-related cause of sarcopenia is an increase in mitochondrial abnormalities (185), resulting in apoptosis of muscle cells.

With increasing age, the production of nitric oxide and the capillary function decline. These changes may result in lower blood flow to muscles (185), thus affecting muscle function. Also, age-related insulin resistance may lead to less available glucose and proteins for muscle anabolism (186-189). The level of anabolic hormones declines with increasing age (190, 191), but this cannot explain loss of muscle mass or muscle strength alone. Alterations in neuromuscular activation, like loss of motor end plates and peripheral neuropathy, may have an impact on muscle mass and strength (192-195). Regarding nutritional status, protein intake, total energy intake and vitamin D status have been shown to affect the development of sarcopenia (196-200). Furthermore, certain pro-inflammatory cytokines may promote protein catabolism (201, 202), thus resulting in declined muscle mass.

Recognition of the mechanisms of sarcopenia is important for designing intervention studies for prevention or treatment of the syndrome. In addition to these molecular mechanisms, medical conditions like atherosclerosis, stroke, diabetes mellitus, heart failure and pulmonary disease have been shown to result in loss of muscle mass or strength (203-213). The role of genetics in the development of sarcopenia is not fully established (214-217).

**Figure 2.** Suggested mechanisms of sarcopenia. From Morley et al. (218), reprinted with kind permission from Springer Science+Business Media.
1.9 Prevention and treatment

Suggested risk factors for sarcopenia include age, low levels of physical activity, inadequate nutrition and comorbidity (38). Sarcopenia should be regarded as a preventable and treatable condition. Treatments including physical activity, nutritional therapies, androgen therapy, and other behavioural and pharmacological strategies are currently under investigation (36). Resistance exercise is the primary therapeutic approach to prevent and reverse sarcopenia (219-226). Substantial improvements in both muscle mass and muscle strength are seen with strength training in older adults (227). The increase in strength after resistance training is found to be higher than the increase in muscle mass in older adults (228). Resistance training has been shown to improve gait speed, stair climbing and overall strength (220). A therapeutic effect has also been suggested regarding aerobic exercise (229).

Protein intake has been associated with changes in lean mass in the elderly (230). Protein requirement is possibly higher in older than in younger subjects (231, 232). Dietary intake of 1.2-1.5 g/kg of protein has been reported to prevent sarcopenia (233). Nordic nutrition recommendations suggest a protein intake of 15-20 E%. A protein intake of 18 E% corresponds to about 1.2 g protein per kilo body weight and day (234). Twenty-five to thirty gram of high quality protein is suggested to be ingested each meal (235). Supplementation of essential amino acids has been shown to increase handgrip strength and gait speed (236). Furthermore, leucine-enriched essential amino acid supplementation has been shown to increase muscle mass and possibly muscle function (235, 237, 238). Vitamin D deficiency may double the risk of sarcopenia (199). Supplementation of vitamin D may enhance muscle function in persons with low muscle function (239, 240).

Pharmacological treatments of sarcopenia have not yet shown any significant efficacy in the treatment of the condition (241). Agents that may potentially increase muscle mass and muscle strength are testosterone (242-245), selective androgen receptor modulators (246), antibodies that modulate myostatin and the activin II receptor (247), ghrelin agonists (248), creatine (249-251), estrogens, growth hormones and angiotensin-converting enzyme inhibitors (252).
2 Objectives

The primary objective of this Thesis is to provide more knowledge about the prevalence of sarcopenia among community-dwelling elderly living in the municipality of Skedsmo, Norway, who agreed to participate in the current study. The following secondary objectives are appointed:

- Describing the prevalence of reduced muscle mass measured by bioelectrical impedance and estimated by two equations (by Baumgartner et al. and Janssen et al.) in the above mentioned group.

- Describing the prevalence of reduced muscle strength measured by handgrip strength and reduced physical performance measured by gait speed in the above mentioned group.

- Describing the prevalence of sarcopenia, comprising low muscle mass and low muscle strength or physical performance as suggested by EWGSOP in the above mentioned group.
3 Subjects and methods

3.1 Recruitment and collection of data

3.1.1 Study population

Community-dwelling men and women aged 70 years or more living in the municipality of Skedsmo, Norway, were invited for study participation (appendix 1). Contact information was collected from the Norwegian tax-administration. They received invitations by post in the time period August 2014 to December 2014. Written informed consent was signed by participants before involvement. The study was sanctioned by the Regional Committee for Medical and Health Research Ethics, Oslo, Norway (appendix 2). No exclusion criterion was set for participation. One thousand six hundred and thirteen participants were invited, and 260 replied, giving a response rate at 16.1 % (figure 3).

![Flow chart of inclusion of participants](image)

**Figure 3.** Flow chart of inclusion of participants. * Reasons for withdrawal were unknown (n = 18), disease (n = 2), lack of time (n = 1), and participation after collection of data was ended (n = 3).

3.1.2 Study visit

Participants met once at Oslo and Akershus University College of Applied Sciences, campus Kjeller. At the study visit subjects answered questionnaires regarding quality of life and appetite, took blood samples, delivered urinary test, measured blood pressure, height, weight,
and circumferences of waist, hip, upper arm and calf. Body composition was estimated by bioelectrical impedance analysis. The participants were interviewed regarding diet, health, physical activity and cognition. Furthermore, they conducted several physical tests. The visit took two to three hours. This paper is one of two Master Thesis in the AMARONE-project. The title of the other Master Thesis is «Nutritional status and protein intake in elderly community-dwelling men and women». Appendix 9 shows data included in the two Master Thesis in the AMARONE-project. Only cross-sectional data were included in this paper.

3.2 Anthropometric measures

3.2.1 Height

Holtain limited was used to measure height. Height was measured without shoes. Subjects were asked to stand with feet together. Heels, hip and upper back were placed up to the height measurement. Head should be kept in a horizontal position (appendix 3). Height was noted to the nearest mm.

3.2.2 Waist circumference

Waist circumference was measured on naked skin in the middle of lower coastal arch and top of the iliac crest (appendix 3). Subjects should breathe normally and relax during registration. The distance between the measuring tape and skin was minimized, however not tightened. Measures should be read with eyes at the same level as the measuring tape. Measures were noted to the nearest cm.

3.2.3 Hip circumference

Hip circumference was measured outside trousers on the widest part of the hip (appendix 3). The distance between the measuring tape and skin was minimized. Measures should be read with eyes at the same level as the measuring tape. Measures were noted to the nearest cm.

3.2.4 Mid-upper arm circumference (MUAC)

MUAC was measured on the non-dominant arm. The centre of the upper arm was found in the middle of the acromion area on scapula and olecranon. MUAC was measured when the
subject’s arm was relaxed and facing downwards (appendix 3). The distance between the measuring tape and skin was minimized, however not tightened. Measures should be read with eyes at the same level as the measuring tape. Measures were noted to the nearest cm.

3.2.5 Calf circumference (CC)

CC was measured on the non-dominant foot bent orthogonally in the knee joint. The thickest area on bare skin was measured as the subject was relaxed (appendix 3). The distance between the measuring tape and skin was minimized. Measures should be read with eyes at the same level as the measuring tape. Measures were noted to the nearest cm.

3.3 Measure of muscle mass

BIA is a simple, inexpensive, quick and non-invasive technique for estimating body composition. In this study the body composition analyzer Tanita BC-418 MA was used. It cannot be used in subjects with implants leading electricity like pacemakers. In that case a Soehnle professional digital weight was used. Data were typed in on the instrument as shown in appendix 3. One kg was withdrawn for clothes. Subjects were asked to go to the toilet if needed and climb the weight without shoes, socks and heavy belongings. Measures were conducted with subjects standing in supine position, with legs apart and arms not touching the torso. Subjects were asked to hold handles in both hands.

The mechanisms of Tanita BC-418 are described in the instruction manual. Tanita calculates body composition by using a regression formula based on data obtained from DXA. Eight electrodes are positioned so that high frequency electric current is supplied from the tips of the toes of both feet and the fingertips of both hands, and voltage is measured on the heel of both feet and the thenar side of both hands. This allows impedance measurements in the whole body, right leg, left leg, right arm and left arm. Impedance reflects the body’s inherent resistance to an electrical current. Muscle tissue, which contain substantial amounts of water, act as a conductor of the electrical current, while adipose tissue act as a resistor of the electrical current. Additionally, weight, BMI, basal metabolic rate, fat percent, fat mass, fat free mass and total body water are printed when the registration is completed.
There are several methods for estimating muscle mass. In this assignment low muscle mass was estimated by two methods as suggested by EWGSOP:

1. Baumgartner et al. (27): SMI = appendicular muscle mass/height\(^2\) (kg/m\(^2\)).
   Appendicular muscle mass = muscle mass in both legs and both arms.
   Low muscle mass: SMI < 5.5 kg/m\(^2\) in women and < 7.26 kg/m\(^2\) in men.

2. Janssen et al. (45): SMI = absolute muscle mass/height\(^2\) (kg/m\(^2\)).
   Absolute muscle mass = \((\text{height}^2 / \text{bioelectrical impedance analysis resistance} \times 0.401)\) + (gender \(\times 3.825\)) + (age \(\times -0.071\)) + 5.102.
   Height, cm; bioelectrical impedance analysis resistance, ohms; gender, men = 1 and women = 0; age, years.
   Low muscle mass: SMI \(\leq 6.76\) kg/m\(^2\) in women and \(\leq 10.76\) kg/m\(^2\) in men (46).

### 3.4 Measure of physical function

Sarcopenia was present with reduced SMI and reduced handgrip strength or reduced gait speed. In this Thesis other tests were conducted in addition, though not included in the recognition of sarcopenia, as shown in table 6.

#### 3.4.1 Handgrip strength

The purpose of the handgrip strength test is measuring muscle strength. Equipment needed to conduct the handgrip strength test were a chair without armrests and a dynamometer. Tester chose between dynamometers of 20, 40 and 80 kg. Handgrip strength was measured using the KE-MAP80K1 dynamometer, with participants seated, their elbow by their side flexed in 90 degrees and a neutral wrist position (appendix 4). The participants were asked to squeeze the dynamometer as hard as possible simultaneous as breathing out. Shaking of hands and a practical trial were executed before testing. Hand dominance was noted. Three measurements were done on each hand with at least 20 seconds in between. Force was noted to the nearest 0.1 kg. The protocol for handgrip strength was modified after National Health and Nutrition Examination Survey Muscle Strength Procedures Manual (253). Maximum handgrip results < 20 kg in women and < 30 kg in men were categorized as reduced (33).
3.4.2 Short Physical Performance Battery (SPPB)

SPPB measures physical performance, and comprises balance, gait, strength and endurance. It evaluates the subject’s ability to stand with the feet together in different positions, time to walk four meters, and time to rise from a chair and sit down five times (96). The tests were conducted in the same order in all subjects. Equipment needed to conduct SPPB were a stop watch, measuring tape, coloured marking tape and a chair. The chair used in the current study was straight-backed without armrests and with a seat height of 46 cm. The participants were recommended to wear comfortable footwear. Timing started when the tester said “Ready, set, go”. Time was noted to the nearest 100th of a second. If an assistive device was used it was recorded. A total SPPB score was given (appendix 5).

In the balance test the participants were asked to stand with feet together in three different positions; side by side, semi-tandem and full-tandem for ten seconds (figure 4). The subjects had to be able to stand without help. The tester could help the participators into the starting position, and had to stand by their side in case of loss of balance. If the participators couldn’t hold the position in 10 seconds, the time was noted, and the subjects continued to the four meter gait speed test.

**Figure 4.** Illustration of the three balance positions in SPPB.

For the four meter gait speed test, the start and end were marked with easily recognizable coloured marking tape. The subjects stood with both feet close up to the starting line, and were asked to walk four meters in a bit faster than regular pace. The tester walked behind and next to the participators. The timing stopped when the subjects’ first heel passed the finish line. The test was executed two times. The fastest result was used in the calculation of speed (m/s). Gait speed <1m/s implied reduced gait speed (33).

For the rise and sit down test, a chair without armrests was placed against a wall, ensuring it didn’t slide backwards. The participants sat with 90 degrees in knee- and hip joint with arms on the chest. They were asked to rise and sit down on a chair five times as fast as possible. Participants should have 180 degrees in knee- and hip joint in up-raised position and return to 90 degrees in knee- and hip joint in seated position. The tester counted loudly the number of
repetitions. The test terminated if the participators got tired, breathless, used their arms to rise, if the time exceeded one minute or if the tester was worried about the subject’s safety. One trial was performed. Results >12.5 seconds indicated reduced performance. Average values from a study conducted by Solberg et al (254) were used to determine this cut-off in consultation with the Norwegian School of Sport Sciences. Each of the three tests included in SPPB gave a maximal score of four points, giving a maximal score of 12 points in SPPB in total. A total SPPB score ≤8 was categorized as reduced performance (33).

3.4.3 Stair climbing test

The purpose of the stair climbing test is measuring ascending stair activity, which has been found to be a relevant measure of leg power impairments (115). Equipment needed to conduct the test were a stop watch and a stair. The stair included in this study had 16 steps, each 17.8 cm high with little traffic or other external distractions. Participants were informed to bring comfortable shoes for this test. Subjects were asked to ascend the stair as fast as possible in a safe way (appendix 6). The participators could use the hand rail or walking aid, and this should have been noted. Tester stood on top of the stair, or walked behind apparently instable participants as they moved up the stair. A practical trial was offered before testing. Timing began when tester said “ready, set, go”, and ended when the participant had both feet at the top level. The time was recorded to the nearest 100th of a second. The test was terminated if the participator got tired, breathless or if tester was worried about the subject’s safety. The stair climbing test was performed two times with at least two minutes in between. The fastest time was counting regarding classification of performance. Stair climbing test >8.4 seconds was categorized as reduced. Average values from a study conducted by Solberg et al (254) were used to determine this cut-off in consultation with the Norwegian School of Sport Sciences.
Table 6. Cut-offs in measures of muscle mass and physical function. Sarcopenia involved reduced SMI and reduced handgrip strength or reduced gait speed in the current study.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Cut-off women</th>
<th>Cut-off men</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMI (Baumgartner), kg/m²</td>
<td>5.5</td>
<td>7.26</td>
</tr>
<tr>
<td>SMI (Janssen), kg/m²</td>
<td>6.76</td>
<td>10.76</td>
</tr>
<tr>
<td>Handgrip strength, kg</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Stair climbing test, seconds</td>
<td>8.4</td>
<td>8.4</td>
</tr>
<tr>
<td>Gait speed, m/s</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Rise and sit test, seconds</td>
<td>12.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Total SPPB score</td>
<td>≤8</td>
<td>≤8</td>
</tr>
</tbody>
</table>

SMI (Baumgartner), appendicular muscle mass/height². Appendicular muscle mass = muscle mass in both legs and both arms.

SMI (Janssen), absolute muscle mass/height². Absolute muscle mass = (height²/bioelectrical impedance analysis resistance × 0.401) + (gender × 3.825) + (age × 0.071)] + 5.102, where height is measured in centimetres; bioelectrical impedance analysis resistance is measured in ohms; for gender, men = 1 and women = 0; and age is measured in years.

SMI, skeletal muscle index; SPPB, short physical performance battery.

3.5 Mini Nutritional Assessment (MNA)

MNA is an easy and quick screening tool that can be used to identify elderly individuals who are in risk of or have established malnutrition. It is a non-invasive, inexpensive, specific, reliable and well-validated method (255). It includes questions regarding appetite, weight changes, mobility, psychological state, acute illness, BMI, medications, skin-deep, number of daily meals, intake of protein, fruit, vegetables and fluid, self-assessed nutritional status and health, MUAC and CC (appendix 7). Questions were consistently asked the same way, non-leadingly. A total MNA score was given reflecting nutritional status. A score of 24-30 points implies no nutritional risk, a score of 17-23.5 points implies risk of malnutrition and <17 points implies malnutrition.

3.6 Mini-Mental State Examination (MMSE)

MMSE is a sensitive, valid and reliable 30-point questionnaire evaluating cognitive function (256). It tests a number of different mental abilities like registration, attention, calculation, recall, language, ability to follow simple commands and orientation (appendix 8). If every answer are correct a total score of 30 points is given. Normal cognition is indicated in scores greater than or equal to 27 points. Twenty four points or less indicates cognitive impairment (257).
3.7 Blood samples

Blood samples were collected in all participants and analysed by Fürst Medical Laboratory. Parameters assessed and used in this study were HbA1c, triglycerides, total cholesterol, high-density lipoprotein (HDL)-cholesterol, low-density lipoprotein (LDL)-cholesterol, C-reactive protein, haemoglobin, ferritin, albumin and vitamin D.

3.8 Subject characteristics

Regarding health parameters, subjects were interviewed on marital status, ethnicity, smoking, physical activity, diabetes mellitus, cardiovascular disease, cancer and number of prescriptive medications. Inactivity was defined as less than 30 minutes of daily activity. Established cardiovascular disease comprised heart attack, angina pectoris, heart failure and cerebral stroke. Cancer included cases in the past three years.
3.9 Literature search

A systematic literature search was conducted in Ovid-Medline, Ovid-Embase and Pubmed. The search words *sarcopenia* and *prevalence* were used in titles, abstracts, keywords and subject headings. The search was limited to papers published since year 2004 up to 18\textsuperscript{th} of February 2015, to all aged 65 years and older and to papers written in English, Danish, Swedish or Norwegian. Conference abstracts, conference papers, conference proceedings, conference review and editorials were excluded. Reviews and articles which did not include both muscle mass and muscle strength or physical function were excluded based on title or abstract. Exclusion criteria were exclusively hospitalized or institutionalized participants, sarcopenia prevalence not specified and physical function not included in the definition of sarcopenia. Only papers with a well-defined population were included. Flow-chart of the selection of papers in the literature search is shown in figure 5.

**Figure 5.** Selection of papers in the literature search. Exclusion criteria were exclusively hospitalized or institutionalized participants, prevalence not specified and physical function not included in the definition of sarcopenia.
3.10 Statistical analysis

An Excel file containing relevant project data was opened in the statistical program IBM SPSS Statistics version 22 for further analyses. To ensure that the SPSS file did not contain any errors, randomly selected variables from the SPSS file were compared to the raw data file. Mean, maximum and missing values were controlled before analyses were conducted. Normal distribution was assessed using histograms, normal QQ-plots and detrended QQ-plots. Both parametric and non-parametric tests were used for statistical analyses. A two sided p-value <0.05 was considered as statistically significant. n = 236 where other is not specified.

3.10.1 Continuous variables

Continuous data are given as mean (SD) when normally distributed, and as median (25 th – 75 th percentile) when not normally distributed. When comparing two groups, independent-samples t-tests was used as assumptions for parametric tests were fulfilled. When Levenes test was <0.5, results were read from the row equal variance not assumed. Transformations were attempted before use of-non-parametric tests. Logarithm transformation was conducted on ferritin, triglycerides, C-reactive protein and the rise and sit test. The non-parametric alternative used when comparing two groups was Mann-Whitney U-Test. When comparing three groups, One-way between-groups ANOVA was used as a parametric test, and Kruskal-Wallis test was used as a non-parametric test. If these tests were significant, the post-hoc analysis Tukey HSD test and Mann-Whitney U tests were executed, respectively. Bonferroni adjustment to the alpha level was then applied. In correlation analysis, Pearson’s correlation coefficient was used as a parametric alternative and Spearman’s correlation coefficient as a non-parametrical alternative.

