The Effects of Training Load on Injury Rates in an Athletic Population: A Systematic Review.
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Background
- National Center for Health Statistics found “an estimated seven million Americans received medical attention for sports related injuries” in a three-year time period
- One proposed explanation for these injury incidents has been exposure to excessive training loads
- Research has been completed with rugby, soccer and running athletes investigating how training load affects rates of injury

Purpose
The purpose of this study is to complete a systematic review of the current literature concerning how training load affects injury rates in an athletic, adult population.

Methods
A systematic review was conducted using the databases CINAHL, PubMed, and Embase.
- Inclusion criteria - English-language works, athletes, injury rates, and workload
- Exclusion criteria - retrospective studies and participants with baseline neurological or musculoskeletal disabilities
- Risk of Bias Assessment - Downs and Black quality checklist

Definitions
- Training load - Either training intensity multiplied by duration or simply training intensity as a stand-alone parameter
- Injury - Two categories: those that required time loss of more than one day and those that did not require time loss

Training Load Measurements Accepted for Data Extraction
- Heart rate, GPS distance, RPE, sport specific skills and conditioning, periodization, hours of training, questionnaires and interviews

Sports Included
- Basketball, running, rowing, rugby and soccer

Results

Positive Correlation
- Periodization was shown to increase the incidence of overall injuries
- Increased RPE rates were correlated with increased injury rates
- Sport specific training programs decreasing the total hours of training showed a decrease in incidence injury
- Increases in weekly running distance corresponded to an increase in distance related injuries
- Increased time spent at “high” heart rates was correlated with increased injury incidence

Pilot Data Table: The following table depicts data collected from various athletic populations, the training load measured in these populations, and how the training load affected injury rates in the populations studied.

<table>
<thead>
<tr>
<th>Author</th>
<th>Population</th>
<th>Exposure</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson L, et al.</td>
<td>Women’s Collegiate basketball players (n=12) in the United States</td>
<td>Preseason and in-season training loads are measured during pre-season and RPE after each practice session.</td>
<td>A moderate positive correlation was observed between total weekly training loads and injury rates (p=0.01).</td>
</tr>
<tr>
<td>Godbold TJ</td>
<td>Sub-batch rugby players (n=10) in Australia</td>
<td>Journal sport specific skills and recorded changes in training programs as increased during preparatory phase and reduced during competitive phase.</td>
<td>A positive correlation between increased training intensity and training load were observed in a season of competitive phase (p=0.01).</td>
</tr>
<tr>
<td>Godbold TJ, et al.</td>
<td>Professional rugby players (n=10) in Australia</td>
<td>Training load, this study showed the training load was increased during the preparatory phase and reduced during the competitive phase.</td>
<td>A positive correlation between increased training intensity and training load were observed in a season of competitive phase (p=0.01).</td>
</tr>
<tr>
<td>Evertz et al.</td>
<td>Healthy adult runners (n=25) in Germany</td>
<td>Pre-season and in-season training loads are measured during pre-season and RPE after each practice session.</td>
<td>A positive correlation between increased training intensity and training load were observed in a season of competitive phase (p=0.01).</td>
</tr>
<tr>
<td>Givens &amp; et al.</td>
<td>Elite male soccer players (n=5) in Europe</td>
<td>Training load is measured by heart rate (% of training intensity) and training load is measured by heart rate (% of training intensity).</td>
<td>No significant correlation was noted betwee training load and injury rate.</td>
</tr>
<tr>
<td>Wilson F. et al.</td>
<td>Senior male football players (n=15) in Ireland</td>
<td>Training load is measured by heart rate (% of training intensity) and training load is measured by heart rate (% of training intensity).</td>
<td>No significant correlation was noted between injury rates and training load.</td>
</tr>
<tr>
<td>Eriksen J et al.</td>
<td>Members from the top European football clubs (n=10) as selected by UEFA</td>
<td>Training load is measured by heart rate (% of training intensity) and training load is measured by heart rate (% of training intensity).</td>
<td>No significant correlation was noted between injury rates and training load.</td>
</tr>
</tbody>
</table>

Negative Correlation
- High training loads as measured by heart rate were associated with higher incidences of match injuries as compared to very high training loads
- Higher number of training hours are associated with a lower rates of injury

No Correlation
- No significant correlation between monthly training hours and injury rates

Abrupt Increases in Training Load and Injury Rates
- Large increases in reported RPE levels following periods of low RPE levels were associated with significant spikes in injury rates
- Substantial increases in weekly running distance also corresponded to an increase in running-related injuries as compared to more moderate increases in weekly running distances

Conclusions
The results of this review demonstrate conflicting outcomes regarding training load and injury rates. There is support that increases in training load are associated with increases in injury rates. However, there is also support that increases in training load are associated with increases in injury rates.

Clinical Relevance
A trend was noted with abrupt increases in training load and increases in injury rate. Due to lack of standardization of training load measurements and inconclusive findings, a recommendation cannot be provided regarding specific training load to prevent sport-related injury.

Acknowledgements / References

Acknowledgements
Leila Ledbetter, MIB

References