Chapter – IV

RESULTS AND DISCUSSIONS
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4.1 OVERVIEW

This part of the thesis deals with the analysis of the physiological and biochemical data collected from the selected somatotyped samples under study with responses to submaximal treadmill run. The mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph groups were compared with one another for the difference in the measures of selected physiological and biochemical in relation to pre-test and post submaximal exercise test scores.

The subjects were screened by Heath-Carter somatotyped ratings and selected ten subjects in each category by random. The three groups were not equated in relation to the factors in which they were examined. Hence the differences among the means of three groups in pre-exercise test had to be taken into account during the analysis of post-exercise test differences among the means. This was achieved by the application of analysis of covariance where in the final means were adjusted for the differences in the initial means and adjusted means were tested for significance. The significance of the paired adjusted final test means were tested by Scheffes’ post-hoc test.

4.2 TEST OF SIGNIFICANCE

This part of thesis arrives at the conclusion by examining the hypothesis. The procedure of testing hypothesis was done either by accepting the hypothesis or rejecting the same in accordance with the results obtained in relation to the level of confidence. The level of confidence was fixed at 0.05 levels, which was sufficient for this study.
The tests of significance depend on whether the differences among the pre-test and post-test scores of the samples were significant or not. In this present study, if the obtained values were greater than the table value, the hypothesis was accepted to the effect that the existed significance differences among means of the groups were compared. And if the obtained values were less than the required values at 0.05 levels, then the hypothesis was rejected to the effect that, there was no significance difference among the means of the groups under studied. In addition to the test of significance of adjusted means, significance between paired adjusted final mean were tested by computing confidence interval, utilizing Scheffes' post hoc test of significance in which the 6.74 was needed at the 0.05 level of confidence.

4.3 LEVEL OF SIGNIFICANCE

The probability level below, which rejects the hypothesis, is termed as the level of significance. The F-ratio obtained by analysis of covariance needed 3.35 for significance at 0.05 level of confidence.

4.4 COMPUTATION OF ANALYSIS OF COVARIANCE, RESULTS AND DISCUSSIONS

The following tables illustrate the statistical results of the physiological and acid-base balance responses to the submaximal treadmill run among somatotyped university athletes.

4.4.1 Results of Heart Rate

Fig. 6 shows, the means of the pre and post-test submaximal exercise heart rate of the somatotyped athletes. Table - II shows the pre, post and adjusted post-test submaximal exercise heart-rate means and F-ratios'. The pre submaximal exercise heart rate means of the mesomorph-endomorph, ectomorph-mesomorph and mesomorphic-ectomorph athletes were 67.6 +/- 4.09 beats/min, 62.4 +/- 5.64 beats/min and 63.2 +/- 6.34 beats/min. The
obtained F-ratio for the pre submaximal exercise heart rate was 2.65, which was lesser than the required table value of 3.35 needed for significance. Hence the pre submaximal exercise heart rate differences between the somatotyped athletes were insignificant (P > 0.05).

The post submaximal exercise heart rate means of the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 181.2 +/- 4.64 beats/min, 167.4 +/- 4.12 beats/min and 162 +/- 7.89 beats/min. The obtained F-ratio for the post-test submaximal exercise heart rate was 29.21, which was higher than the table value of 3.35 needed for significance. Hence the post-test submaximal exercise heart rate mean differences between the somatotyped athletes were significant (P < 0.05).

The adjusted post-test submaximal exercise heart rate means of the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 178.7 +/- 2.49 beats/min, 168.9 +/- 3.86 beats/min and 162.9 +/- 2.37 beats/min. The obtained adjusted post-test submaximal heart rate F-ratio was 33.65, which was highly significant (P < 0.05) for the table value of 3.37 needed for significance.

The adjusted post-test submaximal exercise heart rate means, means difference and Scheffes’ Test F-ratio of the somatotyped athletes were shown in Table-II A. The adjusted post-test submaximal exercise heart rate mean difference between the mesomorphic-endomorph and ectomorphic-mesomorph, the mesomorphic-endomorph and mesomorphic-ectomorph and the ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 9.8 beats/min, 15.8 beats/min and 6.0 beats/min, and their Scheffes’ test F-ratios were 28.92, 75.19 and 10.84 respectively. The Scheffes’ confidence interval value 0.05 level was 6.74 needed for significance. Hence the adjusted post-test submaximal heart rate mean differences between the somatotyped athletes were significant (P < 0.05).
4.4.2 Discussion on Findings

The result of the pre-test heart rate shows that the mesomorphic-endomorph athletes had a higher mean resting heart rate than the ectomorphic-mesomorph and mesomorphic-ectomorph athletes. This finding shows that the trained athletes have lower heart rate and it depends upon the type of training, nature of events, which they are participating, and somatotyped components of their physique. Regular participation in aerobic exercise often results in a decrease in resting heart rate by 5 to 25 beats per minute. The lesser resting heart rate from exercise training is proposed to be due primarily to an increase in the parasympathetic activity with minor decrease in sympathetic discharge. An adaptation to the lowering of the resting heart rate, from aerobic training, is the heart’s ventricles are able to accommodate a greater volume of blood. As the resting heart rate decreases there are then more time for filling the ventricle with blood, and more time for delivery of oxygen and nutrients to the body and heart muscle, making the heart more efficient in meeting circulatory challenges at rest.

The results of this investigation was supported by the findings of Wallin and Schendal (1969)\(^1\), Massicotte, Avon and Corrivead (1979)\(^2\), Covey (1972)\(^3\), Milton (1966)\(^4\), Slordahl et al. (2004)\(^5\) and Steinhaus et al. (1988)\(^6\) states that endurance training reduces the resting heart rate and athletes have significantly lesser heart rate than the non athletes.

