**What is the optimal body mass index range for older adults?**

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**Abstract**

**Background:** Obesity is pathophysiologically complex in older adults when compared to young and middle aged adults. The aim of the present study was to determine the appropriate BMI (body mass index) range based on geriatric evaluation parameters, in which complications can be minimized in older adults.

**Methods:** 1051 older adult patients who had undergone comprehensive geriatric assessment were included. The patient's demographic characteristics, comorbid diseases, number of drugs, BMI, Basic and Instrumental Activities of Daily Living (BADL and IADL), Tinetti balance and walking scale, mini nutritional assessment, geriatric depression scale-15, mini mental state examination, time up and go test, and hand grip strength measurement were extracted from patient’ files.

**Results:** Of the patients who took part73% were female and the mean age was 77.22 ± 7.10 years. The most negative results were observed in those with a BMI˂25 and in those with a BMI˃35. ROC analysis of the optimum BMI cut-off levels to detect the desirable values of geriatric assessment parameters were found to be 31-32 kg/m2 for females and 27-28 kg/m2 for males.

**Conclusion:** Older adults with BMI below 25 and above 35 are at a higher risk of a decrease in functional capacity, gait and balance problems, fall risk, decrease in muscle strength and malnutrition. Data from this study suggest that the optimum range of BMI levels for older adults are 31-32 for females kg/m2 and 27-28 kg/m2 for males.

**Keywords:** Geriatric obesity, body mass index, Barthel scale, Lawton scale, Tinetti , Time up and go test

**1.Introduction**

Life expectancy has steadily increased over recent decades. Moreover, the global prevalance of older adults has increased owing to a decrease in birth and death rates 1-2) . Obesity is an important public health concern that is increasing among the older population and society as a whole. In the United States during the 1990s there were approximately32 million older adults and 26.1% of these had a BMI (body mass index) above 30, while in 2008 there was approximately 40 million older adults and 39.5% had a BMI over 30 3) . Moreover, according to the Korean national health insurance database, the prevalence of obesity among adults aged 70-79 years increased from 31.7% in 2006 to 36.6% in 2015. Obesity frequency among those over 80 years was 21.9% in 2006 andincreased to 27.5% in 2015 4) . In Turkey, the prevalence of obesity in the adult population has exceeded 30%. Although the prevalence of obesity is higher in females, the rapid increase in males has also drawn attention in recent years 5) .

Obesity among older adults is most likely the result of consuming more calories than energy expended. Decreased basal metabolic rate and physical activity levels in the elderly are important contributions to obesity 6) . Often in older adults changes in body composition such as an increase in fat mass and decrease in muscle mass are observed. Obesity is pathophysiologically complex in older adults when compared to young and middle aged adults. This complexity, makes it difficult to identify comorbidities related to obesity and creates a clinical uncertainty in terms of weight management 1) .  It should also be noted that some studies in older adults with cardiovascular diseases, cancer and stroke have found that patients with overweight and obesity have a lower risk of mortality. This situation is named obesity paradox  7-8) . Therefore, it is not clear which range of BMI is most beneficial for older adults in terms of outcomes, such as functionality, risk of falls, nutritional status, and strength. Altough there are some studies investigating associations between obesity or BMI and geriatric conditions, the present study is the first study to examine associations between many geriatric assessment parameters, such as nutritional status, cognitive and functional status, gait and balance, and muscle strengthand BMI groups, simultaneously 9)

The aim of the present study was to identify a suitable BMI range that can minimize negative clinical results in geriatric patients, based on geriatric evaluation parameters.

**2. Materials and Methods**

**2.a. Participitants:** Data were utilised from 2335 older adultswho applied to one hospital's geriatric outpatient clinic in Turkey between January 2017 and November 2020. After obtaining the ethics committee and institution approvals for the present study, data were retrospectively analyzed. 1312 people with either a diagnosis of dementia, history of cerebrovascular disease or had missing data were excluded from the study. The final sample included 1051 patients over 65 years of age.

