MUSCLE MASS AND FUNCTION FOR ELDERLY PEOPLE. A ROLE FOR MINERALS?

A CROSS-SECTIONAL STUDY

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ACKNOWLEDGEMENTS

We are Kim and Yolanda, before you lies our bachelor thesis, the final part of the bachelor Nutrition and Dietetics at the Amsterdam University of Applied Sciences. During the last four months of our study we conducted a scientific research at VITAMINE.

VITAMINE is a randomised controlled trial (RCT) that studies what the effectiveness is of a tablet supported home-based training program combined with optimal protein intake in community dwelling elderly people. Their study aims to improve physical function. For us this graduation project was the perfect closure of our study. It allowed us to improve our English knowledge and to learn how it is to work closely as a team. But most importantly we got the chance to write a thesis that may contribute to the work of health professionals in the working field, plus it gave us more insight into the health problems that occur when people are aging.

We couldn’t have done this research without the help of a few people, we would like to thank them. Special thanks go out to our mentor Michael Tieland for pushing us in the right direction, because at the beginning of our study, we were a little bit lost. We would also like to thank him for the guidance, the trust, his feedback and for always being there to answer our questions during this hectic period. We are sure that without his guidance this thesis would not have been at this level.

Carliene van Dronkelaar and Jantine van den Helder, we want to show them our gratitude because they gave us the opportunity to be a part of the VITAMINE research. They also put in a lot work and effort to create our dataset, which made this study possible to begin with.

Last but not least we would like to thank our families and our loved ones for supporting us and for keeping us motivated during our thesis period.
ABSTRACT

Introduction:
The society is aging. Sarcopenia is an age-related loss of muscle mass and physical performance. The cause of sarcopenia is multifactorial and nutritional intake has been addressed as an important factor. The intake of the minerals magnesium, selenium and calcium might play a role in muscle mass and physical activity of elderly people, however, this is poorly studied. Therefore we assess the association between the mineral intake and muscle mass and physical activity.

Methods:
In this cross-sectional study, we studied the association of dietary mineral intake of magnesium, selenium, and calcium with appendicular muscle mass and habitual physical activity (PAL). The following confounders have were used: gender, age, the usage of diuretics, levothyroxine, tetracycline us, phenytoin, phenobarbital and the intake of protein and energy (kcal).

Results:
The study included 97 elderly men and women with an mean age of 72 years. Multiple linear regression analyses revealed that magnesium was not significantly associated with muscle mass ($\beta$ = -0.16, $P$= 0.971) and physical performance ($\beta$= 0.00, $P$=0.374). Selenium also showed that there was no significant association with muscle mass ($\beta$= 38.30, $P$= 0.052) and physical activity ($\beta$= -0.00, $P$= 0.313). Likewise, calcium also didn’t showed a significant association with muscle mass ($\beta$= -1.34, $P$=0.251) and physical activity ($\beta$= -0.00, $P$= 0.188).

Conclusion:
The findings of this cross-sectional study suggest that there is no significant association between magnesium, selenium and calcium intake with muscle mass and physical activity.
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</table>
INTRODUCTION

Aging
The Dutch society is aging, 243,000 people were 55 years or older in 2016. The expectation of elderly >55 years old in 2025 will be 259,000 (1). This means that the total amount of elderly might increase with 6.2% in 2025.

Sarcopenia
Aging is associated with a decreasing quality and quantity of the muscle mass, which is also known as sarcopenia (2, 3). This process starts at the age of 40 (2), but currently, there is no generally accepted definition of sarcopenia (4). As muscle mass declines, the physical disability will increase (5) and with the growing number of physical problems the risk of falls, disability, and mortality will also increase (2). Studies show that direct results of diminished mobility and balance control can be linked to mortality due to sarcopenia (6). The cause of sarcopenia is multifactorial and nutritional intake has been addressed as an important factor. Dietary protein intake has been mostly studied and showed to be an important factor (7, 8). Mineral intake might also play an important role in the development of sarcopenia.

