Objective: Hepatitis B virus (HBV) affects over 400 million people in the world and is a major threat despite all measures taken for its prevention. It is one of the most important causes of liver cirrhosis. Liver cirrhosis causes malnutrition as a result of decreased oral intake, both because of the disease itself and multiple other reasons. Studies showed an inverse correlation between muscle mass and insulin resistance. We aimed to evaluate the relationship between insulin resistance, muscle mass, and muscle strength in patients with HBV-related cirrhosis.

Methods: We included 65 patients with HBV-related cirrhosis in Child-Pugh class A and B groups and 65 healthy control individuals in this monocentric study. Muscle mass indices were calculated with bioimpedance analysis for both groups to determine muscle strength and muscle mass. Handgrip strength, arm, and calf circumferences were measured. In both groups, HOMA-IR values were calculated to determine insulin resistance. Correlations of fasting glucose, fasting insulin, HbA1C, LDL, HDL, triglyceride, and cholesterol levels with calf and waist circumference measurements were detected. The relationship between muscle mass and insulin resistance, laboratory results, and waist and calf circumference was evaluated.

Results: The mean value of muscle mass index was 10.98±11.40 kg/m² in cirrhotic patients and 9.88±1.12 kg/m² in healthy control individuals. HOMA-IR values were detected as 3.47±3.80 in the study group and 1.83±1.20 in the control group. The correlation coefficient between muscle mass and insulin resistance was statistically insignificant, especially in the study group.

Conclusion: In our study, there was no relationship between muscle mass and insulin resistance in cirrhotic patients with hepatitis B.
of Clinical Research Ethics Committee of Umranıye Education and Research Hospital. Informed consent was obtained from all patients and the control group before they were being enrolled in the study.

Sixty-five Child-Pugh class A and B HBV-related cirrhotic patients and 65 control patients without any chronic disease were included in our study. Patients in the control group were selected from those who had applied to internal medicine outpatient clinics with no abnormality in their routine examinations. In order to determine the muscle mass in both groups, the muscle mass index was determined using bioimpedance analysis based on the following formula: \[ \text{Muscle mass index} = \frac{\text{length}^2}{R \times 0.401} + (\text{sex} \times 3.825) + (\text{age} \times -0.071) + 5.102. \]

The values found were divided by the square of the height in meters (kg/m²). Handgrip strength, arm, and calf circumference were measured.

The arm circumference was measured with a measuring tape wrapped to fit around the highest point of the biceps and the lowest point of the triceps muscles. The calf circumference was measured from the most bulging part of the leg by wrapping the tape around the leg. Glucose, total cholesterol, HDL, triglyceride levels were measured in whole blood by enzymatic calorimetric method (Hitachi 747 autoanalyzer, Mito, Ibaragi, Japan). LDL levels were calculated with the Friedewald formula. HbA1c levels were measured using the HPLC method. Normal handgrip strength was accepted as 30 mmHg in men and 20 mmHg in women. HOMA-IR \((- simplistic formula \) \) was evaluated in order to determine insulin resistance in both groups. The upper limit of HOMA-IR was accepted as 3.2.

### Results

**1. Comparison of all parameters in patient and healthy groups**

Comparison of the patient and healthy groups in terms of all parameters was achieved (Table 1).

There was a significant difference between the patients and the healthy subjects because of the existence of probability levels \((p<0.05)\) in the arm circumference, fasting insulin, fasting glucose, HOMA-IR, HDL, and total cholesterol.

**2. Investigation of The Relationship between all Parameters and Muscle Mass Index and Handgrip Strength in the Patient Group using Correlation Analysis**

In the patient group, muscle mass index correlated positively with handgrip strength \((.592^{**})\), and calf circumference \((.416^{**})\).

Handgrip strength correlated positively, and significantly with muscle mass index \((.672^{**})\), calf \((.335^{**})\), and waist circumferences \((.303^{*})\) (Table 2).

### Statistical analysis

In the evaluation of the findings obtained in the study, SPSS for Windows 22.0 program was used for statistical analysis. In the evaluation of the study data, descriptive statistical methods (mean, standard deviation, % frequency) for the comparison of qualitative data such as the chi-square test and Fisher exact test were used. The relationship between handgrip strength and muscle mass index measurements with other parameters was examined by correlation and regression analysis. The comparison of all research parameters between the patient and healthy group was performed using an independent t-test. Significance was evaluated at \(p<0.05\) and \(p<0.01\).