3.10.2 Categorical variables

Categorical data are presented as number (n) and frequency (%). When comparing two or more groups, Chi-square test was conducted. Eighty percent of cells should have expected count over five and all cells should have expected count over one to use this test. If these premises were not fulfilled, Fisher’s Exact test was used in data with two categories. No analysis was conducted alternatively on data with three categories.
4 Results

4.1 Subject characteristics

The median age for participants was 74.0 (71.0-79.0) years, and the proportion of men and women was quite similar. When dividing age into three intervals, women were dominant compared to men among subjects aged 75-79 years. Among persons living in Skedsmo municipality, 6.8 % of those aged 70-74 years, 4.4 % of those aged 75-79 years and 3.1 % of those aged 80 years or older participated in the current study. There were 124 subjects aged 70-74 years, 57 subjects aged 75-79 years and 55 subjects aged 80 years or more in the current sample. Age distribution among study participants is shown in figure 6 and age distribution in Skedsmo municipality is shown in figure 7.

It is recommended that blood pressure is less than 140/90 (262), indicating that the mean systolic blood pressure was heightened in both genders and age groups. The Norwegian Directory of Health recommend a BMI between 22 and 27 kg/m\(^2\) in persons aged 70 years or older (259). Thus, the mean BMI of the participants was within this range. Most participants were weight stable. Only three women and seven men had a MNA-score less than 24, which indicates risk of malnutrition. None of the participants had established malnutrition recognized by a MNA-score less than 17. MMSE-score was higher in subjects under 75 years than in older subjects. The median MMSE score was 28.0 (25.0-30.0) in the current study. Normal cognition is indicated in scores greater than or equal to 27 points (257). A MMSE score of 24 points or less indicates cognitive impairment (257). As expected, individuals under 80 years old were significantly more active than individuals aged 80 years or older. Established cardiovascular disease was reported significantly less frequently in women than in men (43.7 %). Although not significant, women reported less daily use of prescriptive medications than men. Participants aged 80 years or older reported significantly more daily use of prescriptive medications than subjects aged 70-74 years old. Subject characteristics are shown in table 7. As expected, men had higher hemoglobin and ferritin levels than women, as shown in table 8. It is interesting to notice that women had significantly higher total cholesterol, LDL cholesterol and HDL cholesterol than men. All of the participant’s average laboratory parameters were within Furst Medical Laboratory’s reference values. There was no significant difference in blood parameters between the age groups.
Figure 6. Age distribution among participants.

Figure 7. Age distribution among inhabitants in Skedsmo municipality. Data were given by Statistical Central Bureau, 2014.
Table 7. Subject characteristics, n = 236.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total</th>
<th>Female</th>
<th>Male</th>
<th>p¹</th>
<th>70-74 years</th>
<th>75-79 years</th>
<th>≥80 years</th>
<th>p²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>74.0 (71.0-79.0)</td>
<td>75.0 (72.0-79.0)</td>
<td>73.0 (71.0-80.0)</td>
<td>0.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Female, n (%)</td>
<td>125 (53.0)</td>
<td>111 (47.0)</td>
<td></td>
<td>-</td>
<td>59 (47.6)</td>
<td>39 (68.4)</td>
<td>27 (49.1)</td>
<td>0.03³⁴⁵⁶</td>
</tr>
<tr>
<td>- Male, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>65 (52.4)</td>
<td>18 (31.6)</td>
<td>28 (50.9)</td>
<td></td>
</tr>
<tr>
<td>Single-living, n (%)</td>
<td>79 (33.5)</td>
<td>55 (44.0)</td>
<td>24 (21.6)</td>
<td>&lt;0.001</td>
<td>32 (25.8)</td>
<td>20 (35.1)</td>
<td>27 (49.1)</td>
<td>0.01⁵⁶</td>
</tr>
<tr>
<td>Immigrant, n (%)</td>
<td>12 (5.1)</td>
<td>7 (5.6)</td>
<td>5 (4.5)</td>
<td>0.93</td>
<td>7 (5.6)</td>
<td>2 (3.5)</td>
<td>3 (5.5)</td>
<td></td>
</tr>
<tr>
<td>Smoker, n (%)</td>
<td>14 (5.9)</td>
<td>7 (5.6)</td>
<td>7 (6.3)</td>
<td>1.0</td>
<td>9 (7.3)</td>
<td>3 (5.3)</td>
<td>2 (3.6)</td>
<td></td>
</tr>
<tr>
<td>Systolic blood pressure, mmHg</td>
<td>145.5 (18.6)</td>
<td>145.1 (18.9)</td>
<td>145.9 (18.4)</td>
<td>0.75</td>
<td>143.7 (16.6)</td>
<td>146.7 (18.2)</td>
<td>148.2 (22.8)</td>
<td>0.28</td>
</tr>
<tr>
<td>Diastolic blood pressure, mmHg</td>
<td>77.7 (11.9)</td>
<td>76.7 (12.3)</td>
<td>78.9 (11.3)</td>
<td>0.16</td>
<td>78.7 (11.2)</td>
<td>76.7 (11.6)</td>
<td>76.8 (13.6)</td>
<td>0.46</td>
</tr>
<tr>
<td>BMI*, kg/m²</td>
<td>26.2 (4.1)</td>
<td>26.3 (4.5)</td>
<td>26.0 (3.7)</td>
<td>0.66</td>
<td>26.6 (4.3)</td>
<td>26.3 (4.2)</td>
<td>25.2 (3.5)</td>
<td>0.13</td>
</tr>
<tr>
<td>Inactive*, n (%)</td>
<td>99 (42.1)</td>
<td>56 (44.8)</td>
<td>43 (39.1)</td>
<td>0.38</td>
<td>49 (39.5)</td>
<td>19 (33.9)</td>
<td>31 (56.4)</td>
<td>0.04⁵⁶</td>
</tr>
<tr>
<td>Diabetes mellitus, n (%)</td>
<td>10 (4.2)</td>
<td>6 (4.8)</td>
<td>4 (3.6)</td>
<td>0.90</td>
<td>3 (2.4)</td>
<td>6 (10.5)</td>
<td>1 (1.8)</td>
<td></td>
</tr>
<tr>
<td>Cardiovascular disease**, n (%)</td>
<td>36 (16.1)</td>
<td>12 (10.1)</td>
<td>24 (23.1)</td>
<td>0.01</td>
<td>15 (12.6)</td>
<td>8 (15.1)</td>
<td>13 (25.5)</td>
<td>0.11</td>
</tr>
<tr>
<td>Cancer, n (%)</td>
<td>19 (8.1)</td>
<td>8 (6.4)</td>
<td>11 (9.9)</td>
<td>0.45</td>
<td>9 (7.3)</td>
<td>3 (5.3)</td>
<td>7 (12.7)</td>
<td></td>
</tr>
<tr>
<td>Number of daily prescriptive medications</td>
<td>2.0 (1.0-4.0)</td>
<td>2.0 (1.0-4.0)</td>
<td>3.0 (1.0-4.0)</td>
<td>0.09</td>
<td>2.0 (1.0-3.0)</td>
<td>2.0 (1.0-4.0)</td>
<td>3.0 (2.0-5.0)</td>
<td>0.04⁵⁶</td>
</tr>
<tr>
<td>MNA score</td>
<td>28.0 (26.5-29.0)</td>
<td>28.0 (26.8-29.0)</td>
<td>28.0 (26.5-29.0)</td>
<td>0.99</td>
<td>28.0 (27.0-29.0)</td>
<td>28.0 (26.5-29.0)</td>
<td>28.0 (26.5-28.5)</td>
<td>0.24</td>
</tr>
<tr>
<td>MMSE score</td>
<td>28.0 (25.0-30.0)</td>
<td>27.0 (26.0-30.0)</td>
<td>28.0 (25.0-30.0)</td>
<td>0.87</td>
<td>29.0 (26.0-30.0)</td>
<td>26.0 (25.0-30.0)</td>
<td>26.0 (24.0-28.0)</td>
<td>&lt;0.001⁵⁶</td>
</tr>
</tbody>
</table>

Continuous data are presented as mean (SD) when normally distributed, and as median (25 th – 75 th percentile) when not normally distributed. * n = 235; ** n = 223.

BMI, body mass index; MNA, Mini Nutritional Assessment; MMSE, Mini-Mental State Examination.

p¹ Female vs. male (Independent-samples t-test, Mann-Whitney U test, chi-square or Fisher’s Exact test), statistically significant when p < 0.05.

p² Between age groups (One-way between-groups ANOVA, Kruskal-Wallis Test, chi-square or Fisher’s Exact test), statistically significant when p < 0.05.

³ p<0.05 between subjects aged 70-74 and 75-79 years (Tukey HSD, Mann-Whitney U test, chi-square or Fisher’s Exact test).

⁴ p<0.05 between subjects aged 77-79 and 80 years or more (Tukey HSD, Mann-Whitney U test, chi-square or Fisher’s Exact test).

⁵ p<0.05 between subjects aged 75-79 and 80 years or more (Tukey HSD, Mann-Whitney U test, chi-square or Fisher’s Exact test).

⁶ p<0.05 between subjects aged 75-79 and 80 years or more (Tukey HSD, Mann-Whitney U test, chi-square or Fisher’s Exact test).
Table 8. Laboratory parameters, n = 236.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Reference</th>
<th>Total</th>
<th>Female</th>
<th>Male</th>
<th>p(^1)</th>
<th>70-74 years</th>
<th>75-79 years</th>
<th>≥80 years</th>
<th>p(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HbA1c*, %</td>
<td>&lt;6.1</td>
<td>5.9 (0.5)</td>
<td>5.9 (0.5)</td>
<td>5.9 (0.6)</td>
<td>0.57</td>
<td>5.8 (0.5)</td>
<td>6.0 (0.6)</td>
<td>5.9 (0.6)</td>
<td>0.03</td>
</tr>
<tr>
<td>TG**, mmol/l</td>
<td>&lt;2.60</td>
<td>1.3 (1.0-1.8)</td>
<td>1.4 (1.0-1.9)</td>
<td>1.2 (0.9-1.8)</td>
<td>0.11</td>
<td>1.4 (1.0-1.9)</td>
<td>1.3 (1.0-1.9)</td>
<td>1.2 (0.9-1.6)</td>
<td>0.23</td>
</tr>
<tr>
<td>TC, mmol/l</td>
<td>3.9-7.8</td>
<td>5.2 (1.1)</td>
<td>5.5 (1.0)</td>
<td>4.8 (1.1)</td>
<td>&lt;0.001</td>
<td>5.2 (1.0)</td>
<td>5.2 (1.3)</td>
<td>5.1 (1.2)</td>
<td>0.97</td>
</tr>
<tr>
<td>HDL-C, mmol/l</td>
<td>F: 1.0-2.7</td>
<td>M: 0.8-2.1</td>
<td>F: 1.6 (0.5)</td>
<td>M: 1.7 (0.5)</td>
<td>&lt;0.001</td>
<td>1.5 (0.4)</td>
<td>1.6 (0.5)</td>
<td>1.7 (0.6)</td>
<td>0.17</td>
</tr>
<tr>
<td>LDL-C, mmol/l</td>
<td>2.0-5.3</td>
<td>2.9 (0.9)</td>
<td>3.1 (0.9)</td>
<td>2.7 (0.9)</td>
<td>0.001</td>
<td>3.0 (0.9)</td>
<td>2.8 (1.0)</td>
<td>2.9 (0.9)</td>
<td>0.41</td>
</tr>
<tr>
<td>CRP, mg/l</td>
<td>&lt;5</td>
<td>1.3 (0.7-3.0)</td>
<td>1.5 (0.9-3.3)</td>
<td>1.1 (0.6-2.4)</td>
<td>0.07</td>
<td>1.3 (0.7-2.5)</td>
<td>1.3 (0.8-3.5)</td>
<td>1.6 (0.7-3.5)</td>
<td>0.62</td>
</tr>
<tr>
<td>Hemoglobin**, g/100ml</td>
<td>F: 11.7-15.3</td>
<td>M: 13.4-17.0</td>
<td>14.1 (1.0)</td>
<td>13.7 (0.9)</td>
<td>14.4 (1.0)</td>
<td>0.001</td>
<td>14.2 (0.9)</td>
<td>14.0 (1.0)</td>
<td>13.8 (1.3)</td>
</tr>
<tr>
<td>Ferritin***, µg/l</td>
<td>F: 15-200</td>
<td>123.5</td>
<td>107.0</td>
<td>148.5</td>
<td>0.01</td>
<td>136.5</td>
<td>111.0</td>
<td>125.0</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>M: 20-300</td>
<td>(79.0-187.3)</td>
<td>(68.8-168.5)</td>
<td>(85.8-204.3)</td>
<td></td>
<td>(80.0-208.3)</td>
<td>(69.0-154.0)</td>
<td>(68.0-182.0)</td>
<td></td>
</tr>
<tr>
<td>Albumin, g/l</td>
<td>34-46</td>
<td>41.5 (2.2)</td>
<td>41.3 (2.1)</td>
<td>41.7 (2.3)</td>
<td>0.23</td>
<td>41.7 (2.1)</td>
<td>41.5 (2.1)</td>
<td>41.1 (2.5)</td>
<td>0.32</td>
</tr>
<tr>
<td>Vitamin D3, nmol/l</td>
<td>50-150</td>
<td>86.8 (23.4)</td>
<td>85.1 (21.2)</td>
<td>88.8 (25.6)</td>
<td>0.22</td>
<td>85.9 (23.6)</td>
<td>87.0 (21.4)</td>
<td>88.7 (25.0)</td>
<td>0.76</td>
</tr>
</tbody>
</table>

Continuous data are presented as mean (SD) when normally distributed, and as median (25 th – 75 th percentile) when not normally distributed.
Blood samples are mainly non-fasting. Reference values are from Fürst Medical Laboratory. *n = 219, **n = 235, ***n = 220.
F, female; M, male; TG, triglycerides; TC, total cholesterol; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol;
CRP, C-reactive protein.
p\(^1\) Female vs. male (Independent-samples t-test), statistically significant when p < 0.05.
p\(^2\) Between age groups (One-way between-groups ANOVA, Kruskal-Wallis Test), p > 0.05 in post-hoc tests.
4.2 Anthropometric measures

To get a comprehensive idea on the participant’s anthropometry, several measures were performed in the current study. As expected there were significant difference in height, weight, waist circumference, hip circumference, fat mass and fat free mass between men and women (table 9a). Both height and weight were significantly lower among subjects aged 75 or older when compared to subjects aged 70-74 years. Similar differences were seen when stratified by gender (table 9b). Waist circumference, MUAC and CC were significantly lower in women aged 80 years or older than women between 70 and 74 years old. This was not found in men. As expected, fat mass was relatively similar between the age groups, while fat free mass was significantly lower in subjects aged 75 years or older when compared to subjects aged 70-74 years.

According to the MNA-form, MUAC <22 cm and CC < 31 cm are classified as reduced. By this method, only one person (0.4 %) had reduced MUAC and two persons (0.8 %) had reduced CC in the total sample.
Continuous data are presented as mean (SD). Weight, fat percent, fat mass, fat free mass and total body water were measured by BIA. *n = 235, ** n = 227.