Minerals
The Dutch Health Council (‘De Gezondheidsraad’ in Dutch) has drawn up a daily recommended intake for the minerals calcium, magnesium, and selenium (9). The daily recommended intake of calcium is 1100 mg per day. Magnesium has a daily recommended intake of 250-300 mg per day and for selenium, the recommendation is 50 µg per day. Studies have shown that most of the elderly do not meet the recommended intake of these minerals, which can cause health problems (10). Literature shows that calcium, magnesium, and selenium have a role in the muscle function and muscle metabolism (11). For healthy nerve and muscle activity calcium is essential and magnesium has shown to improve muscle function and muscle relaxation (12, 13). Various muscular diseases have a relation with a selenium deficiency (14) and some studies have showed a relation between selenium and muscle mass (15). Despite these interesting findings and a possible role of these minerals, the association of calcium, magnesium, and selenium with muscle mass and activity are poorly studied and certainly, no strong evidence is available. Therefore, we aim to study the association between the mineral intake (magnesium, calcium, and selenium) and muscle mass and physical activity.
METHODS

Study design
The purpose of this study was to find out if there is an association between mineral intake and muscle mass and physical performance of elderly people >55 years old. A cross-sectional research has been conducted to provide more insight. This research method was chosen because it consists of using collected data from a subset of the population at a single point in time and it examines the relationship between variables.

Subjects and recruitment
The subjects were men (n= 21) and women (n= 76) from different ethnicities who were participating in the VITAMINE study. Each subject is >55 years old and has completed a medical examination before being enrolled into the VITAMINE study. Recruitment of participants was done via a group exercise program called ‘More Physical Activity for Seniors’ (called Meer Bewegen voor Ouderen MBvO in Dutch). The recruitment scheme involved 24-48 MBvO- trainers who recruited as many subjects possible that are partaking the program in the Amsterdam region. All subjects had to give written consent to participate. The exclusion criteria were:

- Not being able to understand the Dutch language
- If the investigator suspects current alcohol or drug abuse. In Many violent events alcohol and, to a lesser extent, illicit drugs are present. These substances could play a contributing role in violent behavior (16). To prevent risky situations for the coaches, who visit the participants in their homes, these subjects were excluded.
- Cognitive impairment (MMSE < 15)
- Surgeries are done to the hip or the knee within the last six months. (Patients who underwent hip arthroplasty are 6 months postoperatively still very vulnerable. The bone needs this period of time to adjust to the new prosthetic. Pressure on the joints should be avoided. The study consists of a few physical test that pressurizes the joints, therefore these subjects were excluded (17, 18).

To assess the association between mineral intake and muscle mass and physical activity the following measurements were executed:

- DXA
- Three day dietary record
- PAL value based on a three-day physical activity diary

Research method
This study is quantitative and descriptive. These methods look at relationships between variables which is what we aimed to examine. The collected data was obtained from subjects in their natural setting (19).

Data collecting
For this study, we used three measurements: the DXA, the three-day dietary record, and PAL value. After these measurements were registered into Research Manager we statistically analyzed the data.

Mineral intake
Mineral intake was collected by three-day food records. Two week days and one weekend day.
The three-day food record was sent by mail, along with the PAM and the three-day activity form (18). The RIVM’s (Rijksinstituut voor Volksgezondheid en Milieu) NEVO table and Excel were used to calculate the mineral intake.

**Physical activity**

Participants were asked to log their activities for three days, two weekdays and one weekend day, to calculate their PAL values (18).

**Muscle mass**

The DXA (Dual Energy X-ray Absorptiometry) was used to assess muscle mass. This procedure has a very low radiation dose and is non-invasive. With this method, the appendicular skeletal muscle mass could be determined. The DXA scan was executed by a trained and licensed staff member of the Amsterdam Nutritional Assessment Center, Faculty of Sports and Nutrition at the Amsterdam University of Applied Sciences. At the beginning of the measurements, the participant has to lie down on the scan table and will be asked by the staff member to remain still during the measurement. A detector measures the skeletal muscle section that is targeted by a dual energy beam (0.03 mrem). Licensed staff members evaluated the scans. Whenever important medical details appeared, the study physician reviewed it (18).