### RESULTS

The study group (78 men: 60%, and 52 women: 40%) consisted of 65 (50%) patients and 65 (50%) control subjects. The mean ages of the patient and the healthy groups were significantly different from each other \((p<0.05)\). The mean age of the patient group \((55.4154±10.84967 \text{ years})\) was found to be higher than the mean age \((36.8154±11.18159 \text{ years})\) of the healthy group.

### Table 1. Comparison of all parameters in the patient, and the healthy groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>Mean±SD</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle mass index (kg/m²)</td>
<td>Patient</td>
<td>10.985±11.40</td>
<td>0.438</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>9.88±11.12</td>
<td></td>
</tr>
<tr>
<td>Handgrip strength (mmHg)</td>
<td>Patient</td>
<td>29.48±8.42</td>
<td>0.263</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>31.28±9.80</td>
<td></td>
</tr>
<tr>
<td>Arm circumference (cm)</td>
<td>Patient</td>
<td>29.43±3.55</td>
<td>0.001**</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>32.28±5.86</td>
<td></td>
</tr>
<tr>
<td>Calf circumference (cm)</td>
<td>Patient</td>
<td>46.80±5.37</td>
<td>0.616</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>47.29±5.59</td>
<td></td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>Patient</td>
<td>98.98±11.05</td>
<td>0.096</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>95.38±13.35</td>
<td></td>
</tr>
<tr>
<td>Fasting blood insulin (uIU/mL)</td>
<td>Patient</td>
<td>13.63±13.72</td>
<td>0.002**</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>7.85±4.24</td>
<td></td>
</tr>
<tr>
<td>Fasting blood glucose (mg/dL)</td>
<td>Patient</td>
<td>98.63±14.70</td>
<td>0.009**</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>92.58±10.94</td>
<td></td>
</tr>
<tr>
<td>HBA1C</td>
<td>Patient</td>
<td>5.51±4.77</td>
<td>0.705</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>5.98±3.63</td>
<td></td>
</tr>
<tr>
<td>HOMA-IR</td>
<td>Patient</td>
<td>3.47±3.80</td>
<td>0.001**</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>1.83±1.20</td>
<td></td>
</tr>
<tr>
<td>LDL (mg/dL)</td>
<td>Patient</td>
<td>109.05±37.69</td>
<td>0.316</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>115.88±39.72</td>
<td></td>
</tr>
<tr>
<td>HDL (mg/dL)</td>
<td>Patient</td>
<td>40.20±12.65</td>
<td>0.001**</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>46.91±10.67</td>
<td></td>
</tr>
<tr>
<td>Total cholesterol (mg/dL)</td>
<td>Patient</td>
<td>170.48±43.90</td>
<td>0.034*</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>186.66±42.26</td>
<td></td>
</tr>
<tr>
<td>Triglyceride (mg/dL)</td>
<td>Patient</td>
<td>106.98±54.25</td>
<td>0.373</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>116.09±61.70</td>
<td></td>
</tr>
</tbody>
</table>

\(^{*}p<0.05; ^{**}p<0.01; ^{*}\text{Independent sample t-test p value.}\)

HOMA-IR: Homeostatic Model of Assessment-Insulin Resistance; LDL: Low-density lipoprotein; HDL: High density lipoprotein; SD: Standard deviation.
3. Regression analysis of the explanatory status of the relevant parameters for the variables of muscle mass index and handgrip in the patient group

The regression analysis revealed the impact of relationships found in the correlation analysis in detail. In regression analysis, only statistically significant variables of correlation analysis were used as independent variables.

In the patient group, muscle mass index affected the waist circumference positively (.915*). Increased waist circumference could be interpreted as an increase in muscle mass (Table 3).

In the patient group, the calf (.558**) and waist circumference (.221*) affected the handgrip strength positively (Table 4).

4. Comparison of handgrip strength groups of female and male participants in the patient and healthy groups

The parameter of handgrip strength is evaluated differently in men and women. For this purpose, handgrip strength was grouped as HGS <30 mmHg and HGS ≥30 mmHg in males, and as HGS <20 mmHg and HGS ≥20 mmHg in females. Patients and healthy individuals in each gender group were compared in consideration with this grouping.

In male participants, because of the detection of a test probability level of p<0.05 between HGS groups and health status of the study participants, a correlation is found between these parameters. Indeed, all participants in the HGS <30 mmHg group consisted of patients, while 64.3%, and 35.7% of HGS ≥30 mmHg group comprised of patients and healthy individuals, respectively.