**2.b. Comprehensive Geriatric Assessment:** Demographic information (patient age, gender, marital status, with whom they live), height, weight, BMI, calf circumference measurements, the number of drugs used, having a history of falling in the last year, Barthel basic daily living activities scale (BADL), Lawton instrumental daily living activities scale (IADL), Tinetti balance and gait scale, Mini nutritional assessment (MNA) test, Geriatric depression scale-15, Mini mental state examination (MMSE), Time up and go (TUG) test, and Hand grip strength (HGS) (3 measurements were made from the dominant hand and the highest value was taken ) were recorded. According to these parameters, BADL (Scores≥ 91) , IADL (Scores ≥ 17) , Tinetti Total (Scores > 19),TUG (˂ 13,5 s) , MNA (Scores ˃ 23.5), GDS (Scores ˂5), MMSE (Scores ≥ 23), and HGS (Female: ≥ 16 kg, male: ≥27 kg) were considered healthy 10-17)

**2.c. Evaluation of Weight Status:** BMI is defined as the person's weight in kilograms divided by the square of the person's height in meters (kg/m2). The World Health Organization categorizesBMI for adults over the age of 20 years as follows: under 18.5 underweight, between18.5-24.9 normal weight, between 25-29.9 preobesity, between 30-34.9 stage 1 obesity, between 35-39 stage 2 obesity and above 40 stage 3 obesity 18) .

**2.d. Statistical analysis**: IBM SPSS statistics 22.0 program was used for statistical analysis. Descriptive statistics were carried out to assess central tendency and distribution of study variables (e.g. mean, standard deviation, median, frequency). Skewness and kurtosis values were used together with the Shapiro–Wilk test to test for normal distribution of the data. The one-way ANOVA test was used to compare more than two normally distributed variables, the Kruskal Wallis test was used to evaluate more than two non-normally distributed variables. The chi-square test was used to evaluate the relationship between variables. The cut-off scores were assessed by the receiver operating characteristics (ROC) curve. Sensitivity, and specificity were calculated for different BMI cut-off scores to detect the desirable cut-off values of BADL, IADL, MNA, Tinetti, TUG, MMSE, GDS and HGS. After evaluating all BMI cut-off values, the optimum BMI values were detected according to best sensitivity and specificity. p-values for each AUC (Area Under the Curve) from the ROC was determined. Results were evaluated using 95% confdence interval and signifcance was set at a level of p<0.05

**3.Results**

**3.a. General Charactaristics**: A total of 1051 people, 768 women (73%) and 283 men (27%), were included in the study. The mean age of the participants was 77.22 ± 7.10 years (range 65-103 years), for men the mean age was 78.41 ± 7.39 years and for women 76.77 ± 6.94 years. There was a statistically significant difference between men and women in terms of age (p = 0.002).

The mean BMI of the sample was 30.79 ± 5.77 (range 18.5 and 56) kg/m2, for men the mean BMI was 28.12 ± 4.37 kg/m2 and for women 31.71 ± 5.92 kg / m2. There was a significant difference in BMI between men and women (p˂ 0.001). When women and men were evaluated separately, the results were similar. Moreover, whenpatients under 80 years were evaluated in the BMI groups, it was thought that the results were independent of age. General charactaristics for both gender shown in Table 1.

The patients were divided into groups according to the WHO BMI criteria. [Group 1: (BMI 18.5-24.9); Group 2: (BMI 25-29.9) ; Group 3 : (BMI 30-34.9) ; Group 4 : (BMI 35-39.9); Group 5 : (BMI ≥40)]. Of the total sample , 181 (17.2%) were living alone, 544 (51.8%) with their spouse, 173 (16.4%) with their children, and 153 (14,6%) with someone else (caregiver, relative, etc.).

The mean number of drugs used was 5.08 ± 3.11 (between 0-15), for men this figure was 4.9 ± 3.39 and for women 5.15 ± 3.00, there was no statistically significant difference between women and men (p = 0.261).The number of drugs (5.51 ± 3.13) used by those who stated that they had fallenin the past year was significantly higher than the number of drugs used by those who did not fall (4.86 ± 3.06) (p = 0.003).

**3.b. The relationships of geriatric assessment parameters with BMI groups** (**Table 2**): In the evaluation of the correlation between these parameters and BMI, a significant negative correlation was found between the Tinetti balance test and BMI. A significant positive correlation was found between Tinetti walking, MNA, calf circumference, MMSE, the number of drugs used by individuals and BMI (p <0.05). Figure 1 shows associations between BMI groups and geriatric assessment parameters.