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The results of the pre-test heart rate mean value shows that ectomorphic-mesomorph and mesomorphic-ectomorph athletes had lower heart rate than the mesomorphic-endomorph athletes. When comparing the somatotyped athletes post-test submaximal exercise heart rate, the mesomorphic-endomorph athletes had increased higher heart rate than the ectomorphic-mesomorph and mesomorphic ectomorph athletes in terms of mean gains.

The results of the study was supported by the findings of Wallin and Schendal (1969)^7, Harger (1971)^8, Covey (1972)^9, Gutin, Fogile and Stewart (1976)^10, Jovanović and Jovanović (2005)^11, Gall, Parkhouse and Goodman (2004)^12, Warburton et al. (2002)^13 and Gibson et al. (2000)^14 states that endurance training reduces the submaximal exercise heart rate and elite athletes have significantly lesser heart rate than the untrained.

From this finding it was observed that the mesomorphic-ectomorph and ectomorphic-mesomorph athletes had an excellent endurance training adaptation particularly in both resting heart rate and post-test submaximal exercise heart rate than the mesomorphic-endomorph. Most of the somatotype studies were found that, elite athletes who were participating in the high level competitions having the dominance in ectomorphic and mesomorphic components than the endomorph.

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13 Warburton, et al. (2002). Experimental Physiology. 87(5): pp. 613 -
The results of the investigation supported by the findings of Raschka and Zanellato (2003)\textsuperscript{15}, Porcella, Succa and Vona (1992)\textsuperscript{16}, Bolonchuk et al. (2000)\textsuperscript{17}, Stewart, Williams and Gutin (1977)\textsuperscript{18}, Garrity (1976)\textsuperscript{19}, Sills and Everett (1953)\textsuperscript{20}, Toriola, Salokun and Mathur (1985)\textsuperscript{21}, Mathur, Toriola and Igbokwe (1985)\textsuperscript{22}, Quarrie et al. (1995)\textsuperscript{23}, and Gualdi-Russo and Zaccagni (2001)\textsuperscript{24} states that anthropometric and somatotype factors play a fine role in cardio-respiratory endurance performance. Ectomorphic and mesomorphic components were predominant in endurance athletes and ventilatory measures were higher in ectomorphic athletes. Athletes tend to be more mesomorphic and less endomorphic when compared with the mean of the normal population. Both these differences can be explained by environmental factors, related to the amount and type of physical activity engaged by athletes. The ectomorphy component increases as the requirement for endurance. This is shown by groups of athletes participating in different sports requiring different proportions of strength and endurance. Athletes in endurance sport are characterized by an increased heart size and a more efficient heart and circulatory system at rest and during submaximal work.

TABLE - II

Computation of Analysis of Covariance of Pre and Post-test Submaximal Exercise Heart-Rates of Mesomorphic-Endomorph, Ectomorphic-Mesomorph and Mesomorphic- Ectomorph Athletes (Heart-rate: Beats / minute)

<table>
<thead>
<tr>
<th>Hear-Rate Beats/minute</th>
<th>Mesomorphic-Endomorph</th>
<th>Ectomorphic-Mesomorph</th>
<th>Mesomorphic-Ectomorph</th>
<th>Sources of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre test means</td>
<td>67.6</td>
<td>62.4</td>
<td>63.2</td>
<td>B:</td>
<td>156.8</td>
<td>2</td>
<td>78.4</td>
<td>2.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>798.4</td>
<td>27</td>
<td>29.57</td>
<td></td>
</tr>
<tr>
<td>Post-test Means</td>
<td>181.2</td>
<td>167.4</td>
<td>162.0</td>
<td>B:</td>
<td>1960.8</td>
<td>2</td>
<td>980.4</td>
<td>29.21*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>906.8</td>
<td>27</td>
<td>33.56</td>
<td></td>
</tr>
<tr>
<td>Adjusted Post-test Means</td>
<td>178.7</td>
<td>168.9</td>
<td>162.9</td>
<td>B:</td>
<td>1117.85</td>
<td>2</td>
<td>558.93</td>
<td>33.65**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>431.96</td>
<td>26</td>
<td>16.61</td>
<td></td>
</tr>
<tr>
<td>Mean Gains</td>
<td>113.6</td>
<td>105.0</td>
<td>98.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at 0.05 level – table value of 3.35

**Significant at 0.05 level for adjusted Post-test Means – table value of 3.37
**TABLE - II A**

Adjusted post-test means of sub-maximal exercise Heart-Rate Mean Differences and Scheffe’s Test F-ratio of Somatotyped Athletes

<table>
<thead>
<tr>
<th>Mesomorphic-Endomorph (n = 10)</th>
<th>Ectomorphic-Mesomorph (n = 10)</th>
<th>Mesomorphic-Ectomorph (n = 10)</th>
<th>Mean Differences</th>
<th>Scheffe’s Test F = ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>178.7</td>
<td>168.9</td>
<td></td>
<td>9.8</td>
<td>28.92*</td>
</tr>
<tr>
<td>178.7</td>
<td></td>
<td>162.9</td>
<td>15.8</td>
<td>75.19*</td>
</tr>
<tr>
<td></td>
<td>168.9</td>
<td>162.9</td>
<td>6.0</td>
<td>10.84*</td>
</tr>
</tbody>
</table>

Scheffe’s F-ratio needed for significance 6.74 at 0.05 level

*Significant at 0.05 level
Fig. 6

Pre and Post Submaximal Exercise Heart Rate Means of the Somatotyped Athletes

Heart Rate [Beats/Minute]

Mesomorphic-Endomorph  Ectomorphic-Mesomorph  Mesomorphic-Ectomorph

67.6  62.4  63.2
181.2  167.4  162

Pre Exercise Heart Rate
Post Exercise Heart Rate
4.4.3 Results of Respiratory Rate

Fig. 7 shows the means of the pre-test and post submaximal exercise respiratory rate of somatotyped athletes. Table-III shows the pre, post and adjusted post submaximal exercise respiratory rate means and F-ratios. The pre-test respiratory rate means of the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 18.8 +/- 1.4, 16.6 +/- 2.32 and 14.2 +/- 2.2 respirations per minute. The obtained F-ratio for the pre submaximal exercise respiratory rate was 14.09, which was higher than the table value of 3.35 needed for significance. Hence the pre-test respiratory rate differences between the somatotyped athletes were significant (P < 0.05).