Table 9a. Anthropometric measures, n = 236.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total</th>
<th>Female</th>
<th>Male</th>
<th>p&lt;sup&gt;1&lt;/sup&gt;</th>
<th>70-74 years</th>
<th>75-79 years</th>
<th>≥80 years</th>
<th>p&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height*, cm</td>
<td>169.1 (9.5)</td>
<td>162.6 (6.1)</td>
<td>176.5 (6.8)</td>
<td>&lt;0.001</td>
<td>171.8 (9.6)</td>
<td>165.6 (7.5)</td>
<td>166.7 (9.3)</td>
<td>&lt;0.001&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Weight*, kg</td>
<td>75.0 (13.6)</td>
<td>69.6 (12.8)</td>
<td>81.1 (11.8)</td>
<td>&lt;0.001</td>
<td>78.3 (13.6)</td>
<td>72.0 (12.3)</td>
<td>70.4 (12.9)</td>
<td>&lt;0.001&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Waist circumference*, cm</td>
<td>95.2 (12.1)</td>
<td>91.7 (12.4)</td>
<td>99.2 (10.3)</td>
<td>&lt;0.001</td>
<td>97.4 (11.6)</td>
<td>92.9 (12.4)</td>
<td>93.0 (12.0)</td>
<td>0.02</td>
</tr>
<tr>
<td>Hip circumference*, cm</td>
<td>104.9 (8.1)</td>
<td>106.1 (9.2)</td>
<td>103.5 (6.3)</td>
<td>0.01</td>
<td>105.7 (8.4)</td>
<td>104.1 (8.6)</td>
<td>104.0 (6.5)</td>
<td>0.30</td>
</tr>
<tr>
<td>Waist/hip ratio*</td>
<td>0.9 (0.1)</td>
<td>0.9 (0.1)</td>
<td>1.0 (0.1)</td>
<td>0.001</td>
<td>0.9 (0.1)</td>
<td>0.9 (0.1)</td>
<td>0.9 (0.1)</td>
<td>0.03</td>
</tr>
<tr>
<td>MUAC, cm</td>
<td>30.7 (3.5)</td>
<td>30.4 (3.9)</td>
<td>31.1 (3.1)</td>
<td>0.13</td>
<td>31.4 (3.4)</td>
<td>30.6 (3.5)</td>
<td>29.2 (3.3)</td>
<td>&lt;0.001&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>CC, cm</td>
<td>37.5 (3.2)</td>
<td>37.2 (3.3)</td>
<td>37.8 (3.1)</td>
<td>0.22</td>
<td>37.9 (3.0)</td>
<td>37.6 (3.3)</td>
<td>36.4 (3.2)</td>
<td>0.01&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fat percent**</td>
<td>31.1 (8.7)</td>
<td>36.2 (7.3)</td>
<td>25.0 (6.0)</td>
<td>&lt;0.001</td>
<td>30.8 (9.1)</td>
<td>32.4 (8.1)</td>
<td>30.2 (8.6)</td>
<td>0.41</td>
</tr>
<tr>
<td>Fat mass**, kg</td>
<td>23.5 (8.6)</td>
<td>25.9 (9.0)</td>
<td>20.7 (7.3)</td>
<td>&lt;0.001</td>
<td>24.4 (9.0)</td>
<td>23.5 (8.4)</td>
<td>21.4 (7.4)</td>
<td>0.11</td>
</tr>
<tr>
<td>Fat free mass**, kg</td>
<td>51.4 (10.5)</td>
<td>43.7 (5.8)</td>
<td>60.5 (7.1)</td>
<td>&lt;0.001</td>
<td>54.0 (10.8)</td>
<td>48.2 (8.6)</td>
<td>48.9 (10.3)</td>
<td>&lt;0.001&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total body water**, kg</td>
<td>37.7 (7.7)</td>
<td>32.0 (4.2)</td>
<td>44.3 (5.2)</td>
<td>&lt;0.001</td>
<td>39.5 (7.9)</td>
<td>35.3 (6.3)</td>
<td>35.9 (7.5)</td>
<td>&lt;0.001&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Table 9b. Anthropometric measures, n = 236.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Female</th>
<th></th>
<th>Male</th>
<th>p&lt;sup&gt;1&lt;/sup&gt;</th>
<th>70-74 years</th>
<th>75-79 years</th>
<th>≥80 years</th>
<th>p&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height*, cm</td>
<td></td>
<td></td>
<td></td>
<td>0.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>179.0 (6.7)</td>
<td>172.6 (4.2)</td>
<td>173.9 (5.9)</td>
<td>&lt;0.001&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Weight*, kg</td>
<td>72.6 (12.7)</td>
<td>69.4 (13.2)</td>
<td>63.5 (10.7)</td>
<td>0.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>83.8 (12.5)</td>
<td>77.4 (8.1)</td>
<td>73.3 (11.8)</td>
<td>0.02</td>
</tr>
<tr>
<td>Waist circumference*, cm</td>
<td>95.1 (12.2)</td>
<td>90.3 (13.2)</td>
<td>86.5 (10.3)</td>
<td>0.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>99.6 (10.8)</td>
<td>98.1 (8.9)</td>
<td>99.0 (11.0)</td>
<td>0.92</td>
</tr>
<tr>
<td>Hip circumference*, cm</td>
<td>107.6 (9.7)</td>
<td>105.2 (9.6)</td>
<td>104.7 (7.4)</td>
<td>0.27</td>
<td>104.1 (6.9)</td>
<td>101.2 (5.6)</td>
<td>103.6 (5.8)</td>
<td>0.39</td>
</tr>
<tr>
<td>Waist/hip ratio*</td>
<td>0.9 (0.1)</td>
<td>0.9 (0.1)</td>
<td>0.8 (0.1)</td>
<td>0.002&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.0 (0.1)</td>
<td>1.0 (0.0)</td>
<td>1.0 (0.1)</td>
<td>0.79</td>
</tr>
<tr>
<td>MUAC, cm</td>
<td>31.2 (3.9)</td>
<td>30.5 (4.0)</td>
<td>28.5 (3.2)</td>
<td>0.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>31.7 (3.1)</td>
<td>30.8 (2.1)</td>
<td>30.0 (3.5)</td>
<td>0.04</td>
</tr>
<tr>
<td>CC, cm</td>
<td>37.8 (3.0)</td>
<td>37.6 (3.7)</td>
<td>35.5 (2.6)</td>
<td>0.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>38.1 (3.1)</td>
<td>37.4 (2.1)</td>
<td>37.3 (3.6)</td>
<td>0.53</td>
</tr>
<tr>
<td>Fat percent**</td>
<td>37.5 (6.8)</td>
<td>35.1 (7.7)</td>
<td>35.1 (7.4)</td>
<td>0.19</td>
<td>24.6 (6.0)</td>
<td>25.7 (4.4)</td>
<td>25.4 (6.9)</td>
<td>0.72</td>
</tr>
<tr>
<td>Fat mass**, kg</td>
<td>28.0 (9.2)</td>
<td>24.9 (9.2)</td>
<td>22.7 (7.1)</td>
<td>0.03</td>
<td>21.1 (7.6)</td>
<td>20.2 (5.1)</td>
<td>20.1 (7.7)</td>
<td>0.81</td>
</tr>
<tr>
<td>Fat free mass**, kg</td>
<td>44.6 (4.30)</td>
<td>44.5 (7.1)</td>
<td>40.7 (5.8)</td>
<td>0.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>62.7 (7.2)</td>
<td>57.2 (3.7)</td>
<td>57.2 (6.6)</td>
<td>&lt;0.001&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total body water**, kg</td>
<td>32.7 (3.1)</td>
<td>32.5 (5.2)</td>
<td>29.9 (4.2)</td>
<td>0.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>45.9 (5.2)</td>
<td>41.9 (2.7)</td>
<td>41.9 (4.8)</td>
<td>&lt;0.001&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Continuous data are presented as mean (SD). Weight, fat percent, fat mass, fat free mass and total body water were measured by BIA. *n = 235, ** n = 227.

MUAC, mid-upper arm circumference; CC, calf circumference.

p<sup>1</sup> Female vs. male (Independent-samples t-test), statistical significant when p < 0.05.

p<sup>2</sup> Between age groups (One-way between-groups ANOVA), statistical significant when p < 0.05.

a p<0.05 between subjects aged 70-74 and 75-79 years (Tukey HSD).

b p<0.05 between subjects aged 70-74 and 80 years or more (Tukey HSD).
4.3 Muscle mass

SMI was determined by two methods in this Thesis. First, SMI was calculated as appendicular muscle mass/height$^2$ according to Baumgartner et al. (27). Low muscle mass was present with SMI <5.45 kg/m$^2$ in women and <7.26 kg/m$^2$ in men (27). Secondly, SMI was estimated as absolute muscle mass/height$^2$ according to Janssen et al. (45). By this method low SMI was defined as ≤6.76 kg/m$^2$ in women and ≤10.76 kg/m$^2$ in men (46). By Baumgartner’s method, the prevalence of low muscle mass was estimated to 10.1 % in total, as compared to 88.1 % when applying Janssen’s method. All subjects with low muscle mass estimated by Baumgartner’s method also had low muscle mass according to Janssen’s method. Women had significantly lower prevalence of reduced muscle mass than men when applying both methods for estimating SMI. Only one woman had low muscle mass by using Baumgartner’s method, and all men had low muscle mass by using Janssen’s method. The prevalence of reduced SMI calculated by Baumgartner’s method was significantly lower in men aged 70-74 years compared to men aged 80 years or older. There was no significant difference in prevalence of reduced SMI between ages by Janssen’s method (table 10).

Using the two equations, it was found similar SMI values. By using Baumgartner’s method the mean SMI was 7.3 (1.0) kg/m$^2$ and by using Janssen’s method the mean SMI was 7.3 (1.5) kg/m$^2$. Box-plots of SMI are demonstrated in figure 8. Distributions of SMI according to gender with appurtenant cut-offs are shown in figure 9. The shape of the curves were similar in both methods, however the cut-offs differ. Furthermore, if Janssen’s cut-offs were applied on SMI estimated by Baumgartner’s method and the other way around, similar numbers would have been classified with low muscle mass. There was a strong correlation between the two methods at estimating SMI (r=0.87, p<0.001).
### Table 10a. Calculations of skeletal muscle index (SMI), n = 227.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total</th>
<th>Female</th>
<th>Male</th>
<th>p</th>
<th>70-74 years</th>
<th>75-79 years</th>
<th>≥80 years</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMI Baumgartner*, kg/m²</td>
<td>7.3 (1.0)</td>
<td>6.7 (0.8)</td>
<td>7.8 (0.9)</td>
<td>&lt;0.001</td>
<td>7.4 (1.0)</td>
<td>7.1 (1.0)</td>
<td>7.0 (1.0)</td>
<td>0.04</td>
</tr>
<tr>
<td>Low SMI Baumgartner*, n (%)</td>
<td>23 (10.1)</td>
<td>1 (0.8)</td>
<td>22 (21.2)</td>
<td>&lt;0.001</td>
<td>9 (7.5)</td>
<td>3 (5.5)</td>
<td>11 (21.2)</td>
<td>0.01&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>SMI Janssen**, kg/m²</td>
<td>7.3 (1.5)</td>
<td>6.2 (0.9)</td>
<td>8.6 (0.9)</td>
<td>&lt;0.001</td>
<td>7.5 (1.4)</td>
<td>7.0 (1.4)</td>
<td>7.1 (1.6)</td>
<td>0.05</td>
</tr>
<tr>
<td>Low SMI Janssen**, n (%)</td>
<td>200 (88.1)</td>
<td>96 (78.0)</td>
<td>104 (100)</td>
<td>&lt;0.001</td>
<td>107 (89.2)</td>
<td>46 (83.6)</td>
<td>47 (90.4)</td>
<td>0.49</td>
</tr>
</tbody>
</table>

### Table 10b. Calculations of skeletal muscle index (SMI), n = 227.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Female</th>
<th>Male</th>
<th>p</th>
<th>70-74 years</th>
<th>75-79 years</th>
<th>≥80 years</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMI Baumgartner*, kg/m²</td>
<td>6.8 (0.8)</td>
<td>6.8 (0.9)</td>
<td>6.5 (0.7)</td>
<td>0.31</td>
<td>8.0 (0.9)</td>
<td>7.8 (0.7)</td>
<td>7.5 (0.9)</td>
</tr>
<tr>
<td>Low SMI Baumgartner*, n (%)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1 (3.8)</td>
<td>-</td>
<td>9 (14.5)</td>
<td>3 (18.8)</td>
<td>10 (38.5)</td>
</tr>
<tr>
<td>SMI Janssen**, kg/m²</td>
<td>6.3 (0.6)</td>
<td>6.4 (1.0)</td>
<td>5.9 (1.1)</td>
<td>0.04</td>
<td>8.7 (0.8)</td>
<td>8.6 (0.6)</td>
<td>8.3 (1.1)</td>
</tr>
<tr>
<td>Low SMI Janssen**, n (%)</td>
<td>45 (77.6)</td>
<td>30 (83.3)</td>
<td>21 (80.8)</td>
<td>0.93</td>
<td>62 (100)</td>
<td>16 (100)</td>
<td>26 (100)</td>
</tr>
</tbody>
</table>

Continuous data are presented as mean (SD). Skeletal muscle index (SMI) was calculated based on BIA.

*SMI Baumgartner, appendicular muscle mass/height² (kg/m²). Appendicular muscle mass = the sum of muscle mass in both legs and arms. Low SMI is <5.45 in women and <7.26 in men.

**SMI Janssen, absolute muscle mass/height² (kg/m²). Absolute muscle mass = (height²/bioelectrical impedance analysis resistance x 0.401) + (gender x 3.825) + (age x -0.071) + 5.102. Low SMI is <6.76 in women and <10.76 in men.

p<sup>1</sup> Female vs. male (Independent-samples t-test, chi-square or Fisher’s Exact test), statistical significant when p < 0.05.

p<sup>2-4</sup> Between age groups (One-way between-groups ANOVA, chi-square or Fisher’s Exact test), statistical significant when p < 0.05.

<sup>b</sup> p<0.05 between subjects aged 70-74 and 80 years or more (Tukey HSD, chi-square or Fisher’s Exact test).

<sup>c</sup> p<0.05 between subjects aged 75-79 and 80 years or more (Tukey HSD, chi-square or Fisher’s Exact test).
Figure 8. Boxplot of skeletal muscle index (SMI) in Baumgartner’s and Janssen’s method.

Figure 9. Distribution of SMI in women and men in Baumgartner’s and Janssen’s method, respectively. The vertical lines represent cut-offs in women and men.
4.4 Physical tests

Physical function is important in the daily living. It is an element in the definition of sarcopenia, thus several physical tests were conducted in this study. The mean performances were above cut-off on each and all tests. Performances on physical tests are shown in table 11. Figure 10 illustrates the portion of participants with reduced performance on the different physical tests stratified by age and gender. Interestingly, when Baumgartner´s method at calculating SMI was applied, there was no difference in performance on physical tests between those with normal and reduced SMI. However, when Janssen´s method was applied, those with reduced SMI performed significantly better on all physical tests compared with those with normal SMI.

4.4.1 Handgrip strength

As expected, men exerted significantly higher handgrip strength than women. The mean handgrip strength was 21.6 (5.2) kg in women and 37.4 (8.1) kg in men on the dominant hand. Subjects between 70 and 74 years had significantly higher handgrip strength than older subjects. Among women, 37.1 % had handgrip strength less than 20 kg and among men, 11.8 % had handgrip strength less than 30 kg.

4.4.2 Gait speed

The mean gait speed was 1.3 (0.3) m/s in the total sample. Reduced gait speed, classified as <1 m/s, was found in 8.9 % of the sample. Those aged 80 years or older scored significantly lower on gait speed when compared to subjects between 70 and 80 years old.

4.4.3 Other physical tests

In this Thesis, only handgrip strength and gait speed were included in the recognition of sarcopenia. However, the ability of other physical test to identify subjects with low physical function was also explored.
4.4.3.1 SPPB

In the balance test, 17.4% of the participants did not manage to complete all three balance tests. Those aged 80 years or older scored significantly lower on the balance test when compared to subjects aged 70-80 years old. The median rise and sit time was 11.1 (9.6-12.9) seconds. When 12.5 seconds was applied as cut-off, 29.5% had reduced performance. In men, but not women, rise and sit performance was significantly higher among subjects aged 75-79 years than those aged 80 years or older. Of the three tests included in SPPB, the rise and sit test gave lowest score among the participants. The median total SPPB-score was 11.0 (11.0-12.0) points. The score was significantly lower among subjects aged 80 years or older than in subjects aged 70-80 years. Only 5.5% had a total SPPB-score below the cut-off set at eight points or less. There was no significant difference between men and women in any of the tests included in SPPB or in total SPPB score.

4.4.3.2 Stair climbing test

The median stair climbing time was 7.2 (6.3-8.7) seconds. Men performed significantly better in the stair climbing test when compared to women. Participants aged 80 years or older had a significantly lower performance in the stair climbing test than participants between 70 and 80 years old. In total, 24.0% had reduced performance in the stair climbing test, by applying 8.4 seconds as cut off.

The rise and sit test and the stair climbing test classified about as many with low performance as handgrip strength did. SPPB classified fewer with reduced performance than gait speed. Overlaps of the prevalence of reduced performance in different physical tests are demonstrated in figure 11.
Table 11a. Performance on physical tests, n = 232-235.

<table>
<thead>
<tr>
<th>Physical test</th>
<th>Total</th>
<th>Female</th>
<th>Male</th>
<th>p^</th>
<th>70-74 years</th>
<th>75-79 years</th>
<th>≥80 years</th>
<th>p^</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handgrip test, dominant arm, kg</td>
<td>28.9 (10.3)</td>
<td>21.6 (5.2)</td>
<td>37.4 (8.1)</td>
<td>&lt;0.001</td>
<td>32.2 (10.6)</td>
<td>26.1 (8.9)</td>
<td>24.4 (8.7)</td>
<td>&lt;0.001^a,b</td>
</tr>
<tr>
<td>Handgrip test, non-dominant arm, kg</td>
<td>27.0 (9.8)</td>
<td>19.9 (4.6)</td>
<td>35.0 (7.8)</td>
<td>&lt;0.001</td>
<td>30.0 (10.0)</td>
<td>24.4 (8.7)</td>
<td>22.7 (8.1)</td>
<td>&lt;0.001^a,b</td>
</tr>
<tr>
<td>Gait speed, m/s</td>
<td>1.3 (0.3)</td>
<td>1.3 (0.2)</td>
<td>1.3 (0.3)</td>
<td>0.31</td>
<td>1.4 (0.2)</td>
<td>1.3 (0.2)</td>
<td>1.1 (0.2)</td>
<td>&lt;0.001^b,c</td>
</tr>
<tr>
<td>Rise and sit test, seconds</td>
<td>11.1 (9.6-12.9)</td>
<td>11.1 (9.7-13.1)</td>
<td>10.9 (9.3-12.8)</td>
<td>0.30</td>
<td>11.0 (9.5-12.7)</td>
<td>10.4 (8.9-12.4)</td>
<td>11.6 (10.3-14.0)</td>
<td>0.01^c</td>
</tr>
<tr>
<td>Total SPPB score</td>
<td>11.0 (11.0-12.0)</td>
<td>11.0 (10.0-12.0)</td>
<td>12.0 (11.0-12.0)</td>
<td>0.11</td>
<td>12.0 (11.0-12.0)</td>
<td>12.0 (11.0-12.0)</td>
<td>11.0 (9.0-12.0)</td>
<td>&lt;0.001^b,c</td>
</tr>
<tr>
<td>Stair climbing test, seconds</td>
<td>7.2 (6.3-8.7)</td>
<td>7.9 (6.7-9.3)</td>
<td>6.7 (5.7-7.8)</td>
<td>&lt;0.001</td>
<td>6.6 (5.7-7.8)</td>
<td>7.5 (6.4-8.6)</td>
<td>9.1 (7.3-13)</td>
<td>&lt;0.001^b,c</td>
</tr>
<tr>
<td>Reduced handgrip strength, n (%)</td>
<td>59 (25.2)</td>
<td>46 (37.1)</td>
<td>13 (11.8)</td>
<td>&lt;0.001</td>
<td>14 (11.4)</td>
<td>18 (31.6)</td>
<td>27 (50.0)</td>
<td>&lt;0.001^a,b,c</td>
</tr>
<tr>
<td>Reduced gait speed, n (%)</td>
<td>21 (8.9)</td>
<td>11 (8.8)</td>
<td>10 (9.1)</td>
<td>0.94</td>
<td>3 (2.4)</td>
<td>4 (7.0)</td>
<td>14 (25.5)</td>
<td>&lt;0.001^b,c</td>
</tr>
<tr>
<td>Reduced rise and sit test, n (%)</td>
<td>69 (29.5)</td>
<td>39 (31.5)</td>
<td>30 (27.3)</td>
<td>0.48</td>
<td>34 (27.6)</td>
<td>12 (21.1)</td>
<td>23 (42.6)</td>
<td>0.04</td>
</tr>
<tr>
<td>Reduced total SPPB score, n (%)</td>
<td>13 (5.5)</td>
<td>6 (4.8)</td>
<td>7 (6.4)</td>
<td>0.60</td>
<td>3 (2.4)</td>
<td>1 (1.8)</td>
<td>9 (16.4)</td>
<td>&lt;0.001^b,c</td>
</tr>
<tr>
<td>Reduced stair climbing test, n (%)</td>
<td>56 (24.0)</td>
<td>40 (32.5)</td>
<td>16 (14.5)</td>
<td>0.001</td>
<td>14 (11.4)</td>
<td>11 (19.3)</td>
<td>31 (58.5)</td>
<td>&lt;0.001^b,c</td>
</tr>
</tbody>
</table>

Table 11b. Performance on physical tests, n = 232-235.

