Decreased training frequency and pulmonary function retention in the female athlete

by

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INTRODUCTION

Few experiments have investigated the retention of pulmonary function and anthropometric measurements in the female athlete. Most research dealing with pulmonary function has been devoted to its development rather than its retention. In addition, of the studies which have investigated pulmonary function development, most have used males as subjects.1 Collegiate coaches have recently become more permissive in allowing highly skilled athletes to participate in several sports based on the belief that additional training in a different sport will prolong and possibly increase pulmonary function. Almost no research has been performed to substantiate such beliefs, however. Thus, the effect on pulmonary function and body composition retention in female athletes was investigated after their transition from the two training seasons of the anaerobically and aerobically similar sports of field hockey and lacrosse, the latter having less frequent workouts.2 The Null hypothesis was used.

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METHODOLOGY

Eighteen female athletes volunteered as subjects for the study. All subjects served as their own control and experimental group. Each subject was determined to be healthy on the basis of a medical questionnaire and a stress test. All subjects were non-smokers. Procedures were carried out in accordance with the ethical standards of the policy statement of the American College of Sports Medicine (Table 1).

The field hockey training schedule for participants in the investigation consisted of field practice five days a week and a total of 16 intercollegiate games. The lacrosse training schedule consisted of field practice four days a week, one day of weight training and a total of 12 intercollegiate games. There were 31% more

<table>
<thead>
<tr>
<th>TABLE 1.—Physical characteristics of subjects.</th>
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<td>Age 19.2±1.3 yrs</td>
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<td>Values are means±SE.</td>
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field hockey training sessions (70) than lacrosse (48). Both seasons were 16 weeks in length.

Selected body composition and pulmonary measurements were taken within five days of the termination of each of the two sport seasons. All batteries of pulmonary tests were conducted by the same respiratory technician. For pulmonary data the M100B Automated Pulmonary Laboratory Computer was used. The M100B automated the test process sequence as well as the data reduction. Permanent records were provided by digital printout of computed results and graphic presentations on a two-channel chart recorder and/or X-Y plotter. The M100B used nitrogen as a trace gas to detect this point of closure. The volume at closing was determined graphically by noting the expired volume at which the nitrogen plateau showed a distinct point of inflection (departure from the plateau). The M100B computed the closing volume as a percentage of vital capacity (VC):

\[
\text{Closing Volume (CV):} \quad CV = \frac{\text{Expired Volume} - \text{Volume at Closing}}{\text{Expired Volume}} \times 100 \\
\text{Phase IV } \%
\]

2. **Nitrogen Delta (N2 Delta)**

A mixing index was based on the percentage of nitrogen change (delta) per half-liter of alveolar volume change. On a plot of nitrogen versus volume, the best straight line was drawn by eye over the alveolar region to smooth out any cardiac artifact present. The percentage of nitrogen at 750 ml and 1250 ml was then read from the line and the difference (delta) obtained. The M100B calculated the mixing index in a similar manner. A straight line fit of the curve over the 750 ml to 1250 ml region was performed using the least squares method and the percentage of nitrogen change per half-liter (N2 Delta) was then computed. The units were expressed in N2 delta percent.

3. **Closing Capacity (CC)**

Closing capacity (CC) was obtained using the following formula: closing capacity = closing volume + residual volume. Closing capacity was expressed as percent of total lung capacity (TLC):

\[
\text{Closing Capacity (CC):} \quad \frac{\text{Phase IV + RV}}{\text{TLC}} \times 100
\]

4. **Residual Volume (RV)**

The helium analyzer was used to measure the helium concentration using a
TABLE 2.—Between- and post-season training data of body composition and pulmonary parameters in female athletes.