In female participants; because of the detection of a test probability level of p<0.05, a significant relationship between the HGS groups and health status of the participants existed. While 43.8% of the patients in the HGS <20 mmHg group consisted of sick individuals, only 13.9% of

### Table 2. Correlation analysis of all parameters in the patient group

<table>
<thead>
<tr>
<th>No</th>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MMI</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>HGS</td>
<td>0.592**</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>AC</td>
<td>0.143</td>
<td>0.155</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CC</td>
<td>0.416**</td>
<td>0.335**</td>
<td>0.495**</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>WC</td>
<td>0.310*</td>
<td>0.303*</td>
<td>0.548**</td>
<td>0.536**</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>FMI</td>
<td>0.205</td>
<td>0.192</td>
<td>0.338**</td>
<td>0.290*</td>
<td>0.455**</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>FBG</td>
<td>0.053</td>
<td>-0.031</td>
<td>-0.046</td>
<td>0.149</td>
<td>0.297*</td>
<td>0.447**</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Hba1c</td>
<td>-0.062</td>
<td>-0.020</td>
<td>0.020</td>
<td>-0.039</td>
<td>0.254</td>
<td>0.032</td>
<td>0.467**</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Homa-IR</td>
<td>0.197</td>
<td>0.171</td>
<td>0.308*</td>
<td>0.289*</td>
<td>0.474**</td>
<td>0.986**</td>
<td>0.558**</td>
<td>0.083</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>LDL</td>
<td>-0.129</td>
<td>-0.013</td>
<td>0.092</td>
<td>0.215</td>
<td>0.136</td>
<td>0.014</td>
<td>0.052</td>
<td>0.422**</td>
<td>-0.012</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>HDL</td>
<td>-0.116</td>
<td>-0.073</td>
<td>-0.116</td>
<td>0.028</td>
<td>0.228</td>
<td>-0.082</td>
<td>0.105</td>
<td>-0.097</td>
<td>-0.073</td>
<td>0.138</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>TC</td>
<td>-0.167</td>
<td>0.004</td>
<td>0.114</td>
<td>0.238</td>
<td>0.096</td>
<td>0.041</td>
<td>0.029</td>
<td>0.353**</td>
<td>0.008</td>
<td>0.950**</td>
<td>0.300**</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>TG</td>
<td>-0.117</td>
<td>0.095</td>
<td>0.250*</td>
<td>0.213</td>
<td>0.260*</td>
<td>0.231</td>
<td>-0.073</td>
<td>0.175</td>
<td>0.196</td>
<td>0.305**</td>
<td>-0.396**</td>
<td>0.373**</td>
<td>1.000</td>
</tr>
</tbody>
</table>

*p<0.05; **p<0.01; 1Spearman correlation. FBI: Fasting blood insulin; TG: Triglyceride; TC: Total cholesterol; FBG: Fasting blood glucose; WC: Waist circumference; AC: Arm circumference; CC: Calf Circumference; HGS: Handgrip Strength; MMI: Muscle mass index.

### Table 3. Regression analysis of variables effective on muscle mass index in the patient group

<table>
<thead>
<tr>
<th>Group</th>
<th>Model</th>
<th>Unstd. Coefficients</th>
<th>Std Coefficients</th>
<th>t</th>
<th>p</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handgrip</td>
<td>Patient</td>
<td>0.097</td>
<td>0.170</td>
<td>0.072</td>
<td>0.572</td>
<td>0.570</td>
</tr>
<tr>
<td>Healthy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handgrip (mmHg)</td>
<td>Patient</td>
<td>0.074</td>
<td>0.011</td>
<td>0.645</td>
<td>6.699</td>
<td>0.000**</td>
</tr>
<tr>
<td>Healthy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>Patient</td>
<td>0.286007</td>
<td>0.125</td>
<td>0.277</td>
<td>2.290</td>
<td>0.025*</td>
</tr>
<tr>
<td>Healthy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDL (mg/dL)</td>
<td>Patient</td>
<td>-0.116</td>
<td>0.113</td>
<td>-0.188</td>
<td>-1.116</td>
<td>309</td>
</tr>
<tr>
<td>Healthy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.05; **p<0.01; 1Linear regression coefficients t test p value. HLD: High density lipoprotein.
the patients in the ESG≥20 mmHg group were included in the study (Table 5).