<table>
<thead>
<tr>
<th>Variable</th>
<th>70-74 years</th>
<th>75-79 years</th>
<th>≥80 years</th>
<th>p^</th>
<th>70-74 years</th>
<th>75-79 years</th>
<th>≥80 years</th>
<th>p^</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handgrip test, dominant arm, kg</td>
<td>23.3 (4.1)</td>
<td>21.4 (6.0)</td>
<td>17.8 (4.0)</td>
<td>&lt;0.001^b,c</td>
<td>40.6 (7.5)</td>
<td>36.4 (4.4)</td>
<td>30.8 (7.2)</td>
<td>&lt;0.001^b</td>
</tr>
<tr>
<td>Handgrip test, non-dominant arm, kg</td>
<td>21.3 (3.6)</td>
<td>19.8 (3.6)</td>
<td>18.9 (5.6)</td>
<td>&lt;0.001^b</td>
<td>38.0 (7.0)</td>
<td>34.6 (4.5)</td>
<td>28.3 (7.2)</td>
<td>&lt;0.001^b,c</td>
</tr>
<tr>
<td>Gait speed, m/s</td>
<td>1.4 (0.2)</td>
<td>1.3 (0.2)</td>
<td>1.1 (0.2)</td>
<td>&lt;0.001^b,c</td>
<td>1.4 (0.2)</td>
<td>1.4 (0.3)</td>
<td>1.1 (0.3)</td>
<td>&lt;0.001^b,c</td>
</tr>
<tr>
<td>Rise and sit test, seconds</td>
<td>11.1 (9.9-12.7)</td>
<td>11.0 (9.6-13.3)</td>
<td>11.6 (9.6-14.2)</td>
<td>0.45</td>
<td>10.7 (9.3-12.7)</td>
<td>9.7 (7.6-11.7)</td>
<td>11.7 (10.5-13.5)</td>
<td>0.001^c</td>
</tr>
<tr>
<td>Total SPPB score</td>
<td>11.0 (11.0-12.0)</td>
<td>11.0 (10.0-12.0)</td>
<td>10.0 (9.0-11.0)</td>
<td>0.001^b,c</td>
<td>12.0 (11.0-12.0)</td>
<td>12.0 (11.0-12.0)</td>
<td>11.0 (10.0-12.0)</td>
<td>0.006^b,c</td>
</tr>
<tr>
<td>Stair climbing test, seconds</td>
<td>7.2 (6.4-8.1)</td>
<td>7.7 (6.7-9.5)</td>
<td>9.9 (8.6-11.9)</td>
<td>&lt;0.001^b,c</td>
<td>6.0 (5.4-6.9)</td>
<td>7.0 (6.1-7.8)</td>
<td>8.4 (7.1-10.2)</td>
<td>&lt;0.001^b,c</td>
</tr>
</tbody>
</table>

Continuous data are presented as mean (SD) when normally distributed, and as median (25 th – 75 th percentile) when not normally distributed.

SPPB, short physical performance battery.

p^<sup>1</sup> Female vs. male (Independent-samples t-test, Mann-Whitney U test, chi-square or Fisher’s Exact test), statistical significant when p < 0.05.

p^<sup>2</sup> Between age groups (One-way between-groups ANOVA, Kruskal-Wallis Test, chi-square or Fisher’s Exact test), statistical significant when p < 0.05.

<sup>a</sup> p<0.05 between subjects aged 70-74 and 75-79 years (Tukey HSD, Mann-Whitney U test, chi-square or Fisher’s Exact test).

<sup>b</sup> p<0.05 between subjects aged 70-74 and 80 years or more (Tukey HSD, Mann-Whitney U test, chi-square or Fisher’s Exact test).

<sup>c</sup> p<0.05 between subjects aged 75-79 and 80 years or more (Tukey HSD, Mann-Whitney U test, chi-square or Fisher’s Exact test).
Figure 10. Portion of participants with reduced handgrip strength (<20kg in women, <30kg in men), balance (<4 points), gait speed (<1m/s), rise and sit performance (>12.5 seconds), total SPPB-score (≤8 points) and stair climbing performance (>8.4 seconds) stratified by age and gender.
4.5 Correlations between measures of muscle mass and physical function

There was a strong correlation between handgrip strength and SMI estimated by both Baumgartner’s and Janssen’s method. No correlation was found between both methods estimating SMI to gait speed and the rise and sit test. The stair climbing test had a low correlation to SMI estimated by Baumgartner’s method and by Janssen’s method. MUAC and CC correlated strongly to SMI by using Baumgartner’s method. The correlations between MUAC and CC to SMI estimated by Janssen’s method were moderate. Correlation coefficients and p-values are shown in table 12.

Table 12. Correlations between measures of muscle mass and physical function.

<table>
<thead>
<tr>
<th></th>
<th>SMI, Baumgartner</th>
<th></th>
<th>SMI, Janssen</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r</td>
<td>p&lt;0.001</td>
<td>r</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Handgrip strength, kg</td>
<td>0.56</td>
<td></td>
<td>0.73</td>
<td></td>
</tr>
<tr>
<td>Gait speed, m/s</td>
<td>0.01</td>
<td>0.83</td>
<td>0.09</td>
<td>0.16</td>
</tr>
<tr>
<td>Rise and sit test, seconds</td>
<td>0.05</td>
<td>0.44</td>
<td>-0.03</td>
<td>0.63</td>
</tr>
<tr>
<td>Stair climbing test, seconds</td>
<td>-0.14</td>
<td>0.04</td>
<td>-0.29</td>
<td></td>
</tr>
<tr>
<td>CC</td>
<td>0.71</td>
<td></td>
<td>0.44</td>
<td></td>
</tr>
<tr>
<td>MUAC</td>
<td>0.66</td>
<td></td>
<td>0.41</td>
<td></td>
</tr>
</tbody>
</table>

Correlations calculated by Pearson’s or Spearman’s method. Data are statistical significant when p<0.05.

SMI, skeletal muscle index; SPPB, short physical performance battery; CC, calf circumference; MUAC, mid-upper arm circumference.

p<0.001 between SMI estimated by Baumgartner’s method and other variables. p<0.001 between SMI estimated by Janssen’s method and other variables. Statistical significant when p<0.001.
4.6 Prevalence of sarcopenia

In this assignment, the prevalence of sarcopenia was estimated by the presence of low muscle mass and low muscle strength or physical performance. By applying Baumgartner’s method at estimating low muscle mass, 4.0 % was classified as sarcopenic. If only handgrip strength or gait speed were used, 3.1 % and 1.8 % would have been classified as sarcopenic, respectively. Sarcopenia was more common in men than in women by this method (p=0.01). It was present in 0.8 % of women and 7.8 % of men. The prevalence of sarcopenia was higher in subjects aged 80 years or older than the subjects aged 70-80 years old (p<0.001).

By applying Janssen’s method at estimating low muscle mass, 24.4 % was classified as sarcopenic. If only handgrip strength or gait speed were used, 22.7 % and 7.1 % would have been classified as sarcopenic, respectively. Sarcopenia was more common in women than in men by this method (p=0.004). It was present in 32.0 % of women and 15.5 % of men. The prevalence of sarcopenia was higher in subjects aged 80 years or older than in subjects aged 70-80 years old (p<0.001). By Janssen’s method, physical active subjects had lower prevalence of sarcopenia (p=0.02) when compared to physical inactive subjects. This was not found by using Baumgartner’s method. Figure 12 demonstrates an algorithm for sarcopenia case finding applied on the current sample.

As suggested by EWGSOP, sarcopenia can be categorized as sarcopenia when either handgrip strength or gait speed is reduced, and as severe sarcopenia when both handgrip strength and gait speed are reduced (33). The prevalence of severe sarcopenia was 0.9 % by applying Baumgartner’s method and 5.3 % by applying Janssen’s method at estimating low muscle mass. There was no significant differences between men and women regarding severe sarcopenia (p>0.05). Figure 13 demonstrates the prevalence of presarcopenia, sarcopenia and severe sarcopenia stratified by gender and age, respectively.

Sarcopenic individuals were significantly older than non-sarcopenic individuals. They also had significantly lower weight, BMI, waist circumference, hip circumference, MUAC, CC, and MNA-score. Only in Baumgartner’s method, sarcopenic subjects used significantly more medications, had a significantly lower fat percent and smoked significantly more than non-sarcopenic subjects. Only in Janssen’s method, sarcopenic subjects were significantly less active and had a significantly lower MMSE score than non-sarcopenic individuals. Comparison of sarcopenic and non-sarcopenic individuals is shown in table 13. When
comparing those categorized as sarcopenic in Baumgartner’s and Janssen’s method at calculating low muscle mass, there were significant differences regarding gender, BMI, hip circumference, MUAC, CC, fat percent and MNA score.

In Baumgartner’s method, a large part of those with normal muscle mass had reduced physical function. In Janssen’s method, only a small fraction of those with normal muscle mass had reduced physical function. Of those with reduced muscle mass estimated by Janssen’s method, there were many with normal physical function. This regarded fewer subjects when Baumgartner’s method was used. All individuals who were sarcopenic by Baumgartner’s method were also sarcopenic by using Janssen’s method at estimating low muscle mass.

Subjects with BMI ≥30 had significantly higher SMI than normal weight subjects. None of the obese subjects had reduced muscle mass calculated by Baumgartner’s method, while 9.7% had reduced muscle mass calculated by Janssen’s method.

**Figure 12.** EWGSOP-suggested algorithm for sarcopenia case finding applied in the current sample (modified after (33)).
Figure 13a. Prevalence of presarcopenia, sarcopenia and severe sarcopenia when Baumgartner’s method was used in the calculation of SMI. Significant differences were seen between both genders and ages when sarcopenia and severe sarcopenia was combined. SMI = appendicular muscle mass/height$^2$ (kg/m$^2$). Appendicular muscle mass = the sum of muscle mass in both legs and both arms. Cut-off was <5.45 in women and <7.26 in men. Presarcopenia, low muscle mass; sarcopenia, low muscle mass and low handgrip strength or gait speed; severe sarcopenia, low muscle mass and both low handgrip strength and gait speed.

Figure 13b. Prevalence of presarcopenia, sarcopenia and severe sarcopenia when Janssen’s method was used in the calculation of SMI. Significant differences were seen between both genders and ages when sarcopenia and severe sarcopenia was combined. SMI = absolute muscle mass/height$^2$ (kg/m$^2$). Absolute muscle mass = (height$^2$/bioelectrical impedance analysis resistance x 0.401) + (gender x 3.825) + (age x -0.071) + 5.102. Cut-off was <6.76 in women and <10.76 in men. Presarcopenia, low muscle mass; sarcopenia, low muscle mass and low handgrip strength or gait speed; severe sarcopenia, low muscle mass and both low handgrip strength and gait speed.
Table 13. Comparison of sarcopenic and non-sarcopenic individuals, n = 219-236.

<table>
<thead>
<tr>
<th></th>
<th>Sarcopenic, Baumgartner</th>
<th>Non-sarcopenic, Baumgartner</th>
<th>Sarcopenic, Janssen</th>
<th>Non-sarcopenic, Janssen</th>
<th>p²</th>
<th>p³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female, n (%)</td>
<td>1 (11.1)</td>
<td>121 (56.0)</td>
<td>39 (70.9)</td>
<td>83 (48.8)</td>
<td>0.01</td>
<td>0.004</td>
</tr>
<tr>
<td>Age, years</td>
<td>82.0 (76.5-85.5)</td>
<td>74.0 (71.0-78.0)</td>
<td>78.0 (74.0-82.0)</td>
<td>73.0 (71.0-76.3)</td>
<td>0.01</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>63.2 (9.0)</td>
<td>75.4 (13.6)</td>
<td>64.9 (10.3)</td>
<td>78.2 (13.0)</td>
<td>0.01</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>21.0 (1.7)</td>
<td>26.4 (4.1)</td>
<td>24.3 (3.7)</td>
<td>26.7 (4.1)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Waist circumference, cm</td>
<td>86.4 (8.6)</td>
<td>95.5 (12.1)</td>
<td>88.1 (11.2)</td>
<td>97.5 (11.5)</td>
<td>0.03</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hip circumference, cm</td>
<td>97.4 (3.3)</td>
<td>105.3 (8.2)</td>
<td>101.4 (6.2)</td>
<td>106.1 (8.4)</td>
<td>0.01</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MUAC, cm</td>
<td>26.5 (2.0)</td>
<td>30.9 (3.5)</td>
<td>28.2 (2.9)</td>
<td>31.6 (3.4)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CC, cm</td>
<td>32.6 (2.4)</td>
<td>37.7 (3.0)</td>
<td>35.4 (2.9)</td>
<td>38.1 (3.0)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MNA score</td>
<td>25.0 (23.0-27.0)</td>
<td>28.0 (26.8-29.0)</td>
<td>27.0 (26.0-28.0)</td>
<td>28.0 (27.0-29.0)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Number of daily prescribed medications</td>
<td>4.0 (2.0-6.5)</td>
<td>2.0 (1.0-4.0)</td>
<td>3.0 (1.0-5.0)</td>
<td>2.0 (1.0-4.0)</td>
<td>0.03</td>
<td>0.05</td>
</tr>
<tr>
<td>Fat percent</td>
<td>23.4 (9.7)</td>
<td>31.4 (8.6)</td>
<td>31.6 (8.5)</td>
<td>30.9 (8.9)</td>
<td>0.01</td>
<td>0.57</td>
</tr>
<tr>
<td>Smoke, n (%)</td>
<td>3 (33.0)</td>
<td>11 (5.1)</td>
<td>6 (10.9)</td>
<td>8 (4.7)</td>
<td>0.01</td>
<td>0.11</td>
</tr>
<tr>
<td>Inactivity, n (%)</td>
<td>6 (66.7)</td>
<td>90 (41.9)</td>
<td>31 (56.4)</td>
<td>65 (38.5)</td>
<td>0.18</td>
<td>0.02</td>
</tr>
<tr>
<td>MMSE score</td>
<td>25.0 (25.0-28.0)</td>
<td>28.0 (26.0-30.0)</td>
<td>26.0 (24.5-28.0)</td>
<td>28.0 (26.0-30.0)</td>
<td>0.14</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diabetes mellitus, n (%)</td>
<td>0 (0)</td>
<td>9 (4.2)</td>
<td>2 (3.6)</td>
<td>7 (4.1)</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Cardiovascular disease, n (%)</td>
<td>2 (28.6)</td>
<td>31 (15.1)</td>
<td>11 (21.6)</td>
<td>22 (13.7)</td>
<td>0.30</td>
<td>0.18</td>
</tr>
<tr>
<td>Cancer, n (%)</td>
<td>1 (11.1)</td>
<td>16 (7.4)</td>
<td>3 (5.5)</td>
<td>14 (8.2)</td>
<td>0.51</td>
<td>0.77</td>
</tr>
</tbody>
</table>

Continuous data are presented as mean (SD) when normally distributed, and as median (25 th – 75 th percentile) when not normally distributed. Sarcopenia includes low skeletal muscle index (SMI) and low physical function. Sarcopenic, Baumgartner: SMI = appendicular muscle mass/height² (kg/m²). Appendicular muscle mass = the sum of muscle mass in both legs and both arms. Low muscle mass was <5.45 in women and <7.26 in men. Sarcopenic, Janssen: SMI = absolute muscle mass/height² (kg/m2). Absolute muscle mass = (height/2/bioelectrical impedance analysis resistance x 0.401) + (gender x 3.825) + (age x -0.071) + 5.102. Low muscle mass was <6.76 in women and <10.76 in men. BMI, body mass index; MUAC, mid-upper arm circumference; CC, calf circumference; MNA, Mini Nutritional Assessment; MMSE, Mini-Mental State Examination. p¹ Sarcopenic vs. non-sarcopenic estimated by Baumgartner’s method (Independent-samples t-test, Mann-Whitney U test, chi-square or Fisher’s Exact test). p² Sarcopenic vs. non-sarcopenic estimated by Janssen’s method (Independent-samples t-test, Mann-Whitney U test, chi-square or Fisher’s Exact test). p³ Sarcopenic Baumgartner vs. sarcopenic Janssen (Independent-samples t-test, Mann-Whitney U test, chi-square or Fisher’s Exact test). Data are statistical significant when p <0.05.
5 Discussion

5.1 Subjects and methods

5.1.1 Study population

The current study comprised community-dwelling subjects, aged 70 years or older living in Skedsmo municipality in 2014. When comparing age distribution among the participants to age distribution in Skedsmo municipality, there was an overrepresentation in the current study among individuals in their early seventies. These subjects are likely to have higher muscle mass and physical function than older individuals. In the current sample, there were few immigrants compared to the total population in Skedsmo (260), and there were very few smokers compared to data from Statistics Norway (261). Most participants were weight stable and more than half were physically active and within the normal range of BMI for subjects aged 70 years or older (259). The participant’s mean systolic blood pressure was heightened when compared to the reference value of the Norwegian Directorate of Health (262). However, the mean blood pressure was lower than the findings in a large Norwegian blood pressure study including subjects aged 70 years or older (263). All blood samples were within the reference values of Fürst Medical Laboratory. The above mentioned factors together with MNA- and MMSE scores, suggest that participants in the current study were in good health.

Of those who received invitations for study participation, 16.1% agreed to participate. Being able to meet at Oslo and Akershus University College was a necessity for participation. In this regard, individuals with impaired health may have had practical limitations, such as disease or lack of transportation. Immigrants may have been poorly represented due to difficulties regarding language. Subjects with low interest in health or research and subjects with regular health service contact may have been underrepresented. Subjects with health above average may thus have been recruited, implying that selection bias may have occurred and the true prevalence of sarcopenia may have been underestimated. To reach subjects with different characteristics, recruitment could have been done differently. Oral invitations could additionally have been given to subjects at the mall, at welfare service centers for the elderly or by telephone. Either way, it is challenging to obtain a sample representative for all
community-dwelling subjects aged 70 years or older living in Skedsmo. Generalization of the current results to populations with different characteristics is difficult, implying a potentially low external validity.

5.1.2 Study design

The cross-sectional design of the current study implies that it cannot say anything about causal connections, but rather associations that can be used to generate hypotheses. The study was not free of unmeasured or uncontrolled confounders, such as nutrition, education and workplace, due to its observational nature. Thus, one should be careful generating hypotheses regarding associations between sarcopenia and potential risk factors. Furthermore, despite a systematic operating processes, one cannot completely out rule random or systematic bias in the collection or in the analyses of data. Reporting bias may have occurred in self-reported data. Self-reported data were however not included in the main results in the Thesis.

The current study also had several strengths regarding study design. It was inexpensive and allowed assessment of many variables. To the best of our knowledge, it was the first study to investigate the prevalence of sarcopenia in Norwegian elderly. All subjects aged 70 years or older could participate. The study included a large well-characterized sample in a geographical defined area. Thus, external factors affecting health, such as health service and activity provision, may have been more similar than in subjects living far apart. However, some of the participants may have lived elsewhere previously, and this was not recorded. Invitations were sent to subjects by post, instead of recruiting subjects from pre-defined locations, making selection bias less likely. Information bias should have been avoided by consistently giving equal, standardized information and questions to all participants. The same person conducted most of the measurements regarding muscle mass and physical function. The resulting inter-individual variance in data collection and processing was thus small.

5.1.3 Anthropometric measures

Measurement of height in elderly may be imprecise due to difficulties standing in upright position. This is likely to be of more importance in elderly samples than the current. Waist circumference is not aimed at estimating muscle mass, but rather predict risk of metabolic disease (264). It entails an eminent day to day variation. Although participants were asked to
relax in the abdomen during measurement, it may not have been consistently accomplished. MUAC may give an indication on subjects in risk of having low muscle mass or physical function (74). MUAC is less affected by oedema than CC. CC has been correlated to muscle mass, and a circumference <31 cm has been associated to disability (78). CC has been found to be relevant in the screening of sarcopenia when BIA is not available (78). However, all anthropometric measures are sensitive to measurement error. Furthermore, changes in fat deposits and loss of skin elasticity occur with increasing age (33). In the current study, anthropometric measures were not included in the recognition of sarcopenia, as it is not recommended by EWGSOP (33).