The post-test submaximal exercise respiratory rate means of the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 35.4 +/- 2.67, 31.2 +/- 3.16 and 28 +/- 2.11 respirations per minute. The obtained F-ratio for the post submaximal exercise respiratory rate was 11.67, which was higher than the table value of 3.35 needed for significance. Hence the post-submaximal exercise means differences between the somatotyped athletes were significant (P < 0.05).

The adjusted post-test submaximal exercise respiratory means of the mesomorphic-endomorph and ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 33.79, 31.15 and 29.65 breaths per minute. The obtained F-ratio for the adjusted post test mean difference between the somatotyped athletes was 5.34, which was significant (P < 0.05) for the table value of 3.37 needed for significance.

The adjusted post-test submaximal exercise respiratory rate means, mean differences and Scheffes' Test F-ratio of the somatotyped athletes were shown in the Table-III A. The adjusted post-test respiratory rate mean difference between the mesomorphic-endomorph and ectomorphic-mesomorph, the mesomorphic-endomorph and mesomorphic-ectomorph and
the ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 2.64, 4.14 and 7.15 respirations per minute and their Scheffes' test F-ratio were 3.45, 8.48 and 1.11 respectively. The Scheffes' confidence interval value of 0.05 level was 6.74 needed for significance. Hence only the difference between the mesomorphic-endomorph and the mesomorphic-ectomorph athletes was significant (P < 0.05).

4.4.4 Discussion on Findings

The results of the pre-test respiratory rate shows that the mesomorphic-ectomorph and ectomorphic-mesomorph athletes have lesser resting respiratory rate than the mesomorphic-endomorph athletes. The finding of this study was supported by the findings of Massicotte, Avon and Corrivead (1979)\(^25\), Gutin, Fogile and Stewart (1976)\(^26\) and Milton (1966)\(^27\). A systematic endurance training programme will improve the circulatory and respiratory performance and decreases the resting and post submaximal respiratory rate.

The post-test submaximal exercise respiratory rate mean difference shows that the ectomorphic-mesomorph and mesomorphic-ectomorph athletes had lesser respiratory rate than the mesomorphic-endomorphs. Submaximal exercise respiratory rate was higher in the mesomorphic-endomorph athletes than the ectomorphic-mesomorph and mesomorphic-ectomorph athletes.

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The result of this investigation was supported by the findings of Massicotte, Avon and Corrivead (1979)\textsuperscript{28}, Geor et al. (1995)\textsuperscript{29} and Tanaka and Seals (2007)\textsuperscript{30}, which states that the submaximal exercise increases the respiratory rate.

This finding shows mesomorphic-endomorph athletes had an excellent endurance training adaptation in the respiratory rate than the endomorphic-ectomorph and ectomorphic-mesomorph athletes. Somatotyped studies proved that the elite athletes who were participating in the high level competitions, having the dominance in ectomorphic and mesomorphic components.

The results of this study supported by the findings of Zerbo, Flezar and Stefanic (1988)\textsuperscript{31}, Bolonchuk et al. (2000)\textsuperscript{32}, Stewart, Williams and Gutin (1977)\textsuperscript{33}, Sills and Everett (1953)\textsuperscript{34} and Quarrie et al. (1995)\textsuperscript{35} states that the anthropometric and somatotype factors play a major role in cardio respiratory endurance performance. Ectomorphic and mesomorphic components were predominance in endurance athletes and ventilatory measures were highly adapted in ectomorphic athletes.

**TABLE - III**

Computation of Analysis of Covariance of Pre and Post-test submaximal Exercise Respiratory Rate of Mesomorphic- Endomorph, Ectomorphic- Mesomorph and Mesomorphic- Ectomorph Athletes.

<table>
<thead>
<tr>
<th>Respiratory-Rate/ Breaths/minute</th>
<th>Mesomorphic- Endomorph</th>
<th>Ectomorphic- Mesomorph</th>
<th>Mesomorphic- Ectomorph</th>
<th>Sources of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre test means</td>
<td>18.8</td>
<td>16.6</td>
<td>14.2</td>
<td>B:</td>
<td>105.4</td>
<td>2</td>
<td>57.2</td>
<td>14.09*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>109.6</td>
<td>27</td>
<td>4.06</td>
<td></td>
</tr>
<tr>
<td>Post-test Means</td>
<td>35.4</td>
<td>31.2</td>
<td>28.0</td>
<td>B:</td>
<td>275</td>
<td>2</td>
<td>137.5</td>
<td>11.67*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>318</td>
<td>27</td>
<td>11.78</td>
<td></td>
</tr>
<tr>
<td>Adjusted Post-test Means</td>
<td>33.79</td>
<td>31.15</td>
<td>29.65</td>
<td>B:</td>
<td>108.09</td>
<td>2</td>
<td>54.05</td>
<td>5.34**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>263.06</td>
<td>26</td>
<td>10.12</td>
<td></td>
</tr>
<tr>
<td>Mean Gains</td>
<td>16.6</td>
<td>14.6</td>
<td>13.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at 0.05 level – table value of 3.35