5. Comparison of HOMA-IR groups in patient and healthy groups

The study participants were divided into two groups as those having HOMA-IR values of <3.2 or ≥3.2, and it was investigated whether this distinction led to a significant proportional collection among patients and healthy individuals. Because the test probability level was p<0.05, the proportional relationship between HOMA-IR parameter groups and health status of the participants was found to be significant.

In the healthy group, 82.9% of the individuals were in the HOMA-IR (<3.2) group and 10.8% in the HOMA-IR (≥3.2) group, while 68.3% of the patients in the patient group were in HOMA-IR (<3.2) group and 31.7% of them in HOMA-IR (≥3.2) group. When compared with healthy individuals, a greater number of patients were in the HOMA-IR (≥3.2) group (Table 6).

**DISCUSSION**

There is no relationship between muscle mass and insulin resistance in Child-Pugh A and B class cirrhotic patients with hepatitis. In the advanced stages of liver cirrhosis, protein-energy malnutrition is a frequently seen clinical picture. Malnutrition is present in 20% of compensated and 60% of decompensated liver cirrhosis patients.[1] These patients may have malnutrition and lower muscle mass compared to the normal population.

End-stage liver disease can be defined as cachexia accompanied by sarcopenia. Sarcopenia refers to the progressive generalized loss of muscle mass and muscle strength.[5] Increased insulin resistance in these patients means hyper-

---

**Table 4.** Regression analysis of variables affecting handgrip strength in the patient group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>Unstd. Coefficients</th>
<th>Std Coefficients</th>
<th>t</th>
<th>p</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle mass index (kg/m²)</td>
<td>Patient</td>
<td>0.053</td>
<td>0.093</td>
<td>0.072</td>
<td>0.572</td>
<td>0.570</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>5.620</td>
<td>0.839</td>
<td>0.645</td>
<td>6.699</td>
<td>0.000</td>
</tr>
<tr>
<td>Calf circumference (cm)</td>
<td>Patient</td>
<td>0.558</td>
<td>0.177</td>
<td>0.369</td>
<td>3.155</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>0.262</td>
<td>0.218</td>
<td>0.150</td>
<td>1.202</td>
<td>0.234</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>Patient</td>
<td>0.221</td>
<td>0.092</td>
<td>0.290</td>
<td>2.403</td>
<td>0.019</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>0.104</td>
<td>0.092</td>
<td>0.141</td>
<td>1.132</td>
<td>0.262</td>
</tr>
<tr>
<td>HDL (mg/dL)</td>
<td>Patient</td>
<td>0.028</td>
<td>0.084</td>
<td>0.042</td>
<td>0.334</td>
<td>0.739</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>-0.410</td>
<td>0.104</td>
<td>-0.447</td>
<td>3.963</td>
<td>0.000</td>
</tr>
</tbody>
</table>

*p<0.05; **p<0.01; †Linear regression coefficients t test p value. HLD: High density lipoprotein.

---

**Table 5.** Comparison of the patient, and healthy groups in terms of handgrip strength

<table>
<thead>
<tr>
<th>Gender</th>
<th>Handgrip strength (mmHg)</th>
<th>Total</th>
<th>p¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Handgrip strength &lt;30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>Patient</td>
<td>0 (0)</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>8 (100)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>8 (100)</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>Patient</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Healthy</td>
<td>7 (43.8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>7 (43.8)</td>
<td></td>
</tr>
</tbody>
</table>

*p<0.05; †p<0.01; ¹Chi-square p value. (Chi-square) Fisher exact test p value.

---

**Table 6.** Comparison of HOMA-IR values in the patient, and healthy groups

<table>
<thead>
<tr>
<th>HOMA-IR groups</th>
<th>Patient</th>
<th>Healthy</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;3.2</td>
<td>101 (78.9)</td>
<td>58 (92.9)</td>
</tr>
<tr>
<td>≥3.2</td>
<td>7 (10.8)</td>
<td>20 (31.7)</td>
</tr>
<tr>
<td>Total</td>
<td>128 (100.0)</td>
<td>65 (100.0)</td>
</tr>
</tbody>
</table>

*p<0.05; **p<0.01; †Chi-square p value. HOMA-IR: Homeostatic Model of Assessment-Insulin Resistance.
insulinemia and hyperglycemia. Hyperglycemia and hyper-
insulinemia have a negative effect on prognosis in patients
with any critical disease.