5.1.4 Defining low muscle mass by two methods

The prevalence of low muscle mass varies depending on method measuring muscle mass, cut-offs, whether absolute or appendicular muscle mass is used, and whether adjusting for height, weight, BMI or body fat. Two methods adjusting muscle mass for height were conducted in this study. Newman et al. found that correction for height can underestimate the prevalence of sarcopenia in overweight subjects (44). Since elderly decline in height with increasing age, correction for height may overestimate muscle mass when compared to younger persons. Subjects low in height, generally gain a high SMI by this method. Furthermore, reference populations differ in age, ethnicity, genetic background, and environmental factors such as physical activity. Data from the Hordaland Homocysteine Study could have been applied to calculate cut-offs, however, BIA-resistance and appendicular muscle mass were not published (265). American populations were used as reference in this study (27, 46). One may question if the reference population Baumgartner and Janssen used to define cut-offs are representative for Norwegian elderly.

In the literature, Baumgartner’s method at estimating muscle mass has been frequently used (124-126, 129). The young persons Baumgartner used as reference had similar BMI as subjects in the current study (27). There may be intergenerational differences when comparing today’s elderly with today’s younger subjects. One may speculate that young individuals now are more sedate and have lower muscle mass than the elderly did when they were young. Baumgartner’s calculation of appendicular muscle mass was based on data from DXA. According to EWGSOP, Baumgartner’s method can be used on data based on both DXA and BIA (33). Cut-offs based on DXA measures have been applied on BIA measures in several
other studies (41-43). Cut-offs calculated by data from BIA have been found to be similar as Baumgartner’s cut-offs (123, 141, 144, 145). Other studies using DXA to measure muscle mass have gained similar SMI as in the current study using BIA to measure muscle mass (118, 124). Still, one should be careful interpreting the current data with cut-offs based on DXA measures.

Janssen’s calculation of absolute muscle mass was based BIA measures in middle aged Americans (45). This regression equation was developed and cross-validated based on magnetic resonance imaging. However, this calculation may be inaccurate as $r^2$ for the equation was 0.86 (45). The calculation has been shown to be precise in normal weight subjects, but not as precise in extreme obese or sick subjects (72). Later, Janssen developed cut-offs for this equation, including Canadian subjects with similar distribution of gender, age and BMI as subjects in the current study. Cut-offs were developed based on SMI values that were associated with increased risk of disability in this sample (46). Thus, subjects with difficulties in the daily living might be recognized.

5.1.5 Measure of muscle mass

In the current study BIA was used to estimate muscle mass. Direct measures on muscle mass, such as CT, MRI or DXA, are preferable where accuracy is paramount (33, 68). However, these methods are expensive and little accessible. There have been different conclusions in the literature regarding the validity and reliability of BIA. The validity of BIA is dependent on age, gender, hydration, health conditions and cultural influences. Many have found BIA to be reliable and valid at estimating body composition (45, 53, 66, 266, 267). BIA has been shown to correlate well with DXA (65-67). However, BIA has also been found to overestimate muscle mass compared to DXA (125, 268). One study found that BIA had high concurrent validity, but the estimate of fat-free mass was significantly different from DXA (269). Thus, using separate cut-offs for BIA and DXA should be considered.

Different BIA-devices may give different results due to use of dissimilar equations, thus making comparison between studies challenging. In a study comparing the BIA-device used in this study to DXA, high correlations were found regarding both all-body fat free mass and appendicular fat free mass (66). Tanita BC-418 MA has been found to be more precise in estimating whole body fat free mass than fat mass (67). However, others have found this device to underestimate muscle mass in elderly men and overestimate muscle mass in elderly
women (270). Another study found this device to overestimate total muscle mass compared to DXA (271). The accuracy and precision of BIA to predict muscle mass is however generally acceptable for population level studies (68).

BIA is affected by edema, use of diuretics, extreme body weight (53, 272), food intake and exercise (45). Edema and extreme obesity might mask muscular atrophy. Few of the participants in this study had apparent edema or extreme obesity. Intramuscular fat tissue is not assessed by BIA (273). Use of diuretics was not accounted for in the current study. Most participants had eaten before BIA-measurement. This may have resulted in higher values of fat free mass when compared to fasting state. Physical tests were conducted after BIA measurement to limit the effect of exercise. However, physical activity conducted earlier at test day was not registered. Furthermore, withdrawing one kg from weight for clothes may have been inaccurate in some subjects. Even though subjects were asked if they needed to go to the toilet, it is not sure all who felt the need did so, resulting in increased amounts of fat free tissue. BIA can be performed by most clinicians and it requires no special equipment or complicated mathematical skills. BIA is appropriate for both ambulatory and bedridden patients. Furthermore, it is less affected by fluid retention than CC.

5.1.6 Strength and limitations of physical tests

Comparison of muscle mass and physical function may give an indication of muscle quality (21). The physical tests included in the current study may have been affected by medical diagnoses such as arthritis and chronic obstructive pulmonary disease, pain and motivation to perform. In several studies, gender-, BMI- and age specific cut-offs have been used to a larger extent than in the current study. Equal cut-offs in SPPB and the stair climbing test in men and women across different ages and BMI values were applied in the current study.

5.1.6.1 Handgrip strength

The handgrip strength test was performed in sitting position to ensure that all participants could conduct the test, regardless of physical functional level in the lower body. The dynamometer applied in this study was not adapted regarding hand size, thus subjects with big hands may have gained higher values than subjects with small hands. There are ambiguous results regarding comparison of different dynamometers in the literature (88, 125). Arthritis and fractures may have been limiting factors for conducting this test. The use of
three attempts on each hand instead of one, increased the probability of finding the true
handgrip strength, thus not overestimate the prevalence of low muscle strength. Handgrip
strength may be easier to conduct than other physical tests in cognitive or functionally
impaired subjects.

5.1.6.2 SPPB

SPPB requires little equipment and space and it is eligible for patients with variable physical
function. A few participants may have used sleeping pill the night before the balance test was
conducted, thus affecting the result marginally. In the gait speed test, the wording “a bit faster
than normal gait speed”, may have been interpreted differently between subjects. The gait
speed test started with subjects standing still. Thus, reaction time has been a component of the
test. Since a decline in neuromuscular transmission velocity may be a component of
sarcopenia (192-195), reaction time might be useful to include. The use of manual timer,
which may have been an inaccurate measure, was discussed before study start. However, it
was used in all participants and standardized information was given to all. Furthermore, gait
speed is affected by height (274), implying that different cut-offs might be used in different
ethnicities and genders. Cut-off was the same for all subjects in the current study. Regarding
the rise and sit test, arthritis and pain were mentioned by some participants as limiting factors
for conducting the test. Further research is necessary to evaluate SPPB as a predictor of
sarcopenia.

5.1.6.3 Stair climbing test

Arthritis and chronic obstructive pulmonary disease were mentioned by some subjects as
limiting factors for the stair climbing performance. Participants who used the rail in the stairs
may have performed better, however most participants obviously used the rail to maintain
balance. The instructor walked behind participants with distinct reduced balance or physical
function. This regarded few subjects, but might have increased the performance marginally.
5.1.7 Statistics

The large sample in the current study increased the likelihood of finding statistically significant results. However, the limited number of persons with sarcopenia identified by Baumgartner’s method may have limited the statistical power in analyses comparing sarcopenic and non-sarcopenic individuals to some extent. Due to the large discrepancy between the two methods at defining low muscle mass, multiple regression aimed at explaining muscle mass was not conducted.

5.2 Discussion of results

5.2.1 Anthropometry

WHO have defined cut-offs for waist circumferences related to increased risk of metabolic complications. There are increased risk with waist circumference >80 cm in women and >94 cm in men (264). Average waist circumferences were above these limits in both men and women in all ages in the current study. Waist circumference, MUAC and CC were significantly higher in women aged 70-74 years than 80 years or older in this study. This was not found in men, implying a bigger change in body composition with increasing age in women compared to men. De Almeida et al. found similar results (275). Very few participants had low MUAC and CC as classified in the MNA-form. Weight and fat free mass were higher in subjects aged 70-74 years than older, while fat mass was relatively similar across ages. Kyle et al. also found fat free mass to decrease and fat percent to be stable after the age of 75 years (276). This represents a trend towards a disadvantageous body composition, which may impact development of life-style related diseases and activities of daily living.

5.2.2 Prevalence of low muscle mass by using two methods

There was a strong correlation between the two methods at estimating SMI. By using both Baumgartner and Janssen’s method, mean SMI were 7.3 kg/m². Janssen’s equation estimates absolute muscle mass including muscles in the truncus, and is thus expected to be higher than the appendicular muscle mass estimated by Baumgartner’s method. This implies that either method used to estimate muscle mass or cut-off used were not suitable in the current population. Several studies have used Baumgartner’s method at estimating SMI among
community-dwelling elderly, mostly based on DXA measurements. Studies conducted in industrialized countries at subjects with similar BMI as participants in the current study, have found similar SMI as in the current Thesis (118, 128, 139). Furthermore, others have gained lower (125, 129) or higher (31) values.

Several studies in industrialized countries using Janssen’s equation and BIA at estimating SMI among community-dwelling individuals, have gained higher SMI values than the current study (74, 117, 147). The current population may differ from the populations in these studies, however it may also imply that the regression equation developed by Janssen et al. is not suitable for an elderly Norwegian population.

Prevalence of low muscle mass varied considerably in studies included in the literature search conducted in the current Thesis, which encompassed community-dwelling individuals only. No obvious pattern was discovered among studies conducted in industrialized countries regarding age, gender and method used to assess muscle mass. In the current sample, the shapes of the SMI curves were similar in both Baumgartner’s and Janssen’s method, however the cut-offs differed. Baumgartner’s definition classified considerably fewer with low muscle mass than Janssen’s definition due to lower cut-offs. All subjects with low muscle mass estimated by Baumgartner’s method also had reduced muscle mass according to Janssen’s method, indicating that Baumgartner’s method may recognize those with lowest muscle mass.

Considering that subject characteristics indicated that the participants were in good health, and that few participants had low CC or MUAC, the results obtained by Baumgartner’s method seem more reliable than results from Janssen’s method in the current sample. MUAC and CC correlated more strongly to Baumgartner’s method than Janssen’s method. Since Baumgartner’s cut offs were based on DXA measures, its interpretation based on BIA measures should be done carefully. However, in a small pilot (n=33), no significant difference in estimation of SMI by using Baumgartner’s method was found when comparing BIA and DXA measurements in the current study (personal communication, Inger Ottestad). More studies using Baumgartner’s method on BIA measures are however needed.

Women had significantly lower prevalence of low muscle mass than men in both Baumgartner’s and Janssen’s method, which is also found by others (74). Fat-free mass has been found to decline faster in men than in women (16-18). However, women have a lower peak muscle mass and a longer lifespan, thus possibly making them more susceptible for the
consequences of low muscle mass in older age (10). No significant difference in SMI estimated by both methods was found between age groups in the current study, which is opposite to the findings by others (117). However, men in the oldest age group in the current study had a higher prevalence of reduced SMI than men in the youngest age group only by using Baumgartner’s method.

The four main reasons for loss of muscle mass is cachexia, anorexia, dehydration and sarcopenia (233). Loss of muscle mass and strength may result in mobility disorders, osteoporosis, falls and fractures, impaired activities of daily living, disabilities, infections, loss of independence, poor quality of life and death (6-13). To what extent low muscle mass per se is related to poor function and outcome is still controversial (26, 31). A decline in muscle quality is suggested to occur with increasing age (21). It has been found that women with low SMI weigh less than those with high SMI (128), suggesting that a low body weight might be disadvantageous in old age. However, subjects with high gait speed have also been found to weigh less or have lower fat mass than subjects with low gait speed (128, 137). In persons aged 80 years or older, muscle strength and physical performance may be more important than muscle mass in predicting sarcopenia (14, 21, 128, 277).

### 5.2.3 Physical tests

#### 5.2.3.1 Handgrip strength

The mean handgrip strength in the current study was 21.6 (5.2) kg in women and 37.4 (8.1) kg in men on the dominant hand. Other studies in industrialized countries including community-dwelling subjects at similar age as subjects in the current study have gained similar results (128, 129, 134), but also considerably lower values than these (11, 42, 122, 125). Due to variation in practice, comparison between studies should be done cautiously (278). In the current sample, 37.1 % of women and 11.8 % of men had reduced handgrip strength. Others have found more than half of community-dwelling subjects with mean age 74 years to have reduced handgrip strength (125), implying that subjects in this study were agile. A significantly higher proportion of low handgrip strength in women compared to men has also been found by others (139). In the current study, subjects in the youngest age group had higher handgrip strength than older subjects.
In accordance with other studies (70, 117, 130, 279), a strong correlation was found between SMI estimated by both methods and handgrip strength in this study, suggesting that muscle mass is relevant regarding muscle strength. However, handgrip strength has been found to predict disability and clinical outcomes better than low muscle mass (29). Furthermore, although handgrip strength has been correlated to lower extremity muscle strength (29), an isolated increase in leg muscle strength does not lead to increased handgrip strength. Conclusively, handgrip strength is a relevant measure of muscle strength as it has been correlated to incident disability for activities of daily living (80, 81), risk of falls (82), quality of life (83), long term disability onset, increased risk of complications, extended hospitalisation (84) and mortality (8, 26, 85, 86).

5.2.3.2 Gait speed

The mean gait speed in the current sample was 1.3 (0.3) m/s. In several studies including community-dwelling elderly conducted in industrialized countries, the mean gait speed were 1.0-1.1 m/s (74, 77, 117, 128, 134), implying that subjects in the current study were agile. EWGSOP do not specify if gait speed should be measured from still standing position or moving position, which has an impact on the gait speed. Some measure gait speed in three meters without the initiation phase, and others measure gait speed in six meters with the initiation phase. The use of different methods to measure gait speed makes comparison between studies challenging. In the current study, 8.9 % of the sample had reduced gait speed, classified as <1 m/s. In a British study including younger community-dwelling subjects than in the current study, similar numbers gained reduced gait speed classified as <0.8 m/s (135). Malmstrom et al. found 25.1 % of African American middle-aged subjects to have gait speed <1.0 m/s (31).

Gait speed classified significantly fewer subjects with low performance when compared to handgrip strength. Those aged 80 years or older in the current sample had lower gait speed when compared to subjects aged 70-80 years old, suggesting that gait speed is a method more suitable in an older sample with a higher prevalence of sarcopenia. Gait speed may not be sensitive enough in community-dwelling individuals (122). No significant correlation was found between SMI and gait speed, which is also found by others (74). However, some have shown the opposite (117, 137). Furthermore, gait speed has been correlated to SPPB, stair
climb, disability, risk of falls, adverse health outcomes and mortality (97, 98, 103, 104, 106-111), and should thus be regarded as a relevant measure of physical function.

5.2.3.3 Other physical tests

The median total SPPB score was 11.0 (11.0-12.0) points. Finnish community-dwelling women around the same age as the current sample have been found to score 10.7 points in SPPB (128). In the current study, the score was lower among subjects aged 80 years or older than in subjects between 70 and 80 years, implying a greater value in an elderly sample than in the current. Men and women gained similar results in SPPB, which may justify using similar cut-offs in SPPB in both genders. Only 5.5 % had a total SPPB-score below the cut-off set at eight points or less, thus the value of SPPB might be questioned in an agile population. In a Belgian study on community-dwelling subjects at the same age as the current sample, 20.4 % scored eight points or less in SPPB (125). SPPB has been associated with disability, institutionalization and mortality (96, 98-100). Gait speed alone has been found to be nearly as good as SPPB in total to predict disability (98). SPPB classified fewer with reduced performance than gait speed in the current sample. Beaudart et al. found a similar prevalence of sarcopenia in community-dwelling subjects by using gait speed and total SPPB score (125). Thus, one may question if conducting SPPB as a whole, results in additional information than gait speed.

The stair climbing power test has been found to be consistent with other more complex methods for estimating leg power and also SPPB (115). Since men performed better on the stair climbing test than women, gender-specific cut-offs might be an alternative in the future. The significant correlation found between SMI estimated by both methods to handgrip strength and stair climbing test may imply that they were more relevant regarding sarcopenia than SPPB in the current sample. Both the rise and sit test and the stair climbing test defined about as many with low performance as the handgrip strength test. About half of those with reduced stair climbing performance or rise and sit performance also had reduced handgrip strength, implying that the different physical tests comprise different elements of physical function. However, the cut-offs applied to the rise and sit test and the stair climbing test are not well-established.
5.2.4 Prevalence of sarcopenia

EWGSOP’s definition of sarcopenia includes low muscle mass and low muscle strength preferably measured by handgrip strength, or low physical performance preferably measured by gait speed. However, different methods of measuring muscle mass and physical function are suggested by this group (33).

The prevalence of sarcopenia differed considerably when applying Baumgartner’s method and Janssen’s method at estimating low muscle mass, respectively. By using Baumgartner’s method, four percent was defined as sarcopenic. This low share may imply that sarcopenia was not prevalent in this population, or that the cut-offs in this method are too low. Among European studies included in the literature search conducted in the current Thesis, the prevalence of sarcopenia ranged from 0.9 to 27.6 % when Baumgartner’s method was applied on DXA measures (table 3). By using Janssen’s method at estimating low muscle mass, 24.4 % of the current sample was classified as sarcopenic. In studies included in the literature search, the prevalence of sarcopenia ranged from 5.0 % to 30.5 % by using absolute muscle mass divided by height squared measured by BIA (table 4). Cut-offs to this method vary considerably. The cut-offs used in the current study were similar to the highest cut-offs among the studies included in the search (74). By including both Baumgartner’s- and Janssen’s method, handgrip strength classified more subjects as sarcopenic than gait speed, suggesting that handgrip strength was more relevant in this sample.

It was found that sarcopenia was more common in men than in women by using Baumgartner’s method, which is consistent with another study using Baumgartner’s method (40). Sarcopenia was more common in women than in men by using Janssen’s method, which is also found by others using this method (117). In most studies there is no significant difference between genders (30, 121-123). By using both methods, sarcopenia was more common in subjects aged 80 years or older than in subjects between 70 and 80 years old, which are in line with the findings in most other papers (27, 117-119, 124).

In the current study, sarcopenic individuals had significantly lower weight, BMI, waist circumference, hip circumference, MUAC, CC and MNA score than non-sarcopenic individuals. Subjects with sarcopenia have been reported to have lower MNA scores than subjects without sarcopenia by others (119, 280), suggesting that nutritional status is of importance regarding the development of sarcopenia. BMI has also been found to be lower in
sarcopenic individuals when compared to non-sarcopenic individuals in several studies (117, 124, 125, 147), while no difference is found in others (74). BMI may however reflect other confounding factors such as poor nutritional intake or comorbidity. Beaudart et al. also found CC and MUAC together with fat mass to be lower among subjects with sarcopenia than without sarcopenia (125). MUAC and CC provide however indirect measures of muscle mass. Fat percent was found to be lower among sarcopenic individuals than non-sarcopenic individuals only by using Baumgartner’s method in the current study. Body size may thus be inversely related to sarcopenia.