**3.c. Determination of optimum cut-off points:** ROC analysis for the optimum level of BMI in older females and males who were healthier according to the cutoff values of BADL, IADL, MNA, Tinetti, TUG, MMSE, GDS and HGS are shown in Table 3. ROC analysis of the optimum BMI cut-off levels (shown in table 3) to detect the desirable values of these geriatric assessment parameters are shown in Figure 2. Table 3 and figure 2 complement each other. The optimum BMI values were found to be 31-32 kg/m2 for females and 27-28 kg/m2 for males (Table 3).

When the relationship between chronic diseases and BMI groups were evaluated, hypertension, diabetes mellitus and chronic obstructive pulmonary disease were more prevalent in BMI≥30 than in BMI < 30 (p <0.05) (Supplementary Table 1).

**4.Discussion**

Obesity is an important public health issue increasing among the older adult population as well as society as a whole. The BMI of 26.1% of the elderly population was over 30 in the United States in the 1990s, this increased to 39.5% of the elderly population in 2008.In the presentstudy, it was found that 503 (54.6%) people had a BMI above 30. It has been shown in several studies that the prevalence of hypertension, metabolic syndrome, coronary heart disease, obstructive sleep apnea syndrome, and osteoarthritis increases with increasing obesity in geriatric patients and that patients require more surgical intervention. 19-21) Similar to these previous studies, a significant difference was found between different BMI groups in terms of hypertension, diabetes mellitus and COPD prevalence in the present study. It was observed that the frequency of these diseases increases significantly, especially when is above 35. There was no significant difference between the groups in terms of the frequency of coronary artery disease and heart failure.

Galanos et al. observed a J-shaped relationship between BMI and decreased muscle strength in the elderly aged between 65 and 85 years. It was found that weakness increased in both low and high BMI values for both genders 22) . Obesity is a potential additional risk factor for unwanted surgical outcomes in older adults. Surgical complications associated with obesity include poor wound healing, risk of infection, increased operative time, and breathing difficulties 23) . However, some studies have shown that 30-day postoperative mortality is reduced or even improved long-term survival in those who are generally overweight or have milder levels of obesity, thus supporting the obesity paradox hypothesis 8) .

In the present study a significant positive correlation was found between the number of drugs used by individuals and BMI. Moreover, a significant difference was found between the BMI groups in terms of the number of drugs used. It has previously been found that those with a BMI above35 use the highest number of drugs. This may be because hypertension, diabetes mellitus, and COPD are more common in those with a BMI over 30, and the accumulation of drugs used to treat each individual condition increases the total number of drugs taken.

The present study showed that there was a significant difference found between BMI groups in terms of tinetti balance and gait scale (total) and TUG test and it was found that the worst results were seen in the BMI range of 25 and over to ˃35, for both tests. Although there was no difference between BMI groups in terms ofHGS, it was found that the worst results were in this BMI range, similar to Tinetti total score and TUG duration, which are predictive for fall risk and sarcopenia  24). Falsarella et al evaluated the effect of muscle mass on the functionality of 99 elderly women and observed that decreased muscle mass was associated with walking speed and poor physical performance on TUG tests 25) . Leyk et al. found that HGS shows high correlation with lean body tissue 26). Studies have shown that BMI has a weak correlation with HGS. The reason for the weakness of the relationship is that BMI is not an indicator of lean body tissue in individuals 27) . As a result of the decrease in HGS, recovery after illness or surgery is delayed and physical function loss occurs. Indeed, there are publications showing the relationship between muscle strength and acute and chronic diseases 28-29) . In our study, similar parameters (TUG, Tinetti, muscle strength) increased fall risk among those with a BMI below 25, which is considered a normal BMI. This suggests that the ideal values for BMI in elderly individuals may differ from the normal population. However, it is observed that the risk of sarcopenic obesity increases with BMI values above 35 and especially above 40, and the risk of falling increases and functional capacity decreases in this group of the elderly. Thirty percent of people aged 65 and over fall each year, and this rate increases to approximately 40% for people aged 85 and over 30). Various degrees of injuries occur in 12-40% of elderly individuals who experience a fall and 20% require medical assistance 31) . In the present studythe relationship between BMI groups and Barthel Scale which shows functional capacity and Lawton scale was evaluated. A significant difference was found between the BMI groups in terms of Barthel and Lawton scales. In both scales, it was determined that the scale scores above BMI˂25 and BMI˃35 were lower, thus their functional capacities were lower. For these reasons, it seems ideal for the elderly to have a BMI between 25-35 in order to continue their functionality and reduce the risk of falling.