**Significant at 0.05 level for adjusted Post-test Means – table value of 3.37
### TABLE - III A

**Adjusted post-test means of submaximal exercise Respiratory Rate Mean Differences and Scheffe’s Test F-ratio of Somatotyped Athletes**

<table>
<thead>
<tr>
<th>Mesomorphic-Endomorph (n = 10)</th>
<th>Ectomorphic-Mesomorph (n = 10)</th>
<th>Mesomorphic-Ectomorph (n = 10)</th>
<th>Mean Differences</th>
<th>Scheffe’s Test F = ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>33.79</td>
<td>31.15</td>
<td>2.64</td>
<td>3.45</td>
<td></td>
</tr>
<tr>
<td>33.79</td>
<td>29.65</td>
<td>4.14</td>
<td>8.48*</td>
<td></td>
</tr>
<tr>
<td>31.15</td>
<td>29.65</td>
<td>1.50</td>
<td>1.11</td>
<td></td>
</tr>
</tbody>
</table>

Scheffe’s F-ratio needed for significance 6.74 at 0.05 level

*Significant at 0.05 level*
Fig. 7
Pre and Post Submaximal Exercise Respiratory Rate Means of the Somatotyped Athletes

- Pre Exercise Respiratory Rate
- Post Exercise Respiratory Rate

<table>
<thead>
<tr>
<th>Somatotyped Athletes</th>
<th>Respiratory Rate [Respiration/Minute]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesomorphic-Endomorph</td>
<td>35.4</td>
</tr>
<tr>
<td>Ectomorphic-Mesomorph</td>
<td>18.8</td>
</tr>
<tr>
<td>Mesomorphic-Ectomorph</td>
<td>31.2</td>
</tr>
<tr>
<td></td>
<td>16.6</td>
</tr>
<tr>
<td></td>
<td>14.2</td>
</tr>
<tr>
<td></td>
<td>28</td>
</tr>
</tbody>
</table>
4.4.5 Results of Venous Blood Sodium

Fig. 8 shows the means of the pre and post-test submaximal exercise venous blood sodium $[Na^+]$ of somatotyped athletes. Table- IV shows the pre, post-test and adjusted post-test submaximal exercise venous blood sodium $[Na^+]$ means and F-ratios'. The pre-test venous blood sodium $[Na^+]$ means of the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes were $149.03 \pm 3.14$, $146.21 \pm 2.38$ and $145.56 \pm 2.23$ mmol/l. The obtained F-ratio for the pre-test submaximal exercise venous blood sodium $[Na^+]$ was 1.82, which was lower than the table value of 3.35 needed for significance. Hence the pre-test submaximal exercise venous blood sodium mean differences between the somatotyped athletes were insignificant ($P > 0.05$).

The post-test submaximal exercise venous blood sodium $[Na^+]$ means of the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes were $155.10 \pm 3.61$, $153.18 \pm 2.86$ and $153.54 \pm 2.71$ mmol/l. The obtained F-ratio for the post-test submaximal exercise venous blood sodium $[Na^+]$ was 0.87, which was lower than the table value of 3.35 needed for significance. Hence the post-test submaximal exercise venous sodium $[Na^+]$ means differences between the somatotyped athletes were insignificant ($P > 0.05$).

The adjusted post-test submaximal exercise venous blood sodium $[Na^+]$ means of the mesomorphic-endomorph and ectomorphic-mesomorph and mesomorphic-ectomorph athletes were $154.24$, $154.31$, and $154.10$ mmol/l. The obtained F-ratio for the adjusted post-test mean difference between the somatotyped athletes was 0.18, which was insignificant ($P > 0.05$) for the table value of 3.37 needed for significance.
4.4.6 Discussion on Findings

The results of the pre-test submaximal exercise venous blood sodium [Na+] results shows that the mesomorphic-ectomorph and ectomorphic-mesomorph athletes have lesser sodium concentration than the mesomorphic-endomorph athletes. Though the difference is lesser, mesomorphic-ectomorph shows better adaptations than the other two groups. The post-test submaximal exercise venous blood sodium [Na+] mean difference shows that there is no difference among the somatotyped athletes. The result of this study was supported by the findings of McKeever et al. (2002) and Chewaskulyong et al. (1995). A systematic endurance-training programme will improve the metabolic adaptations and due to this effective core temperature is maintained. Since the exercise is not a prolonged there is no change in core temperature and due to this, the loss of sodium [Na+] in the blood is less.

During prolonged exercise, temperature and heart rate will become more elevated compared with a well-hydrated condition. The most serious effect of dehydration resulting from the failure to replace fluids during exercise is impaired heat dissipation, which can elevate body core temperature to dangerously high levels. Exercise-induced dehydration causes hypertonicity of body fluids and impairs skin blood flow, and has been associated with reduced sweat rate, thus limiting evaporative heat loss, which accounts for more than eighty percent of heat loss in a hot-dry environment. Dehydration can also elicit significant reduction in cardiac output during exercise since a reduction in stroke volume can be greater than the increase in heart rate.

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Some sports scientists found that short duration submaximal exercise doesn’t have much impact on electrolytes and only prolonged submaximal exercise causes the change in venous blood sodium [Na+] Singh and Sirisingh (1999), Gore et al. (1992), and McKeever et al. (2002).

From these findings, endomorphic-ectomorph and ectomorphic-mesomorph athletes had an effective thermoregulation and metabolic adaptation than the mesomorphic-endomorph. Somatotyped studies proved that the elite athletes who are participating in the high level competitions, having the dominance in ectomorphic and mesomorphic components, which was supported by the findings of Zerbo, Flezar and Stefancic (1988), Bolonchuk et al. (2000), Stewart, Williams and Gutin (1977), Sills and Everett (1953) and Quarrie et al. (1995).