All the data from the measurements were put into a database called Research Manager and transported to SPSS for further analysis.

**Statistical analysis and reporting**

To analyze the baseline data, statistics (mean, SD, n, minimum and maximum) were used. To make the data visually more appealing statistic tables and graphs were incorporated. Percentages, mean scores and making associations were all done with SPSS. To find out if the variables are associated with each other we used multiple linear regression analysis. In our analyses, an alpha of P 0.05 (5%) was used as the cut-off for significance.

This research contained few confounding variables that could affect the relationship between the independent and dependent variables. The results of our study were adjusted with the following confounding variables:

- **Age**: It has been scientifically proven that the loss of muscle mass increases with age in both sexes (20).
- **Protein intake**: The intake of protein in older adults is associated with muscle mass and the amount of muscle loss (21).
- **Gender**: A study by Gallagher and colleagues found that muscle mass is largely influenced by gender. The decline of muscle mass is twice as high in men compared to women (22).
- **Energy intake**: The American Dietetic Association, the American College of Sports and Dietitians in Canada have a standpoint that optimal nutrition enhances physical activity and that the energy needs must be met during times of high physical activity to maximize exercise performance. (These organizations create guidelines of food intake during competitive sports and training (23).
- **Used medication**: There are certain prescription medications that interact or decrease the absorption of minerals like calcium and magnesium (24).
RESULTS

The characteristics of the study population are presented in Table 1. The study population consisted of 76 females (78.4%) and 21 males (21.6%). The average age of the participants was 72 years and the lightest recorded weight was 45.9 kg, while the highest recorded weight was 143.7 kg. The mean Physical Activity Level (PAL) value was 1.5. The highest measured PAL value was 1.9. The appendicular muscle mass of the study population varied between 14.2 and 31.8 kg.

Table 1 Characteristics of the participants

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, male</td>
<td>21</td>
<td>72</td>
<td>7.29</td>
<td>55</td>
<td>91</td>
</tr>
<tr>
<td>Sex, female</td>
<td>76</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, year</td>
<td>97</td>
<td>73.8</td>
<td>14.04</td>
<td>45.9</td>
<td>143.7</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>94</td>
<td>1.5</td>
<td>0.14</td>
<td>0.9</td>
<td>1.9</td>
</tr>
<tr>
<td>Appendicular muscle mass, kg</td>
<td>96</td>
<td>20.2</td>
<td>4.12</td>
<td>14.2</td>
<td>31.8</td>
</tr>
</tbody>
</table>

The mineral, protein and energy intake of the study population are shown in Table 2. The daily recommended intake of calcium is 1100 mg per day, for magnesium 250-300 mg per day and for selenium the recommendation is 50 µg per day (10). The mean intake of magnesium was 328.7 mg, of selenium 44.7 µg and of calcium 980.5 mg. The mean intake of magnesium is the only one that met the recommended intake with 109.4% - 131.5%. The mean intake of selenium (89.4%) and calcium (89.1%) didn’t meet the recommended intake.

Table 2 Mineral, protein and energy intake

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Reference value*</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnesium, mg</td>
<td>93</td>
<td>250-300</td>
<td>328.7</td>
<td>105.58</td>
<td>92.8</td>
<td>588.7</td>
</tr>
<tr>
<td>Selenium, µg</td>
<td>93</td>
<td>50</td>
<td>44.7</td>
<td>20.18</td>
<td>7.1</td>
<td>116.8</td>
</tr>
<tr>
<td>Calcium, mg</td>
<td>93</td>
<td>1100</td>
<td>980.5</td>
<td>399.78</td>
<td>99.7</td>
<td>2321.4</td>
</tr>
<tr>
<td>Energy intake, kcal</td>
<td>93</td>
<td></td>
<td>1851.3</td>
<td>534.19</td>
<td>633.5</td>
<td>3187.2</td>
</tr>
<tr>
<td>Protein, g</td>
<td>93</td>
<td></td>
<td>76.1</td>
<td>21.63</td>
<td>19.5</td>
<td>122.5</td>
</tr>
</tbody>
</table>

* = The reference value is originating from Dutch National Food Consumption Survey 2007-2010 (10).