By using Baumgartner’s method, sarcopenic individuals used a higher number of medications than non-sarcopenic individuals, which is also found by others (117). Beaudart et al. did not find this (125). There were few smokers in the current sample. Still, there were more smokers among sarcopenic individuals than non-sarcopenic individuals in Baumgartner’s method. Smoking has also been positively associated with sarcopenia by others (44), thus might be regarded as a risk factor for sarcopenia. Due to the small number of subjects classified as sarcopenic by using Baumgartner’s method, one should be careful interpreting appurtenant results. It was found that subjects with sarcopenia had lower MMSE score compared to subjects without sarcopenia by using Janssen’s method. Landi et al. also found a lower cognitive function among sarcopenic than non-sarcopenic individuals (152). No significant difference in comorbidity was found between sarcopenic and non-sarcopenic individuals in the current sample, which is in agreement with the findings by Legrand et al. (147). Additionally, low income (27, 153), low education (31) and depression (152) have been associated with sarcopenia by others.

When comparing those categorized as sarcopenic between Baumgartner’s- and Janssen’s method at calculating low muscle mass, they were significantly different regarding gender, BMI, hip circumference, MUAC, CC, fat percent and MNA score. These differences may partly be a result of different distribution of genders, which may also regard differences discovered between sarcopenic and non-sarcopenic individuals. Due to the observational nature of the current study, causality in the above mentioned factors cannot be determined.

In the current study, there was no significant difference in SMI estimated by both methods between physical active and inactive subjects. However, physical active subjects performed significantly better on all physical tests compared to inactive subjects. By using Janssen’s method, physical active subjects had significantly lower prevalence of sarcopenia when
compared to physical inactive subjects, which is consistent with the findings by others (124, 152). Activity level in middle age has been associated with sarcopenia in older age (144). Furthermore, these findings emphasize the possible preventive effect of physical activity. Physical function may be more relevant than muscle mass regarding sarcopenia due to the possible change in muscle quality (21). Since few subjects were recognized with low muscle mass in Baumgartner’s method, one might miss several subjects with reduced physical function affecting daily living in the definition of sarcopenia.

Furthermore, the large dispersal in the prevalence of sarcopenia discovered in the current study emphasizes the need for a diagnostic consensus regarding sarcopenia. Dam et al. found a poor positive, but good negative agreement when applying FNIH, EWGSOP and IWG criteria for recognizing sarcopenia (134). In the literature search conducted in this Thesis on papers using EWGSOP’s definition of sarcopenia, no obvious pattern was discovered regarding nationality, distribution of genders, age or diagnostic criteria.

Based on the current participant’s age, BMI, MUAC, CC, physical activity level, MNA-score, MMSE-score, blood samples and smoking status, sarcopenia may not be prevalent in the current study sample. Thus, a sarcopenia prevalence of 4.0 % as calculated by using Baumgartner’s method might be more realistic than 24.4 % as obtained by using Janssen’s method.

5.2.4.1 Sarcopenic obesity

Sarcopenia has been suggested to be a bigger problem in obese individuals than in underweight individuals (155). However, in the current study subjects with BMI ≥30 had significantly higher SMI than subjects with BMI <30. Thus, this indicates that obese sarcopenia was not the main challenge in this group. Furthermore, sarcopenic individuals had a lower fat percent than non-sarcopenic individuals. It is important to emphasize that intramuscular fat tissue is not assessed by BIA (273). Excess body weight may be regarded as strength training, thus resulting in increased muscle mass relative to height, but not to weight. A higher BMI may indicate a higher nutritional intake, thus explaining the inverse relationship between sarcopenia and BMI. This inverse relationship is also found in other studies (117, 124, 125, 147). High fat mass is an important determinant for functional status in elderly (23, 164, 281). However, by using Janssen’s method in the current sample, those with reduced SMI performed significantly better on all physical tests. Women with lower
body weight have been found to have higher gait speed than those with higher body weight (128). This may imply that those with high BMI and SMI are hampered by high fat mass. The current results may have been different if fat mass was accounted for (44) or if muscle mass was adjusted for weight (10).

5.2.5 Clinical implications

Sarcopenia has been associated with mortality (30, 31), hospitalization, need for long-term care, higher health care expenditures (33, 38, 282), decreased quality of life (38), osteoporosis (7), functional decline and disability (10, 24, 27-29). Subjects with severe sarcopenia have been found to have 2-5 times increased risk of functional impairment or disability when compared to subjects with normal muscle mass (10, 27, 46). Many observational studies have identified decreased muscle mass or physical function as one of the most important risk factors for falls, subsequently resulting in morbidity and mortality (108, 111, 123, 152, 283). Janssen et al. have suggested a bidirectional relationship between sarcopenia and disability, including that physical disability can cause sarcopenia through lower level of physical activity and decreased stimulus to skeletal muscle (12). A ten percent reduction in the sarcopenic population has been calculated to save $1.1 billion every year in USA (15). The costs of sarcopenia have not been estimated in Norway, thus agreement of diagnostic criteria in order to determine and prevent the costs of sarcopenia are needed.

In the clinic, tests that can be performed simply, safely, cost-effectively and simultaneously predict adverse outcomes are preferred. Early reliable identification of sarcopenia would seem to be a powerful step towards understanding the process of ageing, improving physical functioning, preventing falls and disabilities and consequently improving the quality of life in the older population. Those with early sarcopenia are most likely to benefit of interventions, but those who seek treatment are mostly subjects with more severe cases of sarcopenia. When different diagnostic criteria define different subjects as sarcopenic, they may differ in clinical characteristics and consequences. Thus, therapeutically approaches will not be easily evaluated or implemented. Meanwhile, adequate nutrition, physical activity and not smoking are important to stay healthy (38).
6 Conclusion

The primary objective of this Thesis was to provide more knowledge about the prevalence of sarcopenia among community-dwelling elderly living in the municipality of Skedsmo. Sarcopenia was defined as the presence of low muscle mass and low muscle strength, measured by handgrip strength, or physical performance, measured by gait speed, as suggested by EWGSOP. In this study it was found that:

- The prevalence of low muscle mass was 10.1 % by using Baumgartner’s method and 88.1 % by using Janssen’s method. Women had a lower prevalence of low muscle mass when compared to men. The prevalence of low muscle mass calculated by Baumgartner’s method was lower in men aged 70-74 years than in men aged 80 years or older.

- The prevalence of low handgrip strength was 37.1 % in women and 11.8 % in men, classified as <20 kg and <30 kg, respectively. Mean handgrip strength was 21.6 (5.2) kg in women and 37.4 (8.1) kg in men. Subjects aged 70-74 years had higher handgrip strength and gait speed than subjects aged 80 years or older. The prevalence of low gait speed was 8.9 % classified as <1 m/s. The mean gait speed was 1.3 (0.3) m/s.

- The prevalence of sarcopenia was 4.0 % by using Baumgartner’s method and 24.4 % by using Janssen’s method at estimating low muscle mass. Sarcopenia was more prevalent in men than in women in Baumgartner’s method and more prevalent in women than in men in Janssen’s method. In both methods, sarcopenia was more prevalent in subjects aged 80 years or older than in subjects between 70 and 80 years.

- Sarcopenic individuals were significantly older, had lower weight, BMI, waist-, hip-, upper-arm-, and calf circumference, and MNA score than non-sarcopenic individuals. Sarcopenic subjects were less active, smoked more, had lower MMSE score, used more medications and had lower fat percent than non-sarcopenic subjects only by one of the methods used to estimate muscle mass.

- The prevalence of sarcopenia seems highly dependent on diagnostic criteria, in which regard a consensus is highly needed to limit the potential consequences of sarcopenia in a constantly ageing population.
7 Future perspectives

The association between nutrition and sarcopenia was not investigated in this Thesis, and data are available for further investigation in the AMARONE-project. Due to the discrepancy between the two methods included in this study at estimating low muscle mass, multiple regression analyses to investigate factors affecting muscle mass were not conducted. Factors affecting both muscle mass and physical function need further investigation. Regression analyses allow adjustment for confounding and interacting factors. Data from this Thesis have generated hypotheses regarding sarcopenia in an elderly Norwegian population. However, future prospective studies are needed to be able to recognize risk factors for developing sarcopenia. Estimation of muscle mass by DXA, which is regarded as more accurate than BIA, might then be preferred.

The prevalence of sarcopenia seems highly dependent on definition, diagnostic tools to measure muscle mass, muscle strength and physical performance and cut-off values. A unique set of diagnostic criteria recognizing sarcopenia needs to be established. It is necessary to refine the diagnostic criteria of sarcopenia according to gender, age and ethnicity. The definition of sarcopenia should be validated with adverse outcomes, such as functional decline, falls, institutionalization, quality of life and preventable deaths. To be able to prevent the consequences of sarcopenia, the effect of nutrition, physical activity, and also pharmaceutical options on relevant clinical outcomes need to be further investigated. Based on the impact on clinical outcome, screening of sarcopenia could be included at admission and thereafter regularly in institutions. If sarcopenia is discovered in an early phase, it will be of substantial economic significance considering its consequences in a constantly ageing population.
References


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277. Hairi NN, Cuming RG, Naganathan V, Handelsman DJ, Le Couteur DG, Creasey H, et al. Loss of muscle strength, mass (sarcopenia), and quality (specific force) and its relationship with...


Appendices

Appendix 1. Study invitation and informed consent.

Appendix 2. Approval by REK.

Appendix 3. Protocol for anthropometric measures.

Appendix 4. Handgrip strength protocol.

Appendix 5. SPPB protocol.


Appendix 7. Mini-nutritional assessment.

Appendix 8. Mini-mental state examination.

Appendix 9. Data included in the two Master Thesis in the AMARONE-study.
Forespørsel om deltakelse i forskningsprosjektet

«Muskelmasse og muskelstyrke hos eldre personer»

Bakgrunn og hensikt
Dette er et spørsmål til deg om å delta i en forskningsstudie hvor hensikten er å undersøke forekomst av lav muskelmasse og muskelstyrke hos personer som er 70 år eller eldre. Vi henvender oss til deg fordi vi ønsker å komme i kontakt med alle hjemmeboende personer som er 70 år eller eldre, og som er bosatt på Romerike. Prosjektet er et samarbeidsprosjekt mellom Universitetet i Oslo (avdeling for ernæringsvitenskap), Norges Idrettshøgskole, TINE SA og Høgskolen i Oslo og Akershus. Studien foregår på Kjeller ved Høgskolen i Oslo og Akershus.

Hva innebærer studien?


Enkelte av dere som blir med i dette prosjektet vil bli spurrt om å delta i en annen studie hvor vi skal studere effekt av kost på muskelmasse, muskelstyrke og betennelsesstoffer. Muntlig og skriftlig informasjon vil bli gitt til aktuelle personer under visitten. Det er viktig å understreke at personer som blir invitert til å delta i en annen studie kan fritt velge å si nei til dette.

**Mulige fordeler og ulemper**

Mulige fordeler ved å delta i denne studien er at deltageren vil få svar på ulike undersøkelser og blodprøver (som f.eks. blodtrykk, kolesterol og blodsukker). Avdekker vi noen forhold som krever behandling av lege vil du få informasjon om dette. I tillegg vil vi invitere alle som møter til visitt til et seminar som vi har kalt «kosthold og fysisk aktivitet for eldre».

Mulige ulemper ved å delta i studien er ubehag i forbindelse med blodprøvetaking, samt at visitten vil ta noe tid. Det er for øvrig ingen risiko forbundet med deltagelse i denne studien. Noen kan føle ubehag ved blodprøvetagning, men vi bruker erfarne personer for å minimalisere ubehaget. Vi gjør oppmerksom på at deltagere ikke honoreres, og vi betaler ikke eventuelle utgifter i forbindelse med transport.

**Hva skjer med prøvene og informasjonen om deg?**

Prøvene tatt av deg og informasjonen som registreres om deg skal kun brukes slik beskrevet i hensikten med dette prosjektet. Alle opplysningene og prøvene vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger. En kode knytter deg til dine opplysninger og prøver gjennom en navneliste. Det vil ikke være mulig å identifisere deg i resultatene av studien når disse publiseres.

Det er kun personer knyttet til forskningsprosjektet som har adgang til navnelisten og som kan finne tilbake til deg. Innhenting av navn på innbyggere i kommuner på Romerike som er 70 år eller eldre er hentet fra Skattedirektoratet etter godkjenning fra disse. Det er ikke innhentet andre opplysninger utover navn og bostedsadresse. Innhenting av alle opplysninger og prøverresultater i denne undersøkelsens vil bli slettet i 2024.

**Frivillig deltagelse**

Det er frivillig å delta i studien. Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke til å delta i studien. Dette vil ikke på noen måte få noen konsekvenser for deg. Dersom du ønsker å delta, undertenger du samtykkeerklæringen på siste side. Dette gjøres under visitten hos oss. Om du nå sier ja til å delta, kan du senere trekke tilbake ditt samtykke. Dersom du senere ønsker å trekke deg eller har spørsmål til studien, kan du kontakte oss på telefon: 468 39 650 eller på mail: koststudier-hf@hioa.no.
Ytterligere informasjon om studien finnes i kapittel A – utdypende forklaring av hva studien innebærer.
Ytterligere informasjon om biobank, personvern og forsikring finnes i kapittel B – Personvern, biobank, økonomi og forsikring.

Samtykkeerklæring følger etter kapittel B.
Kapittel A - utdypende forklaring av hva studien innebærer

- Hvem kan delta i studien?
  Kvinner og menn som er 70 år eller eldre og som er hjemmeboende kan delta.

- Bakgrunnsinformasjon om studien:
  Mange eldre personer mister muskelmasse og muskelstyrke. Tap av muskelmasse er knyttet til økt sykelighet, reduksert livskvalitet og økt dødelighet. Det foreligger ikke tall på hvor mange eldre i Norge som er rammet av dette. Med økende antall eldre i Norge de kommende åren kan dette bli et økende folkehelseproblem. Det er stor forskningsinteresse knyttet til det å avdekke faktorer som knytter seg til tap av muskelmasse, og det er behov for norske forskningsstudier på dette området. I denne studien ønsker vi å undersøke forekomsten av aldersrelatert tap av muskelmasse og muskelstyrke i en norsk befolkning, og vi håper at denne studien avdekker faktorer knyttet slike aldersrelaterte endringer. Slike faktorer ønsker vi å studere nærmere i fremtidige studier, for på sikt å kunne avdekke årsaker til aldersrelatert muskelmasse.

Kapittel B - Personvern, biobank, økonomi og forsikring

Personvern
Opplysninger som registreres om deg er i forbindelse med tester, målinger og prøver som blir tatt av deg (se over) blir registrert og oppbevart hos oss (Universitetet i Oslo).

Alle involverte i prosjektet har taushetsplikt, og personer som ikke er involvert i prosjektet har ikke rett til innsyn i journalen som oppbevares hos oss. Alle tester og målinger av deg foregår på Høgskolen i Oslo og Akershus, mens blodprøvene som tas, som brukes til å karakterisere helsestatus til gruppen deltagerne som er med i studien, analyseres ved Fürst Medisinsk Laboratorium. Vi kobler ikke våre data mot andre registre som har opplysninger om deg (eks. Fødselsregister, Kreftregister etc.). Universitetet i Oslo ved professor Kirsten Holven er databehandlingsansvarlig.

Biobank
Kostholdet påvirker genene våre. I denne studien vil vi undersøke om det er endringer i genutttrykk i sirkulerende hvite blodceller, i såkalte perifere blod mononuklære celler (PBMC). Vi vil undersøke om inntaket av melkeproteiner påvirker genutttrykk. De analyser som tas i dette forskningsprosjetet blir tatt med henblikk på potensiell fremtidig forskning, de kan danne grunnlag for fremtidige undersøkelser og være med på å gi økt fagkunnskap. Analysene vil derfor ikke gi svar på om det foreligger feil i gener (mutasjoner), og våre analyser har ikke en relevant verdi for den enkelte deltagar. Resultater fra slike analyser vil du derfor ikke få opplysninger om.

Utlevering av materiale og opplysninger til andre
Hvis du sier ja til å delta i studien, gir du også ditt samtykke til at prøver og avidentifiserte opplysninger utleveres til de institusjoner som er samarbeidspartnere i prosjektet.

Rett til innsyn og sletting av opplysninger om deg og sletting av prøver
Hvis du sier ja til å delta i studien, har du rett til å få innsyn i hvilke opplysninger som er registrert om deg. Du har videre rett til å få korrigert eventuelle feil i de opplysningene vi har registrert. Dersom du trekker deg fra studien, kan du kreve å få slettet innsamlede prøver og opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner.

Økonomi og TINE sin rolle

Forsikring
Dersom et uhell eller en komplikasjon skulle inntreffe, er deltagerne dekket gjennom norsk pasientskadeerstatning.

Informasjon om utfallet av studien
Resultatene fra studien vil bli publisert, og deltagerne har rett til å få informasjon om resultatet av studien. Deltagerne vil få informasjon om hvor publisering skjer og hva som var resultatet av studien.
Samtykke til deltagelse i studien

Jeg er villig til å delta i studien

(Signert av prosjektdeltaker, dato)

Jeg bekrerter å ha gitt informasjon om studien

(Signert, rolle i studien, dato)
Inger Ottestad  
Institutt for medisinske basalfag, UiO  
Postboks 1046 Blindern  
0317 Oslo  

2014/150 Effekt av melkeproteiner på kroppssammensetning, muskelstyrke, inflammasjon og benhelse hos eldre personer

Forskningsansvarlig: Universitetet i Oslo  
Prosjektleder: Kirsten Holven

Prosjektomtale  
Økende alder er relatert til tap av muskelmasse og muskelstyrke. Dette er assosiert med en rekke helseproblemer hos eldre. Foreslåtte underliggende mekanismer er endring i nivå av hormoner og inflammatoriske markører, appetitt, samt inadekvat fysisk aktivitet og kosthold. Proteiner er nødvendig for syntese og oppretholdelse av muskler, men optimalt proteininnntak for å bevare aldersrelatert tap av muskelmasse er ikke kjent. I tillegg er det vist en gunstig sammenheng mellom innntak av melk og inflammasjonsmarkører. Studiens primære mål er å undersøke effekt av et daglig innntak av myse og melk (9 vs.3,4 % protein) på muskelmasse hos eldre personer (70 år) med redusert muskelmasse og muskelstyrke. Sekundært undersøkes effekt på nivå inflammasjonsmarkører, kroppssammensetning (fett og benmasse), muskelstyrke, apetitthormoner, gen ekspresjon i perifere blod mononukleære celler («PBMC whole genome transcriptomics») og DNA skade/reparasjon.

Vi viser til tilbakemelding på komiteens vilkår for ovennevnte prosjekt, mottatt 24.06.2014. Komiteen godkjente prosjektet i møtet 25.02.2014, under forutsetning av at følgende vilkår ble oppfylt:

2. Deltakerens reelle transportutgifter skal dekkes. Dersom det ikke er økonomiske rammer i prosjektet til å dekke slike utgifter, skal deltakerne informeres om det.
3. Informasjonsskriv skal revideres i tråd med det ovennevnte, og sendes komiteen til orientering.