Regardless of the etiology, most of the cirrhotic patients
are malnourished and sarcopenic. There is a relationship
between the density of muscle mass and insulin resistance
and some metabolic values.[5]

In our study, presence of severe sarcopenia was consid-
ered in patients with muscle mass indices (MMIs) of ≤8.5
kg/m² in men and 5.75 kg/m² in women, while MMIs of
10.76 kg/m² in men and ≥6.76 kg/m² in women were
regarded as normal MMIs.[6]

Accordingly, 6 male patients in the patient group were
severely sarcopenic. Of the 65 patients, 11 female and 11
male patients had normal muscle mass indices. We could
classify 37 patients as being moderately sarcopenic.

The original version of Child-Turcotte classification, which
determines the prognosis of patients with liver cirrhosis,
was used until the year 1973 and had taken the nutritional
status of the patients in consideration. In the more recent
modified Child-Pugh classification, this has been replaced
by prothrombin time. Malnutrition rate in cirrhosis was earlier
observed at 80% and an increase in the malnutrition rate
by up to 25% has been reported even in Child-Pugh class A
patients.[7] In the 2006 guidelines of European Society for
Clinical Nutrition and Metabolism (ESPEN), malnutrition
is defined as a condition that causes measurable negative
effects and clinical results in a tissue/body form (shape, size
and composition) and functions as an outcome of a defi-
ciency or excess (i.e. imbalance) of energy, proteins, and
other nutrients.[8] Cirrhotic patients are malnourished in
terms of protein intake due to both reduced intake and hy-
permetabolic conditions. In our study, no significant differ-
ence was found between the patient and the healthy group
in terms of muscle mass and its functions.

It is thought that the introduction of muscle mass mea-
surement into clinical practice in the diagnosis of sarcopen-
ia may be possible with bioimpedance analysis (BIA). In-
deed, according to other muscle measurement methods,
muscle mass measurement with BIA is a more practical ap-
lication.[9,10] Studies on bioimpedance analysis have mostly
been conducted in human populations under the age of
65 years. Impedance measurements in elderly individuals
can overestimate lean muscle mass, so body fat can be
underestimated.[10]

Insulin resistance is a pathological condition that is usually
associated with chronic and usually low-grade inflamma-
tion, such as metabolic syndrome, type-2 diabetes, ath-
erosclerosis, cancer, rheumatoid arthritis, and poly cyc tic
ovary syndrome.[11] It is not known exactly how chronic
low-grade inflammation occurs in these diseases, but it is
thought to play an important role in the formation of
insulin resistance.[12] If we consider that there is a low de-
gree of inflammation in patients with cirrhosis, the possi-
bility of insulin resistance in these patients should not be
overlooked.

In our study, we aimed to determine the relationship be-
tween muscle mass and insulin resistance in patients with
hepatitis B-induced liver cirrhosis. Despite the presence of
advanced diagnostic and therapeutic methods used today,
HBV continues to be an important issue as it infects ap-
proximately 400 million people worldwide.[13]

Many studies have been conducted concerning chronic
liver diseases and impaired glucose tolerance.[18–16] How-
ever, a very small number of studies have examined the
relationship between diabetes mellitus (DM) and hepatitis
B. Obesity, advanced age, and family history are risk fac-
tors for DM, while cirrhosis, liver fatigue, and hepatitis C
have been implicated as a risk factor for DM.[17–19] In clinical
studies based on experimental studies indicating the rela-
tionship between DM and IR and chronic HBV, it has been
reported that the incidence of type 2 diabetes is higher in
patients with chronic HBV and HCV and that gestational
diabetes can be seen more frequently in relation to Hb-
sAg- positivity.[20,21]

A negative correlation was determined between skeletal
muscle index and insulin resistance, HbA1c and prevalence
of diabetes, and prediabetes in The Third National Health
and Nutrition Examination Survey. Consistent with these
studies, an increase in mRNA expression of a peptide
called myostatin that negatively affects the skeletal muscle
mass was also determined in the muscles of patients with
type 2 diabetes.[42,22] In our study, no correlation was found
between skeletal muscle mass and Homa-IR evaluated for
the presence of insulin resistance. We can associate this
finding with a small number of study participants.

Loss of skeletal muscle mass and presence of insulin re-
sistance in skeletal muscle are associated with the aging
process and obesity which can form the basis of metabolic
dysregulation and contribute to the development of MS.[23]
In our study, no significant difference between the healthy
and the patient groups in terms of muscle mass was de-
tected.