Table 3 shows the association between the dietary mineral intake of magnesium, selenium, and calcium and the amount of muscle mass. There was no significant association between magnesium and muscle mass (β= -0.16, P= 0.971).

Table 3 Model 1 shows the relation between selenium and muscle mass (β= 59.38, P= 0.004). Model 2 shows the relation between selenium and muscle mass including the confounders: age, gender, and energy intake (β= 44.28, P= 0.010), this model shows a significant association between the variables. In model 3, the confounders age, gender, protein, and energy intake were included. This model illustrates that there was no significant (β= 38.30, P= 0.052) relation between the intake of selenium and the amount of muscle mass.
The analysis of the association between the intake of calcium and muscle mass was adjusted by the following confounders: age, gender, diuretics, levothyroxine, phenytoin, phenobarbital, protein, and energy intake (see Table 3, model 3). In model 3 the results demonstrate that there was no significant ($\beta = -1.34, P=0.251$) association between the variables.

### Table 3: Association between muscle mass and mineral intake

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Model 1</th>
<th>CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnesium</td>
<td>Model 1</td>
<td>5.60</td>
<td>-2.375-13.768</td>
</tr>
<tr>
<td></td>
<td>Model 2</td>
<td>2.28</td>
<td>-6.066-10.635</td>
</tr>
<tr>
<td></td>
<td>Model 3</td>
<td>-0.16</td>
<td>-9.022-8.701</td>
</tr>
<tr>
<td>Selenium</td>
<td>Model 1</td>
<td>59.38</td>
<td>19.091-99.672</td>
</tr>
<tr>
<td></td>
<td>Model 2</td>
<td>44.28</td>
<td>10.816-77.742</td>
</tr>
<tr>
<td></td>
<td>Model 3</td>
<td>38.30</td>
<td>-0.323-76.928</td>
</tr>
<tr>
<td>Calcium</td>
<td>Model 1</td>
<td>0.92</td>
<td>-1.238-3.073</td>
</tr>
<tr>
<td></td>
<td>Model 2</td>
<td>-0.15</td>
<td>-2.021-1.732</td>
</tr>
<tr>
<td></td>
<td>Model 3</td>
<td>-1.34</td>
<td>-3.640-0.963</td>
</tr>
</tbody>
</table>

Model 1 = crude model  
Model 2 = crude adjusted for age, gender and energy intake  
Model 3\(^a\) = crude adjusted for gender, age, phenytoin, phenobarbital, protein, and energy intake  
Model 3\(^b\) = crude adjusted for gender, age, protein, and energy intake  
Model 3\(^c\) = crude adjusted for age, gender, diuretics, levothyroxine, phenytoin, phenobarbital, protein, and energy intake

Table 4 shows the relation between the dietary mineral intake of magnesium, selenium and calcium and the physical activity.

The relation between physical activity and the intake of magnesium, adjusted for the confounders gender, age, and energy intake, did not show a significant correlation ($\beta = 0.00, P=0.37$)(see Table 4, model 2). Certain confounders (protein intake, levothyroxine, tetracycline, diuretics, phenytoin, and phenobarbital) were excluded from this analysis for the reason that the beta coefficient didn’t change enough (10%).

In the multivariate-adjusted model selenium intake and physical activity did not show a significant relation with each other ($\beta = -0.00, P= 0.313$) (see Table 4, model 3\(^b\)). In this model, adjustments were made by using the confounders age, gender, levothyroxine, tetracycline, protein, and energy intake.