When we evaluated BMI groups in terms of MNA, a significant difference was found between the groups. When we examined the BMI groups, it was found that the best MNA results were in the range of 30-35 BMI, and it was observed that the MNA score tended to decrease gradually in individuals with BMI over 35. Our results showed that malnutrition, which is one of the most important causes of mortality and mobidity in the elderly should be considered not only in individuals with low BMI but also in those with obesity 32-33) .

Additionally, a high positive correlation was found between calf circumference and BMI. Studies have found that calf circumference correlates with other nutritional anthropometric measurements with BMI, free fat mass, and mobility 34) . The linear correlation curve showing the relationship between BMI and calf circumference and especially the tendency of TUG to increase after 30 BMI indicates that sarcopenic obesity should not be overlooked while using 31 cm cut-off for calf circumference screening for sarcopenia 35).

The present study also showed that a significant positive correlation was found between BMI and MMSE. MMSE is a useful and standardized test that is frequently used in clinical practice for the detection of cognitive disorders, for monitoring the stage of dementia and response to treatment, and for epidemiological studies for dementia 36) . In a meta-analysis by Beydoun et al. the existence of a U-shaped relationship between BMI and dementia was shown, and both obesity and underweight were associated with an increased risk of dementia 37). The reason for the difference in the present study may be due to the exclusion of patients with dementia and previous cerebrovascular disease.

Findings from the present study must be interpreted in light of its limitations. One limitation may be the possible selection bias due to the retrospective design. Another limitation is the cross-sectional design; thus, causal relationship can not be determined. Next, metabolic syndrome was not evaluated, only BMI measurements were used to investigate relationships with geriatric conditions. Finally, there is no mortality data to find optimum cut-off BMI values in older patients, Therefore, the study investigated the relationship between current geriatric assessment parameters and BMI. Clear strengths of the present study include th large sample size and multiple geriatric evaluation parameters evaluated simultaneously.

**5.Conclusion**

The present study suggests that the ideal BMI ranges for young and middle-aged individuals are not ideal in elderly patients, especially BMI values below 25 and above 35 in elderly individuals have a higher risk in terms of decreased functional capacity, balance, walking, mobilization disorders, fall risk, reduction in muscle strength and malnutrition. Therefore, a BMI between 25-35 may be optimal for health in the elderly. Data from this study suggest that the optimum range of the BMI level is (31-32) for females and (27-28) for males. With broader studies on this subject, ideal BMI ranges for elderly people can be determined.

**Description of authors’ roles**

PS and MK designed the study, collected the paper. MK wrote the paper. LS and EC supervised and edited the paper. MK was responsible for the statistical design of the study and for carrying out the statistical analysis.

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**Availability of data and materials:** All data generated or analyzed during this study is available for proposals and can be obtained from the corresponding author.

**Declarations Conflict of interest:** None.

**Ethical approval** :The study design and all procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee (Ethics Committee of Bezmialem Vakif University) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

**Human and animal rights disclosure:** This article does not contain any studies with animals performed by any of the authors.

**Informed consent:** Informed consent was obtained from all individual participants included in the study.

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**Table 1. General Charactaristics**

|  |  |  |
| --- | --- | --- |
| Parameters | Female  n:768 (73%) | Male  n:283 (27%) |
| Age (Years) | 76.77*±6.94* | 78.41*±7.39* |
| BMI (Kg/m2) | 31.71*±5.92* | 28.12*±4.37* |
| Hypertension | %73 | %58 |
| DM | %36 | %35 |
| CAD | %14 | %27 |
| COPD | %12 | %10 |
| Heart Failure | %6 | %12 |
| Barthel | *87.68±15.29* | *87.80±18.41* |
| Lawton | *17.19±5.91* | *17.15±6.01* |
| Tinetti Total | *23.77±6.37* | *24.82±6.14* |
| MNA | *23.34±4.11* | *24.36±4.73* |
| GDS | *5.45±4.35* | *3.25±3.89* |
| MMSE | *24.46±4.34* | *25.41±3.90* |
| TUG | *15.00±9.10* | *14.08±10.01* |
| HGS | *18.89±6.64* | *29.41±9.14* |

**DM:**Diabetes mellitus, **CAD:**Coronary artery disease, **COPD:**Chronic obstructive pulmonary disease

**Barthel:** Barthel basic daily living activities scale, **Lawton:** Lawton instrumental daily living activities scale, **MNA:** Mini Nutritional Assessment, **MMSE:** Mini mental state exam ,**HGS:** Hand grip strength, **GDS:** Geriatric Depression Scale, **TUG:** Time up and go test