<table>
<thead>
<tr>
<th></th>
<th>FAT (%)</th>
<th>LBM* (kg)</th>
<th>VC (L)</th>
<th>ERV (L)</th>
<th>FRV (L)</th>
<th>RV (L)</th>
<th>TLC (L)</th>
<th>RV/TLC</th>
<th>N2 Delta (%)</th>
<th>CV/VC (%)</th>
<th>CC/TLC (%)</th>
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<td>Between-season</td>
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<tr>
<td>X</td>
<td>20.90</td>
<td>47.25</td>
<td>4.24</td>
<td>1.44</td>
<td>2.86</td>
<td>1.33</td>
<td>5.66</td>
<td>22.30</td>
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<td>6.72</td>
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<td>±SD</td>
<td>4.85</td>
<td>5.84</td>
<td>.58</td>
<td>.30</td>
<td>.51</td>
<td>.26</td>
<td>.81</td>
<td>6.29</td>
<td>.193</td>
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<tr>
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<tr>
<td>±SD</td>
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<td>.41</td>
<td>.28</td>
<td>.44</td>
<td>.21</td>
<td>.59</td>
<td>2.57</td>
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<td>3.31</td>
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<td>t-test**</td>
<td>NS</td>
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*Lean body mass.
**Paired t-test; n=18; .05 level of significance.

thermal conductivity cell. The helium analyzer measured the subject's expired helium concentration to determine the effective residual volume.

5. Functional Residual Volume (FRV)
The nitrogen analyzer was used to determine functional residual capacity (nitrogen washout). Functional residual volume (FRV) was computed on a breath-to-breath basis by multiplying the instantaneous nitrogen concentration by flow to obtain nitrogen flow. This was then integrated to yield nitrogen volume and then scaled back to equivalent air volume.

6. Expiratory Reserve Volume (ERV)
The M100B expiratory reserve volume (ERV) maneuver measured ERV and tidal volume (TV). The M100B computed the average TV by dividing the minute volume by the number of breaths in the one-minute test duration:

\[
TV = \frac{\text{Minute volume}}{\# \text{ of breaths}}
\]

The ERV was computed automatically by subtracting the average TV from this number.

7. Vital Capacity (VC)
Vital capacity (VC) was determined to be the maximum amount of air a subject can slowly expire after a maximal inspiration. The units were expressed as liters.

8. Total Lung Capacity (TLC)
The M100B computed total lung capacity (TLC)=VC+RV.

9. Body Composition
Subjects underwent an estimation of body composition using the hydrostatic weighing techniques described by Wilmore and Behnke.\(^4\) Ten weighings for both sessions were carried out by the same technician to ensure accurate collection of data.

10. Percent Body Fat
Percent body fat was estimated by obtaining body density scores using the equation of Siri.\(^3\)

RESULTS AND DISCUSSION
Mean scores between the post-season measurements were examined for statistical significance using a paired t-test. An
attempt was made in the present study to determine if a considerable decrease in training frequency of two aerobically and anaerobically similar sports would affect the pulmonary function and body composition retention in 18 female athletes. With 34 df, results of all mean comparisons were non-significant at the .05 level (Table 2).

Results of the current investigation were in agreement with previous investigations, as exemplified by Brynteson and Sinning,\(^1\) who found that retention of achieved fitness levels could be maintained with as few as three exercise sessions per week.

Knowledge of the obtained results in regard to the athlete's pulmonary fitness status could prove to be of substantial interest to the coach. After obtaining a desired level of physical fitness, the coach could devote more time to skill development without concern for loss of pulmonary function. Similarly, when "tapering" for maximum performance, the decrease in training would not need to be a major concern of the coach.

**Summary**

Pulmonary function and body composition retention were observed in 18 female collegiate athletes exposed to a decrease in training frequency while participating in consecutive field hockey and lacrosse competitive seasons. Although one sport season represented 31% fewer workouts than the other, no significant differences were noted in body density, body fat, closing volume nitrogen delta, closing capacity, residual volumes, functional residual volume, expiratory reserve volume, total lung capacity and vital capacity post-season scores. Results were noted as being in agreement with previous investigations in that the degree of fitness achieved can be maintained despite a substantial decrease in training frequency.

**REFERENCES**


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