There was no significant association found between physical activity and calcium ($\beta = 0.00, P=0.188$)(see Table 4, model 3\(^b\)). The used confounders for this analysis were age, gender, levothyroxine, tetracycline, diuretics, phenytoin, phenobarbital, protein, and energy intake.
Table 4 Association between physical activity and mineral intake

<table>
<thead>
<tr>
<th></th>
<th>β</th>
<th>CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnesium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 1</td>
<td>0.00</td>
<td>0.000-0.001</td>
<td>0.071</td>
</tr>
<tr>
<td>Model 2</td>
<td>0.00</td>
<td>0.000-0.001</td>
<td>0.374</td>
</tr>
<tr>
<td>Selenium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 1</td>
<td>0.00</td>
<td>-0.001-0.002</td>
<td>0.913</td>
</tr>
<tr>
<td>Model 2</td>
<td>0.00</td>
<td>-0.002-0.001</td>
<td>0.601</td>
</tr>
<tr>
<td>Model 3\textsuperscript{a}</td>
<td>-0.00</td>
<td>-0.003-0.001</td>
<td>0.313</td>
</tr>
<tr>
<td>Calcium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 1</td>
<td>0.00</td>
<td>0.000-0.000</td>
<td>0.923</td>
</tr>
<tr>
<td>Model 2</td>
<td>-0.00</td>
<td>0.000-0.000</td>
<td>0.360</td>
</tr>
<tr>
<td>Model 3\textsuperscript{b}</td>
<td>-0.00</td>
<td>0.000-0.000</td>
<td>0.188</td>
</tr>
</tbody>
</table>

Model 1 = crude model  
Model 2 = crude adjusted for age, gender and energy intake  
Model 3\textsuperscript{a} = crude adjusted for age, gender, levothyroxine, tetracycline, protein, and energy intake  
Model 3\textsuperscript{b} = crude adjusted for age, gender, diuretics, levothyroxine, tetracycline, phenytoin, phenobarbital, protein, and energy intake
DISCUSSION

The results of our study show that the participants did not meet the daily recommended intake of the minerals calcium and selenium. The mean intake of calcium only fulfilled 89.1% of the daily recommendation and for selenium, this was 89.4% (10). Magnesium was the only mineral that exceeded the recommended intake with 109.4% - 131.5%. Our main findings were that the calcium, magnesium and selenium intake did not have a significant relation with muscle mass and physical activity.

Limitations
This study has several strengths and limitations. A limitation that needs to be addressed is the fact that the PAL values are based on two days physical activity diaries instead of three due to underreporting. However, our results are in accordance of that from other studies which have stated a PAL value for elderly between 1.58 and 1.80. The mean PAL value for our study was 1.5. However, the minimum PAL value was 0.9 which is much lower than the average measured PAL value 1.5. The lowest defined PAL value is 1.2 according to The Health Council (de Gezondheidsraad in Dutch), this is comparable to a sedentary and bedridden lifestyle. Even if using a two-day physical activity record could have been a contributing factor for such a low PAL value (0.9) there are multiple reasons that could have caused the decline of the PAL value to 0.9. Cardiovascular diseases, changes in lifestyle and smaller muscle mass may be possible explanations for the decline in physical activity (25, 26).

The findings of our study may be limited by the fact that more women (78.4%) than men (21.6%) participated. In a study by Janssen et al. found a significant difference in skeletal muscle mass between men and women. Men had significantly (P< 0.001) more muscle mass compared to women. There is a possibility that the overrepresentation of women in our study reduced the mean muscle mass. The crude Pearson’s correlation coefficients were adjusted for gender. The mean muscle mass of our study (20.2 kg) was relatively closer to the minimum (14.2 kg) than the maximum (31.8 kg). The study of Janssen et al. also found that independent of sex, a decrease in skeletal muscle is associated with aging. This happens in large measures after the fifth decade, which correlates with the age group (≥55 years) of our study (27). Despite the possible limitation, adjustment for gender in the model didn’t show a major difference between mineral intake and muscle mass. Therefore gender distribution may not be a major limitation.