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TABLE - IV
Computation of Analysis of Covariance of Pre and Post-test submaximal Exercise Sodium of the Mesomorphic- Endomorph, Ectomorphic- Mesomorph and Mesomorphic- Ectomorph Athletes [Na⁺: mmol/l]

<table>
<thead>
<tr>
<th>Respiratory-Rate</th>
<th>Mesomorphic-Endomorph</th>
<th>Ectomorphic-Mesomorph</th>
<th>Mesomorphic-Ectomorph</th>
<th>Sources of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Squares</th>
<th>F-ratio</th>
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<tbody>
<tr>
<td>Breaths/minute</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre test means</td>
<td>149.03</td>
<td>146.21</td>
<td>145.56</td>
<td>B:</td>
<td>68.06</td>
<td>2</td>
<td>34.03</td>
<td>1.82</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>505.81</td>
<td>27</td>
<td>18.73</td>
<td></td>
</tr>
<tr>
<td>Post-test Means</td>
<td>155.10</td>
<td>153.18</td>
<td>153.54</td>
<td>B:</td>
<td>20.83</td>
<td>2</td>
<td>10.42</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>321.78</td>
<td>27</td>
<td>11.92</td>
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</tr>
<tr>
<td>Adjusted Post-</td>
<td>154.24</td>
<td>154.31</td>
<td>154.10</td>
<td>B:</td>
<td>3.21</td>
<td>2</td>
<td>1.61</td>
<td>0.18</td>
</tr>
<tr>
<td>test Means</td>
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<td></td>
<td>W:</td>
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<td>9.09</td>
<td></td>
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<tr>
<td>Mean Gains</td>
<td>6.07</td>
<td>6.97</td>
<td>7.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at 0.05 level - table value of 3.35

**Significant at 0.05 level for adjusted Post-test Means – table value of 3.37
Fig. 8
Pre and Post Submaximal Exercise Venous Blood Sodium Means of the Somatotyped Athletes
4.4.7 Results of Venous Blood Potassium

Fig. 9 shows the means of the pre and post submaximal exercise venous blood potassium \([K^+]\) of somatotyped athletes. Table-V shows the pre, post and adjusted post submaximal exercise respiratory rate means and F-ratios. The pre-test venous blood potassium \([K^+]\) means of the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 4.51 +/- 1.4, 4.59 +/- 2.32 and 4.81 +/- 2.2 mmol/l. The obtained F-ratio for the pre submaximal exercise venous blood potassium \([K^+]\) was 0.54, which was lower than the table value of 3.35 needed for significance. Hence the pre-test submaximal exercise venous blood Potassium mean differences between the somatotyped athletes were insignificant (P > 0.05).

The post-test submaximal exercise venous blood potassium \([K^+]\) means of the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 4.51 +/- 2.67, 4.54 +/- 2.6 and 4.73 +/- 2.11 mmol/l. The obtained F-ratio for the post-test submaximal exercise venous potassium \([K^+]\) was 0.51, which was lesser than the table value of 3.35 needed for significance. Hence the post-test submaximal exercise venous potassium \([K^+]\) means differences between the somatotyped athletes were insignificant (P > 0.05).

The adjusted post-test submaximal exercise venous blood potassium \([K^+]\) means of the mesomorphic-endomorph and ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 4.53, 4.57 and 4.62 mmol/l. The obtained F-ratio for the adjusted post-test mean difference between the somatotyped athletes was 0.09, which was insignificant (P > 0.05) for the table value of 3.37 needed for significance.
4.4.8 Discussion on Findings

The results of the pre-test submaximal exercise venous blood potassium \([K^+]\) results showed that the mesomorphic-endomorph athletes had lesser potassium \([K^+]\) concentration than the mesomorphic-ectomorph and ectomorphic-mesomorph athletes. The post-test submaximal exercise venous blood potassium \([K^+]\) mean difference showed that there is no difference among the somatotyped athletes. The finding of this study was supported by the findings of Chewaskulyong et al. (1995)\(^{46}\) and Hecker and Wheeler (1994)\(^{47}\). A systematic endurance training programme will improve the metabolic adaptations and due to this effective core temperature is maintained. Since the exercise is not a prolonged there is no change in core temperature and due to this the loss of potassium \([K^+]\) in the blood is less.

During prolonged exercise, temperature and heart rate will become more elevated compared with a well-hydrated condition. The most serious effect of dehydration resulting from the failure to replace fluids during exercise is impaired heat dissipation, which can elevate body core temperature to dangerously high levels. Exercise-induced dehydration causes hypertonicity of body fluids and impairs skin blood flow, and has been associated with reduced sweat rate, thus limiting evaporative heat loss, which accounts for more than eighty percent of heat loss in a hot-dry environment. Dehydration can also elicit significant reduction in cardiac output during exercise since a reduction in stroke volume can be greater than the increase in heart rate.

The result of this investigation was supported by the findings of Singh and Sirisingh (1999)\(^{48}\) and Gore et al. (1992)\(^{49}\) saying that


submaximal exercise in short duration will not change the venous blood potassium \([K^+]\) concentration. Only prolonged submaximal exercise causes the changes in venous blood potassium \([K^+]\).

From these findings, endomorphic-ectomorph and ectomorphic-mesomorph athletes had an effective thermoregulation and metabolic adaptation than the mesomorphic-endomorph. Somatotyped studies proved that the elite athletes who are participating in the high level competitions, having the dominance in ectomorphic and mesomorphic components, which was supported the findings of Zerbo, Flezar and Stefanic (1988)\(^{50}\), Bolonchuk et al. (2000)\(^{51}\), Stewart, Williams and Gutin (1977)\(^{52}\), Sills and Everett (1953)\(^{53}\) and Quarrie et al. (1995)\(^{54}\).