A significant difference was found between HOMA-IR,
fasting insulin, and fasting glucose levels in the compari-
on of all parameters in the patient and healthy groups. In
these three different parameters, the mean values in the
healthy group were found to be comparatively lower. This
may indicate that cirrhotic patients are more likely to ex-
perience impaired fasting glucose, prediabetes, and insulin
resistance when compared with a healthy population.

The term sarcopenia is of Greek origin and consists of a
combination of the words sarx (muscle) and penia (loss). It
expresses the progressive generalized loss of muscle mass
and muscle strength.[3] Sarcopenia is generally associated
with reduced mobility, physical inactivity, slow walking, and
poor physical endurance, and is also a common feature of
frailty syndrome.[24]

The diagnostic criteria of sarcopenia are low muscle mass,
low muscle strength, and low physical performance. There
are not many methods for assessing muscle strength in
these patients. Handgrip strength is used to measure mus-
In our study, significant positive relationships were detected between handgrip strength and muscle mass index, calf circumference, and waist circumference in the patient group which means that the muscle mass increases in parallel with the handgrip strength in the patient group.

In the study of by Laurentani et al., it was determined that in clinical practice, the handgrip strength of 30 mmHg for men and 20 mmHg for women would be a good approach. The use of handgrip is a convenient screening method because its application is easy, fast, and relatively inexpensive. However, exercise can lead to different effects on different muscle groups and should be monitored by appropriate regional methods. Furthermore, handgrip strength may not be strongly correlated with muscle strength in patients affected by rheumatoid arthritis, osteoarthritis, and carpal tunnel syndrome.[53]

In our study, handgrip strength was used to evaluate muscle strength. Here, the test limit was considered as 30 mmHg for men and 20 mmHg for women. Among male participants; a correlation between the HGS groups and the patient and the health status was detected at a test probability value of <0.05. All patients in the HGS <30 mmHg group consisted of sick individuals, while the HGS ≥30 mmHg group consisted of patients (64.3%) and healthy individuals (35.7%). In other words, when we consider the upper limit of normal value of muscle strength in the male patient group, we can say that most (45/53) of the patients were within the normal range. Among the female participants included in the study, the test probability level (p<0.05) indicated the presence of a significant correlation between the HGS groups and the health status of the study participants. Sick individuals consisted of 43.8% and 13.9% of the study participants in the HGS <20 mmHg and HGS ≥20 mmHg groups, respectively. We can say that handgrip strength in the female patient group is lower than the upper limit of normal.

In our study, HOMA-IR levels were estimated in the patient and control groups in order to determine insulin resistance. The participants were divided into two groups in consideration of 3.2 as the upper limit of normal and the presence of a significant proportional accumulation was investigated in patient and healthy individuals if any. Since the test probability level (p) was <0.05, a significant proportional relationship was determined between HOMA-IR parameter groups and health status of the study participants. In other words, the number of sick individuals was higher than the patients in the HOMA-IR ≥3.2 group. In our study, the incidence of insulin resistance in cirrhotic patients was higher than the healthy population. This result demonstrates similarities with the outcomes of previous studies.

The main aim of this study was to determine the relationship between muscle mass and insulin resistance in a special group, namely in hepatitis B-induced cirrhotic patients. The correlation between muscle mass and HOMA-IR levels was not statistically significant.

**CONCLUSION**

In our study, no significant relationship was found between muscle mass index and handgrip strength and HOMA-IR values in both patients and healthy participants. This can be attributed to the small number of our patients, limited survey time, and perhaps the fact that the muscle mass in the cirrhotic patients is difficult to estimate objectively.

In our study, although we found that the incidence of sarcopenia increased in early-stage cirrhosis patients like other studies, this sarcopenia was not related to insulin resistance.

**Ethics Committee Approval**

Approved by the local ethics committee.

**Informed Consent**

Prospective study.

**Peer-review**

Internally peer-reviewed.

**Authorship Contributions**


**Conflict of Interest**

None declared.

**REFERENCES**

9. Kyle Ug, Genton L, Slosman DO, Pichard C. Fat-free and fat mass percentiles in 5225 healthy subjects aged 15 to 98 years. Nutrition 2001;17:534–41. [CrossRef]
Hepatit B'ye Bağlı Sirotik Hastalarda Kas Kitlesi ile İnsülin Direnci Arasındaki İlişki