Strengths
A major strength of this study is that a three-day food diary was used to assess the mineral intake of the participants. Three-day food records have a weakness when it comes to identifying a person’s habitual diet due to within-person variations of daily dietary intake. However, a five-day food diary would have been more reliable as is it shows more details about the food intake over a broader course of time. But keeping track of food consumption over a course of three days is already a difficult task. A study by Yoon Yang et al. showed that the three-day food record is an acceptable dietary assessment tool as it has a relatively high validity. The same study also showed that the three-day food record correlated higher with a nine-day food record than the food frequency questionnaire. In an observational study by Crawford et al 58 girls were assigned to one of three dietary assessments methods: the 24-hour recall, three-day food record, and five-day food frequency. Based on reported and observed intake, the three-day food record proved to be the best overall method. One of the reasons were that the percentage of missing foods (observed food items not reported) and phantom foods (reported food items not observed) were 15-23% lower than the other methods (28, 29).

Another strength of this study is that dual-energy x-ray absorptiometry (DXA) was used to examine the appendicular muscle mass of the participants. However, computed tomography (CT scan) and
magnetic resonance imagining (MRI) are considered to be precise imagining systems with the ability to distinguish fat from other soft tissue of the body. Therefore, these two methods are the golden standards for judging muscle mass in research. But the costs for CT and MRI are high, plus the accessibility to these equipments is limited and due to the high radiation exposure their use must be limited. The DXA produces precise and accurate results of fat, bone mineral and lean tissue at selected sites, making it an attractive alternative method for clinical use and for research (30, 31).

In our study, we did not find a significant association between minerals and physical activity. In contrary, a study by Veronese et al. in which healthy elderly women received oral supplementation of magnesium (300 mg daily) in the form of magnesium oxide for a period of 12 weeks did show that magnesium supplements had a significant positive effect on physical performance. This study used the SPPB, and gait speed and chair stand times to measure physical performance (32). It is difficult to make a direct comparison between our studies because they differ in several ways. The key difference is that we measured physical activity by using the PAL value, whereas in the study by Veronese et al. physical performance was measured which may explain the discrepancy between results.

At first, our study did see a significant correlation between muscle mass and selenium (P= 0.004). After adjusting for confounders (age gender and energy intake) there still appeared to be a significant correlation (P= 0.010). When the confounder protein was added, results showed that there was no significant relation between selenium and muscle mass (P= 0.052). A cross-sectional observational study by Chen et al. was the first study to demonstrate that in elderly people a low serum selenium is independently associated with low muscle mass. But they did not use protein as a confounder and to measure the skeletal muscle mass that study used the bioelectrical impedance analysis, our study used the DXA. To the best of our knowledge, this study was the first cross-sectional study to include elderly people ≥55 years exclusively to analyze the association of minerals (magnesium, calcium, selenium) with muscle mass and physical performance (15).

Selenium plays a role in multiple functions in the human body such as: protecting red blood cells and cells from damage, it ensures a proper thyroid function, it makes heavy metals that end up in food due to contamination less toxic and it protects against prostate cancer. A long-term shortage of selenium leads to muscle ache and muscle weakness (9). A study by Laurentani et al. found that low plasma selenium concentration is significantly associated with poor skeletal muscle strength in community-dwelling older adults in Tuscany. Laurentani et al. showed that selenium plays an important role in muscle function and not necessarily with muscle mass (33). The role of selenium, the study by Laurentani et al. and the fact that we could not find any studies that showed a significant relation between selenium and muscle mass and physical activity may be the explanation why our study also didn’t find a significant association.

The Nutrition Center (Voedingscentrum in Dutch) claims that magnesium is necessary for the formation of bones and maintaining muscle integrity and that it also plays a role in the transmission of nerve stimuli and proper functioning of the muscles (9). Our study did not find a significant relation between magnesium and muscle mass, maybe because magnesium plays a role in maintaining the muscle mass and no in increasing it. Our study also didn’t find a relation between magnesium and physical activity. An article by Lukasi confirms our results that no relation has been found yet and that more research is needed to evaluate the relation between magnesium and physical activity (34).