TABLE – V

Computation of Analysis of Covariance of Pre and Post-test submaximal Exercise Serum Potassium of the Mesomorphic-Endomorph, Ectomorphic-Mesomorph and Mesomorphic-Ectomorph Athletes [K⁺: mmol/l]

<table>
<thead>
<tr>
<th>Diastolic Blood Pressure/mmHg</th>
<th>Mesomorphic-Endomorph</th>
<th>Ectomorphic-Mesomorph</th>
<th>Mesomorphic-Ectomorph</th>
<th>Sources of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre test means</td>
<td>4.51</td>
<td>4.59</td>
<td>4.81</td>
<td>B:</td>
<td>0.5</td>
<td>2</td>
<td>0.25</td>
<td>0.54</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>12.39</td>
<td>27</td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>Post-test Means</td>
<td>4.51</td>
<td>4.54</td>
<td>4.73</td>
<td>B:</td>
<td>0.41</td>
<td>2</td>
<td>0.21</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>10.99</td>
<td>27</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td>Adjusted Post-test Means</td>
<td>4.53</td>
<td>4.57</td>
<td>4.62</td>
<td>B:</td>
<td>0.04</td>
<td>2</td>
<td>0.02</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>6.04</td>
<td>26</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td>Mean Gains</td>
<td>0.0</td>
<td>-0.05</td>
<td>-0.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at 0.05 level table value of 3.35*

**Significant at 0.05 level for adjusted Post-test Means – table value of 3.37**
Fig. 9
Pre and Post Submaximal Exercise Venous Blood Potassium Means of the Somatotyped Athletes

Venous Blood Potassium [mmol/l]

4.35  4.4  4.45  4.5  4.55  4.6  4.65  4.7  4.75  4.8  4.85

Mesomorphic-Endomorph  Ectomorphic-Mesomorph  Mesomorphic-Ectomorph

Somatotyped Athletes

- Pre Exercise Potassium
- Post Exercise Potassium
4.4.9 Results of Venous Blood Chloride

Fig. 10 shows the means of the pre and post-test submaximal exercise venous blood chloride [Cl\(^{-}\)] of somatotyped athletes. Table-VI shows the pre, post and adjusted post-test submaximal exercise venous blood chloride [Cl\(^{-}\)] means and F-ratios. The pre-test venous blood chloride [Cl\(^{-}\)] means of the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 106.67 +/- 1.4, 105.98 +/- 2.32 and 107.51 +/- 2.2 mmol/l. The obtained F-ratio for the pre-test submaximal exercise venous blood chloride [Cl\(^{-}\)] was 0.86, which was lesser than the table value of 3.35 needed for significance. Hence the pre-test submaximal exercise venous blood chloride [Cl\(^{-}\)] mean differences between the somatotyped athletes were insignificant (P > 0.05).

The post-test submaximal exercise venous blood chloride [Cl\(^{-}\)] means of the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 107.55 +/- 2.67, 107.84 +/- 3.16 and 108.80 +/- 2.11 mmol/l. The obtained F-ratio for the post-test submaximal exercise venous blood chloride [Cl\(^{-}\)] was 0.56, which was lesser than the table value of 3.35 needed for significance. Hence the post-test submaximal exercise venous blood chloride [Cl\(^{-}\)] mean differences between the somatotyped athletes were insignificant (P > 0.05).

The adjusted post-test submaximal exercise venous blood chloride [Cl\(^{-}\)] means of the mesomorphic-endomorph and ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 107.58, 108.26 and 108.35 mmol/l. The obtained F-ratio for the adjusted post test mean difference between the somatotyped athletes was 0.31, which was insignificant (P > 0.05) for the table value of 3.37 needed for significance.
4.4.10 Discussion on Findings

The results of the pre-test submaximal exercise venous blood chloride [Cl'] results shows that the mesomorphic-ectomorph and ectomorphic-mesomorph athletes have lesser chloride [Cl'] concentration than the mesomorphic-endomorph athletes. The post-test submaximal exercise venous blood chloride [Cl'] mean difference shows that there is no difference among the somatotyped athletes. The finding of this study was supported by the findings of Leslie Carroll and Lowe (1970)\(^55\) and Chewaskulyong et al. (1995)\(^56\). A systematic endurance training programme will improve the metabolic adaptations and due to this effective core temperature is maintained. Since the exercise is not a prolonged there is no change in core temperature and due to this, the loss of chloride [Cl'] in the blood is less.

During prolonged exercise, temperature and heart rate will become more elevated compared with a well-hydrated condition. The most serious effect of dehydration resulting from the failure to replace fluids during exercise is impaired heat dissipation, which can elevate body core temperature to dangerously high levels. Exercise-induced dehydration causes hypertonicity of body fluids and impairs skin blood flow, and has been associated with reduced sweat rate, thus limiting evaporative heat loss, which accounts for more than eighty percent of heat loss in a hot-dry environment. Dehydration can also elicit significant reduction in cardiac output during exercise since a reduction in stroke volume can be greater than the increase in heart rate.

From these findings, endomorphic-ectomorph and ectomorphic-mesomorph athletes had an effective thermoregulation and metabolic adaptation than the mesomorphic-endomorph. Somatotyped studies proved


that the elite athletes who are participating in the high level competitions, having the dominance in ectomorphic and mesomorphic components, which was supported the findings of Zerbo, Flezar and Stefanic (1988)\textsuperscript{57}, Bolonchuk et al. (2000)\textsuperscript{58}, Stewart, Williams and Gutin (1977)\textsuperscript{59}, Sills and Everett (1953)\textsuperscript{60} and Quarrie et al. (1995)\textsuperscript{61}.