Prosjektleders tilbakemelding på vilkårene

Prosjektleder gjør i sin tilbakemelding rede for at det er etablert en beredskapsløsning med henvisning til fastlege ved relevante funn. Transportutgifter i forbindelse med oppmøte ved Norges Idrettsøyskole vil refunderes, mens det i informasjonsskriv redegjøres for at øvrige utgifter ikke dekkes. Informasjonsskriv er for øvrig revidert i tråd med komiteens merknader.

Komiteen tar denne informasjonen til orientering, og anser med dette vilkårene for oppfylt.

Endringer i prosjektet

Som en del av sin tilbakemelding søker også prosjektleder om endringer i prosjektet. Disse endringene er
beskrevet i en egen endringsprotokoll.

Designt er endret fra tre til to studiearmer, slik at armen som skulle mottatt nativ myse utgår fra prosjektet. Det er gjort justeringer i seleksjonskriteriene, og endringer i primære endepunkt. Fordi daglig inntak av protein er redusert i det nye studiedesignet, er det også gjort en oppdatert risikovurdering. Det legges til nye analyser, og valgfri avgivelse av ytterligere blod- og fecesprøver.

Endringsprotokollen beskriver også mindre studieadministrative justeringer. Samlet sett oppsummeres endringene i prosjektet i en liste på ti punkter i endringsprotokollen. Det henvises til denne listen for en ytterligere presisering av hva prosjektendringssøknaden inneholder.

**Komiteens vurdering av endringene**

Komiteen har behandlet den delen av henvendelsen som dreier seg om endringer i prosjektet, som en formell prosjektendringssøknad, jf. helseforskningslovens § 11.

Komiteen har ingen innvendinger til de endringene man ønsker gjennomført i studien.

**Vedtak**

Prosjektendringssøknaden godkjennes, jf. helseforskningslovens § 11.

Tillatelsen er gitt under forutsetning av at prosjektendringen gjennomføres slik det er beskrevet i prosjektendringssøknaden og endringsprotokoll, og de bestemmelser som følger av helseforskningsloven med forskrifter.

Forskningsprosjektets data skal oppbevares forsvarlig, se personopplysningsforskriften kapittel 2, og Helsedirektoratets veileder for Personvern og informasjonssikkerhet i forskningsprosjekter innenfor helse- og omsorgssektoren.


Med vennlig hilsen

Britt-Ingerd Nesheim
professor dr. med.
leder REK sør-øst C

Kopi til: k.b.holven@medisin.uio.no

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Tor Even Svanes
seniorrådgiver

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Ledet av REK Sør-Øst
Nødvendig utstyr for antropometriske målinger:

- Høydemåler
- Tanita vekt (vi bruker Tanita BC-418 MA)
- Stol
- Sprit/desinfiseringsmiddel
- Tørkepapir
- Søppeldunk
- Penn
- Stiftemaskin
- Målebånd
- Skojern
- Ha i reserve: Ekstra papirruller til tanitavekten

Noter funnene i CRF, i MNA-skjema og på helsekort.

**Høyde (revidert etter Håndbok for Senter for kontrollerte koststudier)**

*Utstyr:* Høydemåler (Holtain Limited).

Dersom høyde ikke kan måles som beskrevet under, se MNA-veiledningen for alternativt høydemål (demispan).

2. Be personen stå utstrakt med helene sammen. Heler, setet og øvre del av rygg skal stå inntil høydemåleren.
3. Hodestillingen skal være slik at nedre orbitakant (den horisontale delen på høydemåleren) skal ligge i horisontalt plan med øreåpningen.
5. Avlesing skjer ved normal respirasjon. Målingen blir lest av til nærmeste millimeter.

Noter verdien med 1 desimal.
Bioimpedans (TANITA BC-418 MA) (revidert etter Håndbok for Senter for kontrollerte koststudier)

1. Spør om deltageren har pacemaker eller noe annet elektrisk ledende i kroppen → Dersom svaret er JA, kan ikke bio-impedansmåling utføres. Da må vedkommende veies på vanlig vekt (se protokoll for slik vektmåling under).
2. Spør om personen har vært på toaletet. Er blæra tømt? Dersom ikke, vis deltageren til toaletet.
3. Desinfiser elektrodene.
4. Be deltageren ta av seg sko og sokker. Sørg for at personen som veies har på seg så lite klær som mulig. Han eller hun må tömme lommene, og ta av andre tunge eller store plagg (genser, skjerf), samt ta av store smykker, klokke, belte. Personen skal kun stå i bukke og tynn genser.
5. Skru på maskinen. Det skal stå ”0,0” øverst- og Pt midt på skjermen.
6. Legg inn 1 kg for vekt på klær.
8. Tast inn alderen de har i dag.
9. Tast inn høyde i cm.
10. Symbolet ”88888” vil vises øverst på skjermen. Deretter vil en blinkende pil vises ved siden av ”Step on” merket.
12. En pil vil blinke ved siden av (STABILIZED) og vekten vil vises øverst til høyre på skjermen.
15. Kalibrering: Se på balansepunktet (grønt punkt nederst på vekten, foran fotplatene) at vekten står i vater (står rett på gulvet). En gang i måneden bør det sjekkes at TANITA vekten stemmer overens med en kalibrert digital vekt (Soehnle professional). Avdelingsbioingeniøren er ansvarlig for at kalibreringen gjøres.

Vekt (revidert etter Håndbok for Senter for kontrollerte koststudier)

Utstyr: Digital vekt (Soehnle professional).
Utøres dersom bioimpedans med TANITA ikke kan gjennomføres.

2. Sørg for at personen som veies har på seg så lite klær som mulig. Han eller hun må tømme lommene, og ta av seg sko og andre tunge eller store plagg (genser, skjerf, store smykker, belte). Personen skal kun stå i bukse og tynn genser.
3. Sjekk at vekten står på 0.
4. Personen stiller seg midt på vekten, uten støtte og med vekten fordelt jevnt på begge fotter.
6. Kalibrering: Den digitale vekten kalibreres en gang i måneden, ved at man legger på lodd og sjekker at vekten viser det samme antall kg som antall kg lodd.
Avdelingsbioingeniøren er ansvarlig for at kalibreringen gjøres.

Målinger med målebånd (revidert etter Håndbok for Senter for kontrollerte koststudier)

Generelt om målinger med målebånd:

- Når målebåndet er trukket rundt det som skal måles, juster målebåndet slik at det ligger i en rett vinkel i lengderetningen når avlesningen foretas.
- Minimaliser mellomrommet mellom målebåndet og forsøkspersonen.
- For å unngå feil avlesning skal målerens øyne være på samme høyde som målebåndet.
Midje (revidert etter Håndbok for Senter for kontrollerte koststudier)

1. Be deltageren om å brette opp genseren/skjorten – vi måler midjeomkretsen på bar hud.
2. Finn den nedre costalbuen (10. ribbebein) og toppen av hoftebeina.
3. Midjeomkretsen måles midt mellom nedre costalbue og toppen av hoftebeinet.
4. Subjektet skal stå avslappet, gjerne med armene i kryss på halsen. Det viktigste er at deltageren er avslappet og puster normalt, pass på at vedkommende ikke heiser skuldrene eller anspanner seg.

Hofte (revidert etter Håndbok for Senter for kontrollerte koststudier)

3. Målingen skal skje på det bredeste punktet av setet.

Overarmsomkrets (revidert etter MNA-veiledning)

1. Overarmsomkretsen skal måles på non-dominant arm. Spør hvilken arm deltageren bruker minst / er svakest i.
2. Be pasienten om å bøy albugen i en 90 graderer vinkel og med håndflaten opp.
3. Mål avstanden mellom akromionområdet av scapula (benete fremstikkende område oppå skulderen) og olecranon (albueknoken) på bak siden av armen (se bildet under). Marker midtpunktet mellom de to med en penn.
5. Les av målingen i hele cm. Noter ned resultatet i CRF og gi poeng i MNA-skjema.
Leggomkrets (revidert etter MNA-veiledning)

1. Deltageren skal sitte med 90 grader vinkel i knærne slik at vekten er jevnt fordelt på begge ben. Bena skal være avslappet, se til at deltageren ikke spenner seg.

2. Spør deltageren om hvilket ben vedkommende ville valgt å stå på om de skulle stå på en fot. Utfør måling på det benet de ville valgt å løfte (non-stamfot).

3. Spør deltageren om å få brette opp buksebenet for å avdekke leggen.

   a. Se samtidig etter om vedkommende har synlige ødener – noter på CRF.

4. Legg målebåndet rundt leggen på det tykkeste stedet og foreta måling. Foreta flere målinger over og under den første målingen for å sikre at målingen ble tatt på det tykkeste stedet.

Gripestyrke AmaroneStudien

Navn på deltager (fornavn, etternavn):

Gripestyrke

Hensikten med testen er å måle gripestyrke. Deltageren skal oppmuntres til å pressse maksimalt.

Fremgangsmåte:

- Be deltager riste begge hendene tre ganger og bøy og strekke alle fingre tre ganger
- Velg mellom fjører som er 20, 40 og 80 kg
- Deltageren skal presse så hardt han kan – samtidig som han/hun puster ut
- Pass på at deltageren sitter riktig
- Deltageren kan prøve en gang først – trenger ikke å ta hardt i
- Deltageren skal ta tre målinger på hver arm – start med høyre arm på alle
- Den beste målingen benyttes til å vurdere deltager med tanke på inklusjon i intervensjonsstudien


Påse at deltager har skuldre bakover og brystkassen rettet oppover. Hode og øyne skal rettes fremover.

Skru på dynamometeret ved å trykke på «ON/zero». Trykk på «mode» til det står «max» på skjermen. Gi deltager dynamometeret og påse at deltager har riktig posisjon.

«Pust inn, pust ut og press.»

Trykk på «zero» for å nullstille dynamometeret mellom forsøkene. Vent minimum 20 sekunder før neste måling foretas på den andre hånden.

Hvilken arm er dominant for deltageren?..............................................................................................................

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<tr>
<th></th>
<th>Dominant</th>
<th>Non-dominant</th>
<th>Aktuell (ja/nej)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Måling 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Måling 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Måling 3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 5. SPPB protocol.

Short Physical Performance Battery (SPPB)

Oversatt til norsk april 2013 v/Sverre Bergh¹, Heidi Lyshol², Geir Selbæk¹, Bjørn Heine Strand². Kristin Taraldsen³, Pernille Thingstad³ 1. Alderspsykiatriske forskningsenter, Sykehuset Innlandet HF 2. Folkehelseinstituttet 3. Forsknings gruppe for geriatri, St. Olavs hospital og NTNU

Innhold:
1. Manual for testprotokoll
2. Registreringsark for testing
3. Scoringsark for poengberegning
4. Vedlegg:
   ▪ Scoring for 3m gangtest der 4m ikke er praktisk mulig
   ▪ Tillegg til originaltesten: Registrering av ganghastighet og reise/sette seg x5 med bruk av armene

Bakgrunn:

Tillegg til originalversjonen:
Utregning og registrering av ganghastighet er ikke en del av originaltesten. Ganghastighet kan brukes som en selvstendig test, er et anbefalt mål på helse og funksjon hos eldre og har veletablerte referanse verdier [10]. Den originale SPPB versjonen kan ha en gulveffekt ved testing av eldre med lavt funksjonsnivå. For eldre som scorer 0 poeng på reise/sette seg kan tiden med bruk av armene registreres i tillegg. Denne tiden regnes ikke inn i totalscoren SPPB, men registreres som en egen test.

Testprosedyre:
Nødvendig utstyr: Stoppeklokke, målebånd, farget markerings teip, stol

Tolkning [1, 2]:
Lav score: 0-6 poeng < 10 poeng indikerer økt risiko for funksjonssvikt
Middels score: 7-9 poeng < 8 poeng indikerer begynnende svikt i ADL funksjoner
Høy score: 10-12 poeng

Klinisk meningsfull endring (totalscore): 1 poeng [3]

For mer detaljerte referanseverdier i forhold til alder og kjønn anbefales originalartikkelen [2]. Referanseverdier for ganghastighet som selvstendig test er oppgitt i vedlegget.


SHORT PHYSICAL PERFORMANCE BATTERY, TEST MANUAL

Alle testene bør gjennomføres i samme rekkefølge som de er presentert i denne manuken. Instruksjoner til deltagerne er vist i uthevet kursiv og skal formulieres på nøyaktig samme måte som beskrevet i dette dokumentet.

1. STATISK BALANSE

Deltageren må være i stand til å stå uten støtte, uten hjelp av stokk eller rullator. Du kan hjelpe deltageren opp i stående.


Har du noen spørsmål før vi starter?

A. Stående stilling, samlede føtter
   1. Nå vil jeg viser deg den første stillingen.
   2. (Demonstrerer) Jeg vil at du skal forsøke å stå med føttene samlet, inntil hverandre, i ca 10 sekunder.
   4. Stå ved siden av deltagerne for å hjelpe han/henne inn i stillingen.
   5. Gi akkurat nok støtte til deltagerens arm for å unngå at han/hun mister balansen.
   6. Når deltageren står med føttene samlet, spør ”Er du klar?”
   7. Slipp så taket og start tidtakingen idet du sier, ”Klar, start”
   8. Stopp stoppeklokken og si ”stopp” etter 10 sekunder eller hvis deltageren flytter føttene og forlater stillingen eller griper tak i armen din.
   9. Hvis deltageren ikke klarer å holde stillingen i 10 sekunder, noter resultatet og gå videre til ganghastighetstesten.

B. Stående stilling, semi-tandem
   1. Nå vil jeg viser deg den andre stillingen.
   2. (Demonstrerer) Nå vil jeg at du skal forsøke å stå med siden av hælen på den ene foten inntil stortåen på den andre foten i ca 10 sekunder. Du kan velge hvilken fot du har fremst, den som føles mest naturlig for deg.
   4. Stå ved siden av deltageren for å hjelpe han/henne inn i semi-tandem stilling.
   5. Gi akkurat nok støtte til deltagerens arm for å unngå at han/hun mister balansen.
   6. Når deltageren står med føttene samlet, spør ”Er du klar?”
   7. Slipp så taket og start tidtakingen idet du sier, ”Klar, start”
   8. Stopp stoppeklokken og si ”stopp” etter 10 sekunder eller hvis deltageren flytter føttene og forlater stillingen eller griper tak i armen din.
   9. Hvis deltageren ikke klarer å holde stillingen i 10 sekunder, noter resultatet og gå videre til ganghastighetstesten.
C. Stående stilling, tandem
1. Nå vil jeg vise deg den tredje stillingen.
2. (Demonstrer) Nå vil jeg at du skal forsøke å stå med hælen på den ene foten foran og inntil tærne på den andre foten i ca 10 sekunder. Du kan velge hvilken fot du har fremst, den som føles mest naturlig for deg.
4. Stå ved siden av deltageren for å hjelpe han/henne inn i tandem stilling.
5. Gi akkurat nok støtte til deltagerens arm for å unngå at han/hun mister balansen.
6. Når deltageren står med føttene samlet, spør ”Er du klar?”
7. Slipp så taket og start tidtakingen idet du sier, ”Klar, start”
8. Stopp stoppeklokkken og si ”stopp” etter 10 sekunder eller hvis deltageren flytter føttene og forlater stillingen eller griper tak i armen din.

2. 4m GANGTEST

A. Første test av ganghastighet
1. Dette er distansen du skal gå. Jeg vil at du skal gå til den andre enden, i din vanlige hastighet, som om du gikk nedover gaten til butikken.
2. Demonstrer øvelsen for deltageren
4. La deltageren stå med begge føttene inntil startlinjen.
5. Når jeg vil du skal starte, sier jeg: ”Klar, start”. Når deltageren bekrefter å ha forstått instruksjonen, si: ”Klar, start.”
6. Start tidtakingen idet deltageren begynner å gå.
8. Stopp tidtakingen når en av deltagerens føtter er helt over mållinjen.

B. Andre test av ganghastighet
1. Nå vil jeg at du skal gjøre det samme en gang til. Husk å gå i din vanlige hastighet, og gå helt over og forbi teip-markeringen.
2. La deltageren stå med begge føttene inntil startlinjen.
3. Når jeg vil at du starter, sier jeg: ”Klar, start”. Når deltageren bekrefter å ha forstått instruksjonen, si: ”Klar, start.”
4. Start tidtakingen idet deltageren begynner å gå.
5. Gå bak og til siden for deltageren.
6. Stopp tidtakingen når en av deltagerens føtter er helt over mållinjen.
3. REISE SEG TEST
Reise seg fra stol én gang

1. **Dette er den siste øvelsen. Er det trygt for deg å reise deg opp fra stolen uten å bruke armene?**

2. **Den neste testen måler styrken i beina dine.**

3. (Demonstrer og forklar øvelsen.) **Først, kryss armene over brystet, og sitt slik at føttene er plassert på gulvet; så reiser du deg opp, behold armene i kryss over brystet.**

4. **Nå vil jeg at du skal prøve å reise deg opp med armene i kryss over brystet.** (Noter resultatet).

5. Hvis deltageren ikke klarer å reise seg uten å bruke armene, si **“OK, prøv å reise deg med bruk av armene.”** Dette avslutter testen. Noter resultatet og gå til scoringsarket.