**Table 2.** Evaluation of the relationship between geriatric assessment parameters and BMI groups

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test and scale name | Group:1  BMI˂24.9  n:163 | Group:2  BMI:25-29.9  n:298 | Group:3  BMI:30-34.9  n:320 | Group:4  BMI:35-39.9  n:182 | Group:5  BMI˃40  n:88 | p |
| Age | 79.12*±7.26* | 78.27*±6.75* | 75.26*±6.70* | 75.22*±6.59* | 74.20*±6.89* | 0.003 |
| Sex (females %) | 61% | 65% | 80% | 91% | 95% | 0.001 |
| BMI | 22.81*±1.85* | 27.63*±1.39* | 32.32*±1.36* | 36.77*±1.29* | 43.45*±4.17* | 0.001 |
| Barthel | *87.91±18.47* | *90.52±11.94* | *90.40±12.61* | *87.14±13.41* | *86.20±12.73* | *0.005* |
| Lawton | *16.45±6.53* | *17.73±5.20* | *18.55±5.03* | *17.76±5.38* | *16.72±5.62* | *0.009* |
| Tinetti Balance | *13.25±4.27* | *14.03±3.30* | *14.43±3.09* | *13.71±3.62* | *13.48±3.76* | *0.016* |
| Tinetti Walking | *9.99±3.25* | *10.73±2.46* | *11.01±2.38* | *10.73±2.28* | *10.09±2.84* | *0.002* |
| Tinetti Total | *23.34±6.85* | *24.85±5.23* | *25.43±5.11* | *24.52±5.43* | *23.65±6.20* | *0.004* |
| MNA | *21.82±5.17* | *23.91±3.72* | *24.83±3.53* | *24.50±3.15* | *24.16±2.95* | *0.001* |
| Calf Circumference (cm) | *32.37±2.86* | *35.33±3.10* | *37.66±3.57* | *40.20±3.72* | *42.28±3.32* | *0.001* |
| GDS | *5.22±4.61* | *4.44±4.28* | *4.60±4.14* | *5.41±4.23* | *4.88±4.22* | *0.156* |
| MMSE | *24.17±4.08* | *24.69±4.01* | *25.45±3.23* | *24.91±4.23* | *25.89±3.32* | *0.005* |
| TUG | *15.55±10.66* | *13.78±7.37* | *12.52±6.58* | *14.79±8.96* | *16.18±10.98* | *0.001* |
| HGS | *21.03±9.25* | *23.03±8.91* | *22.42±8.66* | *21.67±8.53* | *22.41±8.66* | *0.229* |
| Number of drugs | *4.35±3.12* | *4.81±3.22* | *4.98±2.94* | *5.56±2.86* | *5.73±3.25* | *0.005* |

**Barthel:** Barthel basic daily living activities scale, **Lawton:** Lawton instrumental daily living activities scale, **MNA:** Mini Nutritional Assessment, **MMSE:** Mini mental state exam ,**HGS:** Hand grip strength, **GDS:** Geriatric Depression Scale, **TUG:** Time up and go test

**Figure 1. Evaluation of the relationship between geriatric assessment parameters and BMI groups**

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**Barthel:** Barthel basic daily living activities scale, **Lawton:** Lawton instrumental daily living activities scale, **MNA:** Mini Nutritional Assessment, **MMSE:** Mini mental state exam ,**HGS:** Hand grip strength, **GDS:** Geriatric Depression Scale, **TUG:** Time up and go test