**TABLE - VI**

Computation of Analysis of Covariance of Pre and Post-test submaximal Exercise Serum Chloride of the Mesomorphic-Endomorph, Ectomorphic-Mesomorph and Mesomorphic-Ectomorph Athletes [Cl⁻: mmol/l]

<table>
<thead>
<tr>
<th>Systolic Blood Pressure/mmHg</th>
<th>Mesomorphic-Endomorph</th>
<th>Ectomorphic-Mesomorph</th>
<th>Mesomorphic-Ectomorph</th>
<th>Sources of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test means</td>
<td>106.67</td>
<td>105.98</td>
<td>107.51</td>
<td>B:</td>
<td>11.74</td>
<td>2</td>
<td>5.87</td>
<td>0.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>184.83</td>
<td>27</td>
<td>6.85</td>
<td></td>
</tr>
<tr>
<td>Post-test Means</td>
<td>107.55</td>
<td>107.84</td>
<td>108.80</td>
<td>B:</td>
<td>8.56</td>
<td>2</td>
<td>4.28</td>
<td>0.56</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>206.69</td>
<td>27</td>
<td>7.66</td>
<td></td>
</tr>
<tr>
<td>Adjusted Post-test Means</td>
<td>107.58</td>
<td>108.26</td>
<td>108.35</td>
<td>B:</td>
<td>3.46</td>
<td>2</td>
<td>1.73</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>146.56</td>
<td>26</td>
<td>5.64</td>
<td></td>
</tr>
<tr>
<td>Mean Gain</td>
<td>0.88</td>
<td>1.86</td>
<td>1.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at 0.05 level - table value of 3.35

**Significant at 0.05 level for adjusted Post-test Means – table value of 3.37
4.4.11 Results of Core Temperature

Fig. 11 shows the means of the pre-test and post submaximal exercise core temperature of somatotyped athletes. Table VII shows the pre, post-test and adjusted post submaximal exercise core temperature means and F-ratios. The pre-test core temperature means of the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 98.64 +/- 1.49, 98.62 +/- 3.32 and 98.60 +/- 2.24 °F. The obtained F-ratio for the pre-test core temperature 0.62, which was lower than the table value of 3.35 needed for significance. Hence the F-value of pre-test core temperature means differences between the somatotyped athletes were insignificant (P > 0.05).

The post-test submaximal exercise core temperature means of the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 98.82 +/- 4.37, 98.78 +/- 2.18 and 98.76 +/- 3.91 °F. The obtained F-ratio for the post-test submaximal exercise core temperature was 0.64, which was lower than the table value of 3.35 needed for significance. Hence, the post-test submaximal exercise core temperature mean differences between the somatotyped athletes were insignificant (P > 0.05).

The adjusted post-test submaximal exercise core temperature mean of the mesomorphic-endomorph and ectomorphic-mesomorph and mesomorphic-ectomorph athletes were 98.80, 98.78 and 9.78 °F. The obtained F-ratio for the adjusted post-test mean difference between the somatotyped athletes was 0.02, which was insignificant (P > 0.05) for the table value of 3.37 needed for significance.
4.4.12 Discussion on Findings

The pre-test submaximal exercise core temperature mean shows that mesomorphic-endomorph had slightly higher than the ectomorphic-mesomorph and mesomorphic-ectomorph athletes. The post-test submaximal exercise core temperature mean shows that mesomorphic-endomorph had slightly higher than the ectomorphic-mesomorph and mesomorphic-ectomorph athletes. The finding of the study shows that systematic sport training may improve the metabolic and thermoregulatory adaptations. The result of the adaptation is not much in the pre-test submaximal exercise core temperature among the athletic groups. When compared the post-test core temperature and the pre-test core temperature, there is a slight increase Israel et al. (1989)\(^62\) and Martin (2001)\(^63\) but no significant increment was found due to submaximal exercise.

At the initiation of exercise, the metabolic rate increases immediately; however, the thermoregulatory effector responses respond more slowly. The thermoregulatory effector responses, which enable dry and evaporative heat loss to occur, increase in proportion to the rate of heat production. Eventually, these heat loss mechanisms increase sufficiently to balance metabolic heat production, allowing a steady-state core temperature to be achieved.

This result is supported by the findings of Doubt and Hsieh (1991)\(^64\), Ertl et al. (2000)\(^65\), McCutcheon and Geor (2000)\(^66\), Booth et al. (2001)\(^67\),

Fortney and Vroman (1985), Lindqvist et al. (2003), Layden, Malkova and Nimmo (2004), saying that there is no significant effect due to the submaximal exercise in the trained athletes and only prolonged submaximal exercise in heat influences core temperature with minute ventilation.

Exercise training improves thermoregulation during exercise at the same absolute work rate. To obtain thermoregulatory benefits as a result of training, individuals must adequately stimulate thermoregulatory effector responses; in other words they must exercise at sufficiently high exercise intensity. Most serious athletes exercise regularly at an intensity of above 70% VO2max. Such training has been shown to allow individuals to achieve thermal equilibrium during exercise at 25-35% VO2max in desert heat conditions. However, appropriate training does allow an increased tolerance of exercise in hot conditions and acclimatization to warm environments confers further benefits in terms of the ability to regulate body temperature during exercise in the heat at higher intensity.

Sport training improves thermoregulation in the heat by an earlier onset of sweat secretion, and increasing the total amount of sweat that can be produced. Thus, training induces an increase in the sensitivity of the sweat rate/core temperature relationship, as well as a decrease in the internal temperature threshold for sweating. Sweat rates can vary markedly between individuals, even at the same relative exercise intensity, but there is evidence that those characterized as heavy sweaters have larger sweat glands than light sweaters. Training appears to induce a hypertrophy of existing sweat glands, without increasing the total number. Other adaptations to training include an increase in total blood volume and maximal cardiac output. As a

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result, blood flow in muscle and skin, with its heat flux, is better preserved during strenuous exercise in the heat.