**Reise/ sette seg x5**

1. **Tror du det vil være trygt for deg å reise deg opp fra stolen fem ganger uten å bruke armene?**

2. (Demonstrer og forklar øvelsen.) **Nå vil jeg at du skal reise deg helt opp så RASKT du kan fem ganger, uten stopp. Etter at du har reist deg hver gang, sett deg ned og reis deg opp igjen. Behold armene i kryss over brystet. Jeg tar tiden med en stoppeklokke.**


4. Tell høyt hver gang deltageren reiser seg, opp til fem ganger.

5. Stopp om deltageren blir sliten eller tungpustet av å reise seg fra stolen flere ganger.


7. **Stopp også**
   - Hvis deltageren bruker armene
   - Etter 1 minutt, hvis deltageren ikke har fullført 5 repetisjoner
   - Hvis du bekymrer deg for deltakerens sikkerhet

8. Hvis deltageren er utslitt og stopper før fem repetisjoner, spør **“Kan du fortsette?”** for å bekrefte dette.

1. Balansetest

1. Samlede føtter
   10 sekunder
   1. [ ] [ ] [ ] sek

2. Semi-tandem
   10 sekunder
   2. [ ] [ ] [ ] sek

3. Tandem
   10 sekunder
   3. [ ] [ ] [ ] sek

Gå til gangtest

2. Gangtest

Ganghjelpemidler ved test (kryss av):
1. [ ] uten
2. [ ] krykke/stokk (er)
3. [ ] rollator
4. [ ] Annet (spesifiser)___________________
   Tid test 1: [ ] [ ] [ ] sek
   Tid test 2: [ ] [ ] [ ] sek

3. Reise/sette seg

Pre-test

I stand til

5 repetisjoner

Avslutt

Ikke i stand til

Setehøyde [ ] cm

Tid 5 repetisjoner uten armbruk: [ ] [ ] [ ] sek

Tester:
SCORING SPPB:

1. Score statisk balanse
Hvis deltageren ikke har forsøkt eller mislyktes, kryss av hvorfor:
1. Forsøkte, men ikke i stand til(0p)
2. Deltageren kunne ikke holde stillingen uten hjelp(0p)
3. Ikke forsøkt, tester følte det utrygg(0p)
4. Ikke forsøkt, deltager følte seg utrygg(0p)
5. Deltager tar ikke instruksjon(missing)
6. Annet (spesifiser)___________________
7. Deltager nektet(missing)

2. Score 4m gangtest
Hvis deltageren ikke har forsøkt eller mislyktes, kryss av hvorfor:
1. Forsøkte, men ikke i stand til(0p)
2. Deltageren kunne ikke gå uten assistanse(0p)
3. Ikke forsøkt, tester følte det utrygg(0p)
4. Ikke forsøkt, deltager følte seg utrygg(0p)
5. Deltager tar ikke instruksjon(missing)
6. Annet (spesifiser)___________________
7. Deltager nektet(missing)

3. Score reise/sette seg x5
Hvis deltageren ikke har forsøkt eller mislyktes, kryss av hvorfor:
1. Forsøkte, men ikke i stand til(0p)
2. Deltageren kunne ikke reise seg uten hjelp(0p)
3. Ikke forsøkt, tester følte det utrygg(0p)
4. Ikke forsøkt, deltager følte seg utrygg(0p)
5. Deltager tar ikke instruksjon(missing)
6. Annet (spesifiser)___________________
7. Deltager nektet(missing)

Deltager var ikke i stand til/brukte >60 sek = 0 poeng
Hvis tiden var  
≥16.7 sek = 1 poeng
Hvis tiden var  
13.7 – 16.69 sek = 2 poeng
Hvis tiden var  
11.20 – 13.69 sek = 3 poeng
Hvis tiden var  
≤ 11.19 sek = 4 poeng

Poeng reise/sette seg x5:

TOTAL SCORE SPPB 1.+2.+3.: [ ]
Vedlegg/tillegg til orginaltesten:
1. Ganghastighet-test
2. Reise/sette x5 m/armbruk
3. Scoring for 3m gangtest (der 4m ikke er mulig)

**Ganghastighet-test:**
Ganghastighet = Distanse(m)/ tid (sekunder):

Test 1. [ ] m / [ ] sek = [ ] m/sek

Test 2. [ ] m / [ ] sek = [ ] m/sek

**Tolkning [1-3]:**

- **Skropelig:**
  - Økt risiko for fall
  - Økt risiko for funksjonssvikt
  - Økt risiko for sykehusinnleggelse
  - Redusert innendørs og utendørsmobilitet

- **Begynnende funksjonssvikt:**
  - Økt risiko for fall og funksjonssvikt
  - Selvhjulpen i ADL
  - Redusert utendørsmobilitet

- **Normal:**
  - Ingen økt risiko eller begrensninger i ADL og mobilitet

**Reise/sette seg x5 m/armbruk:** Samme instruksjon som SPPB, men med bruk av armlener på stolen.

**Tid 5 repetisjoner m/armbruk:** [ ] sek

Ved testing av skropeelige populasjoner anbefales å legge til et ekstra element i tillegg til originaltesten i form av registrert tid på reise/sette seg x5 med bruk av armer (armlener på stol) der deltager ikke klarer å reise seg uten støtte.

**Skåring for 3m distanse** (hvis 4m ikke er mulig å gjennomføre):

- Deltager var ikke i stand til: = 0 poeng
- Hvis tiden var > 6.52 = 1 poeng
- Hvis tiden var 4.66 - 6.52 = 2 poeng
- Hvis tiden var 3.62 - 4.65 = 3 poeng
- Hvis tiden var < 3.62 = 4 poeng


Trappetest AmaroneStudien

Navn på deltager (fornavn, etternavn):

Trappetest

Hensikten med testen er at deltageren beveger seg raskest mulig opp trappen, på en trygg måte.

Fremgangsmåte:

- Benytt den samme trappen for alle deltagere (16 trappetrinn, 17.8 cm høyde)
- Det bør være fritt for forstyrrelser under testen
- Deltager bør ha komfortable sko på bena
- Deltagerne starter på gulvet med bena samlet slik at de kan ta sette en fot på første trappetrinn på signal
- Start tiden på signal (klar-ferdig-gå) og stans klokken når begge bena er nådd toppen av trappa
- Det er lov å løpe, og det er lov å bruke rekkelig for å støtte seg på, men deltageren må berøre alle trinn
- Hver deltager får to forsøk
- Det bør gå minimum 2 minutter mellom forsøkene
- Deltageren kan gå trappen 1 gang før man gjør registreringen, hvis han/hun ønsker det – i rolig tempo
- Den beste tiden benyttes til å vurdere deltager med tanke på inklusjon i intervensjonsstudien

Tidtaker står øverst i trappen dersom det er trygt at deltageren går alene. Er deltageren svak/føler seg utrygg går tidtaker ved siden av deltageren under testen. Når deltageren er klar starter han/hun på signal: «klar-ferdig- gå!» Tidtaker starter stoppekloken på: «gå».

<table>
<thead>
<tr>
<th>Test 1 (sek)</th>
<th>Test 2 (sek)</th>
<th>Aktuell (ja/nei)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 7. Mini Nutritional Assessment.

<table>
<thead>
<tr>
<th>MNA® Nano Nutritional Assessment</th>
<th>Nestlé Nutrition Institute</th>
</tr>
</thead>
</table>

**Etternavn:**
**Fornavn:**
**Kjønn:**
**Alder:**
**Vekt, kg:**
**Høyde, cm:**
**Dato:**

Besvar undersøkelsen (screeningen) ved å fylle inn de riktige poengsifrene. Bruk tallene fra hvert enkelt spørsmål og summer. Hvis oppnådd sum er 11 eller mindre, fortsett med del II for å få en samlet vurdering av ernæringslilstandene.

### Screening, del I

<table>
<thead>
<tr>
<th>Spørsmål</th>
<th>Poeng</th>
<th>Beskrivelse</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td></td>
<td>Har matinntaket gått ned i løpet av de 3 siste månedene pga nedsatt appetitt, fordyvelsesproblemer, vanskeligheter med å tykke eller svelge?</td>
</tr>
<tr>
<td>0</td>
<td>= betydelig redusert matinntak</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>= noe redusert matinntak</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>= ingen endring i matinntaket</td>
<td></td>
</tr>
<tr>
<td><strong>B</strong></td>
<td></td>
<td>Vekttap i løpet av de 3 siste månedene</td>
</tr>
<tr>
<td>0</td>
<td>= vektvis stabilt</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>= vekttap mindre enn 1 kg</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>= vekttap 1-3 kg</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>= vekttap 3 kg eller større</td>
<td></td>
</tr>
<tr>
<td><strong>C</strong></td>
<td></td>
<td>Mobilitet</td>
</tr>
<tr>
<td>0</td>
<td>= sengeliggende / sitter i stol</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>= i stand til å gå ut av seng / stol, men går ikke ute</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>= går ute</td>
<td></td>
</tr>
<tr>
<td><strong>D</strong></td>
<td></td>
<td>Har opplevd psykologisk stress eller akutt sykdom i løpet av de 3 siste månedene?</td>
</tr>
<tr>
<td>0</td>
<td>= ja</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>= nei</td>
<td></td>
</tr>
<tr>
<td><strong>E</strong></td>
<td></td>
<td>Neuropsychologiske problemer</td>
</tr>
<tr>
<td>0</td>
<td>= alvorlig demens eller depresjon</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>= mild demens</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>= ingen psykologiske lidelser</td>
<td></td>
</tr>
<tr>
<td><strong>F</strong></td>
<td></td>
<td>Body Mass Index (BMI) (vekt kg) / (høyde x høyde)</td>
</tr>
<tr>
<td>0</td>
<td>= BMI mindre enn 19</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>= BMI 19 til mindre enn 21</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>= BMI 21 til mindre enn 23</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>= BMI 23 eller større</td>
<td></td>
</tr>
</tbody>
</table>

### Screening resultatet, del I

(sumtotal maks. 14 poeng)

12-14 poeng: Normal ernæringsstatus
8-11 poeng: Risiko for undernæring
0-7 poeng: Undernært

For en mer dyptgående vurdering, fortsatt med spørsøml G-R

### Screening, del II

<table>
<thead>
<tr>
<th>Spørsmål</th>
<th>Poeng</th>
<th>Beskrivelse</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>G</strong></td>
<td></td>
<td>Bor i egen bolig (ikke på alders/sykehjem eller sykehus)</td>
</tr>
<tr>
<td>1</td>
<td>= ja</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>= nei</td>
<td></td>
</tr>
<tr>
<td><strong>H</strong></td>
<td></td>
<td>Bruker mer enn tre typer reseptbelagte medisiner pr dag</td>
</tr>
<tr>
<td>0</td>
<td>= ja</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>= nei</td>
<td></td>
</tr>
<tr>
<td><strong>I</strong></td>
<td></td>
<td>Tryksåer eller hudsår</td>
</tr>
<tr>
<td>0</td>
<td>= ja</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>= nei</td>
<td></td>
</tr>
</tbody>
</table>

**J** Hvor mange fullstendige måltider spiser pasienten pr dag?
| 0 = 1 måltid |
| 1 = 2 måltider |
| 2 = 3 måltider |

**K** Utvalgte markører for proteininntak
- Minst en porsjon melkeprodukter (melk, ost, yoghurt) pr dag |
- To eller flere porsjoner belgrukter, eller egg pr uke |
- Kjøtt, fisk eller kylling/kalkun hver dag |
| 0.0 = hvis 0 eller 1 ja |
| 0.5 = hvis 2 ja |
| 1.0 = hvis 3 ja |

**L** Spiser to eller flere porsjoner frukt eller grønnsaker pr dag?
| 0 = nei |
| 1 = ja |

**M** Hvor mye væske (vann, juice, kaffe, te, melk...) inntas pr dag?
| 0.0 = mindre enn 3 kopper |
| 0.5 = 3 til 5 kopper |
| 1.0 = mer enn 5 kopper |

**N** Matinntak
| 0 = ikke i stand til å spise uten hjelp |
| 1 = spiser selv med noe vanskeligheter |
| 2 = spiser selv uten vanskeligheter |

**O** Eget syn på ernæringsmessig status
| 0 = ser på seg selv som undernært |
| 1 = er usikker på ernæringsmessig tilstand |
| 2 = ser ikke på seg selv som undernært |

**P** Hvordan vurderer pasienten sin egen helsestilstand sammenlignet med mennesker på samme alder?
| 0.0 = ikke like bra |
| 0.5 = vet ikke |
| 1.0 = like bra |
| 2.0 = bedre |

**Q** Overarmens omkrets (OO) i cm
| 0.0 = OO mindre enn 21 cm |
| 0.5 = OO 21 til 22 cm |
| 1.0 = OO mer enn 22 cm |

**R** Leggomkrets (LO) i cm
| 0 = LO mindre enn 31 cm |
| 1 = LO 31 cm eller større |

### Screenning, del II (maks. 16 poeng)

### Screenning, del I

### Samlet vurdering, del I + del II (maks. 30 poeng)

**MNA resultat**

| 24 til 30 poeng | Normal ernæringsstatus |
| 17 til 23.5 poeng | Risiko for undernæring |
| Mindre enn 17 poeng | Undernært |

Se mer info på: www.mna-elderly.com
Demensutredning i kommunehelsetjenesten

Norsk revidert mini mental status evaluering (MMSE-NR)

Carsten Strobel & Knut Engedal, 2009

Testleder (TL): ____________________________ Dato: ____________________________ Tidspunkt: ____________________________

Teststed: ____________________________ Har MMSE vært administrert samme sted tidligere? Ja ☐ Nei ☐

Hvis ja, når? ____________________________ Når/hvor ble MMSE sist administrert? __________________________________________________________________________

Oppg. 11 og 12: Angi oppgavesett (ordsett, starttall) administrert i dag:

1. adm ☐ 2. adm ☐ 3. adm ☐ 4. adm ☐ 5. adm ☐

Pasient (PAS): ________________________________________________________________________________________________________________________

Fødselsdato: ____________________________ Nasjonalitet/morsmål: ____________________________

Utdanning/antall år: ____________________________ / _____år Yrke: ____________________________

Hørsel/høreapparat: ____________________________ Syn/briller: ____________________________ Geriatrisk leseprove: ____________________________

Henvisningsgrunn/diagnose: ____________________________________________________________________________________________________________

Legemidler: __________________________________________________________________________________________________________________________

Instruksjon


Kommentarer/spesielt å bemerke

(atferd, stemningsleie, smerter, afasi, tidsbruk, glemt briller/høreapparat etc.)

—

* Manual fåes tilsent fra: bibliotek@aldringoghelse.no

TL starter med følgende spørsmål: Synes du hukommelsen har blitt dårligere? Ja ☐ Nei ☐ Vet ikke ☐
Jeg skal nå stille deg noen spørsmål, som vi spør alle om. Svar så godt du kan.
Instruksjon kan gjentas, unntatt på oppg. 12 og 17.

**TIDSORIENTERING**

1. Hvilket årstall har vi nå? (kun fullt årstall med 4 sifre gir poeng) ☐ 0 ☐ 1
2. Hvilken årstid har vi nå? (ta hensyn til vær og geografiske forhold) ☐ 0 ☐ 1
3. Hvilken måned har vi nå? (kun riktig navn på måned gir poeng) ☐ 0 ☐ 1
4. Hvilken ukedag har vi i dag? (kun riktig navn på dag gir poeng) ☐ 0 ☐ 1
5. Hvilken dato har vi i dag? (kun dagsledd trenger å være riktig for å få poeng) ☐ 0 ☐ 1

**STEDSORIENTERING**

På spørsmål 7 brukes “Landsdel” ved testing i Oslo, “Fylke” utenfor Oslo.
Sett ring rundt valgt stedsord for spørsmål 8 og 9.

6. Hvilket land er vi i nå? ☐ 0 ☐ 1
7. Hvilket fylke/landsdel er vi i nå? (Sør-Norge gir også poeng for landsdel) ☐ 0 ☐ 1
8. Hvilken by/kommune er vi i nå? ☐ 0 ☐ 1
9. Hva heter dette stedet/bygningen/tilhørende/heggekontoret/hvor er vi nå? ☐ 0 ☐ 1
10. I hvilken etasje er vi nå? (Spørsmål stilles også om man er i 1. etasje) ☐ 0 ☐ 1

**UMIDDELBAR GJENKALLING/REGISTRERING**


Dersom pasienten ikke gjetar alle 3 ord, repeteres alle ord inntil alle gjengis i samme forsøk, maks. 3 presentasjoner. Det gis kun poeng etter 1. presentasjon, rekkefølge pasienten sier ordene er uten betydning.

Husk disse ordene, for jeg vil be deg gjetta dem senere.

**OPPMERKSOMHET OG HODERECKNING** (Vær oppmerksom på eventuell distraksjonsbetingelse**)


**Eventuell distraksjonsbetingelse – OBS, er ikke poenggivende!**

Dersom pasienten ikke vil utføre eller kan besvare oppg. 12 med 5 avgitte tallsvare, skal distraksjonsbetingelsen brukes for å sikre kartlegging av langtidshukommelse på oppg. 13. Be da pasienten telle baklengs fra 100 ca. 30 sek. med følgende instruksjon: [Tell baklengs fra 100 på denne måten: 99, 98, 97..., helt til jeg sier stopp. Vær så god!]
**UTSATT GJENKALLING**

13. Hvilke 3 ord var det jeg ba deg om å huske? [*Ikke gi hjelp/stikkord*]

<table>
<thead>
<tr>
<th>Ord</th>
<th>Poeng</th>
</tr>
</thead>
<tbody>
<tr>
<td>HUS</td>
<td>[Ord ved retest: …………………………………]</td>
</tr>
<tr>
<td>KANIN</td>
<td>[Ord ved retest: …………………………………]</td>
</tr>
<tr>
<td>TOG</td>
<td>[Ord ved retest: …………………………………]</td>
</tr>
</tbody>
</table>

Nevnes mer enn 3 ord, må pasienten velge hvilke 3 ord som skal være svaret. Rekkefølge er uten betydning. Det gis kun poeng for eksakt gjengivelse, dvs. bolighus, hytte, hare, kanindyr, togbane, lokomotiv etc. gir ikke poeng.

**BENEVNING**

14. Hva heter dette? [*Pek på en blyant*]...[Ord ved retest: …………………………………] | 0 1 |

15. Hva heter dette? [*Pek på et armbåndsur*]...[Ord ved retest: …………………………………] | 0 1 |

Bruk kun blyant og armbåndsur, gjelder også retesting. Alternative poenggivende svar: Penn, gråblyant, klokke, ur etc.

**REPETISJON**


17. Hør godt etter, for jeg skal be deg gjøre 3 ting i en bestemt rekkefølge. Er du klar? Ta arket med én hånd, brett arket på midten én gang med begge hender samtidig [*pause*], og gi arket til meg. [*Pause*] Vær så god! [*Instruksjon gis kun én gang*]...[Ord ved retest: …………………………………] | 0 1 |

**FORSTÅELSE**

Legg et blankt A4-ark på bordet midt foran pasient, kortsiden mot pasienten. TL legger egen hånd på arket til all instruksjon er gitt. Gi poeng for hver utført delhandling, også dersom pasienten bretter arket med én hånd eller legger arket foran TL.

18. Nå vil jeg at du gjør det som står på arket [*Vis pasienten teksten*].

**LESNING**

19. Skriv en meningsfull setning her [*Pek på øvre del av side 4*].


**TEGNING/FIGURKOPIERING**

Legg figurark over setningen pasienten skrev, viskelær ved siden av.

20. Kopier figuren så nøyaktig du kan her [*Pek på nedre del av side 4*].

Det gis poeng når tegningen består av to 5-kantede figurer som former en 4-sidet figur der 5-kantene overlapper. Tegnet figur trenger ikke være identisk med modellen. Se skåringseksempler i manual*.

**TOTAL POENGSUM** = ___/30. Presiser hva pasienten hadde utfall (feilsvar) på:
Appendix 9. Data included in the two Master Thesis in the AMARONE-study.

**Table 14.** Data included in the two Master Thesis in the AMARONE-study.

<table>
<thead>
<tr>
<th>AMARONE-study</th>
<th>Linn’s Master Thesis</th>
<th>Kristin’s Master Thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRF-form(^1)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>MMSE</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>MNA</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>SPPB</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Handgrip strength test</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Stair climbing test</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>24 hours recall</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>SF-36(^2)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>«Eldreskjema»(^3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Questions on dairy products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood samples</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Anthropometric measures</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Medical list</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

MMSE, mini-mental state examination; MNA, mini nutritional assessment; SPPB, short physical performance battery.

\(^1\) CRF-form includes summary of all data collected at study visit.

\(^2\) SF-36 is a questionnaire evaluating quality of life.

\(^3\) «Eldreskjema» is a questionnaire evaluating appetite.