As for calcium, it’s primary role is to construct and keep maintenance of the bones and the teeth. Calcium is also required for proper functioning of nerves and muscles, blood clotting and transport of other minerals in the body cells, such as sodium, potassium, and magnesium (9). Calcium’s primarily
role in the human body could be the explanation why our study did not find a significant association between calcium and muscle mass and physical activity. This has also been confirmed by a randomized control study by Hedström et al. in which calcium only showed to have a beneficial effect on muscle mass of elderly women when given in combination with anabolic steroids and vitamin D (35). No other study was found that showed whether calcium has the same effect independently.

**Public relevance**
The intake of several minerals on a daily basis are necessary for the basic functioning of our bodies. Minerals such as calcium and magnesium contribute to the overall health of individuals due to their necessity for proper function and growth of many systems in the human body (36). Certain studies have shown that most elderly people do not meet the recommended intake of these minerals (10). Nutritional intake has been addressed to be an important factor to developing sarcopenia (7). Considering that the Dutch society is aging and that aging is associated with sarcopenia, these nutritional factors need to be taken into consideration (1, 3). In the Netherlands, more than 90% of people >65 years live independently. Half of them have one or more chronic diseases. Since the current Dutch government policy is aimed at enabling the elderly to live independently as long as possible, maintaining good health will play an important role in the lives of elderly people (37). More studies are currently focussing on trying to find a solution for this issue. With this study, we wanted to contribute to this social problem (38).
CONCLUSION

In conclusion, our cross-sectional study did not find a significant association between the dietary intake of magnesium, selenium, and calcium and the amount of muscle mass and physical activity in elderly over >55 years.
RECOMMENDATION

This study did not find a significant association between the dietary intake of magnesium, calcium, and selenium and the amount of muscle mass and physical activity in elderly. As a dietician, it is important to be aware that there are studies that did show an effect. (35, 39). As a dietician it is also important to know that in general, the Dutch elderly population does not meet the recommended daily intake of magnesium, selenium, and calcium (10). But a study showed that the average Dutch population does eat enough meat, but not enough dairy and cereal products (9, 10). Dairy and cereal products contain a lot of magnesium, selenium, and calcium (10). We recommend that this population consume at least three to four portions of dairy products, eat 2 slices of cheese and three to four slices of whole grain bread, bread substitutes (such as muesli), unpolished rice, whole grain pasta, and potatoes (40). Also, the use of the hype superfoods can increase the intake of these minerals (41). Gooseberries are considered to be superfoods. Even though it is not advisable to use them in large quantities because they contain a lot of carbohydrates (64.1 g of carbohydrates per 100 g), they do contain a lot of calcium (190 mg of calcium per 100 g). Cocoa powder (78 mg per 15 g) and hemp seeds (42 mg per tablespoon) are also rich in magnesium. Chia seeds contains both magnesium (20.1 mg per tablespoon) and selenium (3.3 μg per tablespoon)(42). These superfoods can be added to multiple food products such as yoghurt, desserts, salads or smoothies. Adding these products to the diet will make it easier to meet the daily recommendation.

When the daily recommended intake of these minerals can’t be achieved by nutrition, we recommend supplements. Previous studies have proven that supplementation can be an effective alternative (32). One of the reasons is that elderly people have problems with absorbing the minerals out of nutrition (43). The human body generally absorbs minerals from supplements better than minerals from regular food. These supplements can help to meet the daily recommended intake (9).

Currently there aren’t many intervention studies done to investigate the effect of minerals on muscle mass and physical activity (39). Therefore, more research is needed. Our study was observational. This method doesn’t have the ability to show that one variable has an effect on the other one, in contrary to an intervention studies (RCT), who does have this ability (44). Thus, in the future we recommend that a randomized controlled trial should be conducted to research more into this trending subject. The ideal conditions would be:

- To consist of one population group only (45);
- That the variables being studied should be the same between the control group and the intervention group (45);
- To use a control group and an intervention group (46, 47). The control group maintains their lifestyle without any changes and the intervention group should receive supplements or nutrition that meet at least the minimum needs;
- To use the DXA for muscle mass and PAL value for physical activity;
- To use a baseline measurement and a follow up after six months (48).

A study design with this quality might provide evidence about whether minerals (magnesium, selenium and calcium) have a beneficial effect on muscle mass and physical activity.
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