From these findings mesomorphic-ectomorph and ectomorphic-mesomorph athletes had better metabolic adaptations than the mesomorphic-endomorph. Somatotyped studies proved that the elite athletes who were participated in the higher level competitions having dominance in ectomorphic and mesomorphic component. The results of this investigation supported by the findings of Raschka and Zanellato (2003)\(^1\), Bolonchuk et al. (2000)\(^2\), Stewart, Williams and Gutin (1977)\(^3\), Mathur, Toriola and Igbokwe (1985)\(^4\) and Quarrie et al. (1995)\(^5\) states that the anthropometric and somatotype factors plays major role in metabolic and thermoregulatory performance.


### TABLE - VII

Computation of Analysis of Covariance of Pre and Post-test Submaximal Exercise Core Temperature of the Mesomorphic-Endomorph, Ectomorphic-Mesomorph and Mesomorphic-Ectomorph Athletes (Core Temperature: Degree Fahrenheit [°F])

<table>
<thead>
<tr>
<th>Core Temperature</th>
<th>Mesomorphic-Endomorph</th>
<th>Ectomorphic-Mesomorph</th>
<th>Mesomorphic-Ectomorph</th>
<th>Sources of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre test means</td>
<td>98.64</td>
<td>98.62</td>
<td>98.60</td>
<td>B:</td>
<td>29177.71</td>
<td>2</td>
<td>14588.86</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>632731.87</td>
<td>27</td>
<td>23434.51</td>
<td></td>
</tr>
<tr>
<td>Post-test Means</td>
<td>98.82</td>
<td>98.78</td>
<td>98.76</td>
<td>B:</td>
<td>29276.42</td>
<td>2</td>
<td>14638.21</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>614804.28</td>
<td>27</td>
<td>22770.53</td>
<td></td>
</tr>
<tr>
<td>Adjusted Post-test Means</td>
<td>98.80</td>
<td>98.78</td>
<td>98.78</td>
<td>B:</td>
<td>30.67</td>
<td>2</td>
<td>15.34</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W:</td>
<td>19432.94</td>
<td>26</td>
<td>747.42</td>
<td></td>
</tr>
<tr>
<td>Mean Gains</td>
<td>0.16</td>
<td>0.16</td>
<td>0.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at 0.05 level – table value of 3.35

**Significant at 0.05 level for adjusted Post-test Means – table value of 3.37
Fig. 11
Pre and Post Submaximal Exercise Core Temperature Means of the Somatotyped Athletes

Core Temperature [Degree F]

<table>
<thead>
<tr>
<th>Somatotyped Athletes</th>
<th>Pre Exercise Core Temp</th>
<th>Post Exercise Core Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesomorphic-Endomorph</td>
<td>98.64</td>
<td>98.6</td>
</tr>
<tr>
<td>Ectomorphic-Mesomorph</td>
<td>98.62</td>
<td>98.6</td>
</tr>
<tr>
<td>Mesomorphic-Ectomorph</td>
<td>98.82</td>
<td>98.76</td>
</tr>
</tbody>
</table>

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4.5 DISCUSSION ON HYPOTHESES

Hypothesis number one stated that hypothesized that there would be a statistical significant difference among the somatotyped athletes when compared the pre-test Heart Rate.

The results of this finding confirmed that there was a significant difference among the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes when comparing the pre-test heart rate. Ectomorphic-mesomorph and mesomorphic-ectomorph athletes had lesser resting heart rate than the mesomorphic-endomorph.

*Hence the hypothesis number one has been accepted.*

Hypothesis number two stated that there would be a statistical significant difference among the somatotyped athletes when compared the pre-test Respiratory Rate.

The results of this finding confirmed the hypothesis and declared that there was a significant difference among the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes when comparing the pre-test submaximal exercise respiratory rate. Ectomorphic-mesomorph and mesomorphic-ectomorph athletes had lesser resting respiratory rate than the mesomorphic-endomorph.

*Hence the hypothesis number two has been accepted.*

Hypothesis number three stated that there would be a statistical significant difference among the somatotyped athletes when compared the post-test submaximal Heart Rate and Respiratory Rate.
The results of this finding confirmed the hypothesis and declared that there was a significant difference in the post submaximal heart rate and respiratory rate among the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes. Ectomorphic-mesomorph and mesomorphic-ectomorph athletes had lesser submaximal exercise heart rate and respiratory rate than the mesomorphic-endomorph.

_Hence the hypothesis number three has been accepted._

Hypothesis number four stated that hypothesized that there would be a statistical significant difference among the somatotyped athletes when compared the pre--test submaximal exercise venous blood electrolytes.

The findings of this study showed that there was no significant difference in the pre-test venous blood electrolytes among the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes.

_Hence the hypothesis number four has been rejected._

Hypothesis number five stated that there would be a statistical significant difference among the somatotyped athletes when compared the pre-test submaximal exercise Core Temperature.

The findings of this study showed that there was no significant difference among the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes when compared with their pre-test core temperature.

_Hence the hypothesis number five has been rejected._

Hypothesis number six stated that there would be a statistical significant difference in post-test submaximal exercise core temperature and venous blood sodium, potassium and chloride among the somatotyped athletes.
The findings of this study showed that there was no significant difference among the mesomorphic-endomorph, ectomorphic-mesomorph and mesomorphic-ectomorph athletes when compared the post submaximal core temperature and venous blood electrolytes.

*Hence the hypothesis number six has been rejected.*