**Table 3.** Evaluation of cut-off values of BMI with ROC analysis

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Female** | **AUC (%95)** | **BMI**  **Cut off** | **p** | **Sensitivity (%)** | **Specificity (%)** |
| **Factor** |
| **Barthel (Scores ≥ 91)** | *0.576 (0.533-0.619)* | *31.56* | *0.002* | *0.564* | *0.562* |
| **Lawton (Scores ≥ 17)** | *0.552 (0.503-0.601)* | *31.24* | *0.020* | *0.554* | *0.555* |
| **Tinetti Total (Scores >19)** | *0.560 (0.497-0.622)* | *31.2* | *0.035* | *0.553* | *0.543* |
| **MNA ( Scores ˃ 23.5)** | *0.648 (0.604-0.693)* | *31.21* | *0.001* | *0.615* | *0.616* |
| **GDS ( Scores ˂ 5 )** | *0.488 (0.444-0.532)* | *31.56* | *0.588* | *0.478* | *0.476* |
| **MMSE ( Scores ≥ 23 )** | *0.589 (0.536-0.643)* | *31.21* | *0.002* | *0.549* | *0.544* |
| **TUG ( ˂ 13.5 s)** | *0.525 (0.479-0.572)* | *31.32* | *0.274* | *0.533* | *0.529* |
| **HGS (Female˃ 16 kg)** | *0.610 (0.563-0.657)* | *31.20* | *0.001* | *0.575* | *0.527* |
| **Male** | **AUC (%95)** | **BMI**  **Cut off** | **p** | **Sensitivity (%)** | **Specificity (%)** |
| **Factor** |
| **Barthel (Scores ≥ 91)** | *0.540 (0.461-0.619)* | *27.81* | *0.305* | *0.545* | *0.540* |
| **Lawton (Scores ≥ 17)** | *0.533 (0.450-0.616)* | *27.45* | *0.431* | *0.521* | *0.522* |
| **Tinetti Total (Scores >19)** | *0.635 (0.502-0.769)* | *27.10* | *0.030* | *0.594* | *0.604* |
| **MNA ( Scores ˃ 23.5)** | *0.646 (0.561-0.731)* | *27.12* | *0.002* | *0.585* | *0.586* |
| **GDS ( Scores ˂ 5 )** | *0.556 (0.471-0.642)* | *27.37* | *0.186* | *0.540* | *0.547* |
| **MMSE ( Scores ≥ 23 )** | *0.613 (0.518-0.707)* | *27.10* | *0.030* | *0.593* | *0.595* |
| **TUG ( ˂ 13.5 s)** | *0.522 (0.439-0.605)* | *27.45* | *0.596* | *0.524* | *0.529* |
| **HGS (Male ˃ 27 Kg)** | *0.579 (0.664-0.787)* | *27.37* | *0.040* | *0.575* | *0.587* |

**Barthel:** Barthel basic daily living activities scale, **Lawton:** Lawton instrumental daily living activities scale, **MNA:** Mini nutritional assessment test, **GDS:** Geriatric depression scale, **MMSE:** Mini mental state examination, **TUG:** Time up and go test, **HGS:** Hand grip strength, **AUC:** Area under the curve

**Figure 2.** ROC analysis of BMI cut-off levels to detect the desirable values of geriatric assessment parameters.

|  |  |  |
| --- | --- | --- |
| **Factor** | **Female** | **Male** |
| **Barthel**  **(Scores ≥ 91)** |  |  |
| **Lawton**  **(Scores ≥ 17)** |  |  |
| **Tinetti Total**  **(Scores >19)** |  |  |
| **MNA**  **( Scores ˃ 23,5)** |  |  |
| **GDS**  **( Scores ˂ 5 )** |  |  |
| **MMSE**  **( Scores ≥ 23 )** |  |  |
| **TUG**  **( ˂ 13,5 sn)** |  |  |
| **HGS**  **(Female˃ 16 kg)**  **(Male ˃ 27 Kg)** |  |  |

**Barthel:** Barthel basic daily living activities scale, **Lawton:** Lawton instrumental daily living activities scale, **MNA:** Mini nutritional assessment test, **GDS:** Geriatric depression scale, **MMSE:** Mini mental state examination, **TUG:** Time up and go test, **HGS:** Hand grip strength

**Supplementary Table 1.** Evaluation of the relationship between individuals' chronic diseases and BMI groups

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test and scale name | Group:1  BMI˂24.9  n:163 | Group:2  BMI:25-29.9  n:298 | Group:3  BMI:30-34.9  n:320 | Group:4  BMI:35-39.9  n:182 | Group:5  BMI˃40  n:88 | p |
| Hypertension | %62 | %63 | %75 | %80 | %78 | **0.004** |
| DM | %21 | %35 | %35 | %51 | %49 | **0.006** |
| CAD | %22 | %17 | %14 | %16 | %14 | **0.360** |
| COPD | %7 | %9 | %12 | %13 | %23 | **0.004** |
| Heart Failure | %5 | %9 | %6 | %8 | %8 | **0.643** |

**DM:**Diabetes mellitus, **CAD:**Coronary artery disease, **COPD:**Chronic obstructive pulmonary disease