Is it necessary to adjust current creatine kinase reference ranges to reflect levels found in professional footballers?

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ABSTRACT

Objective We aimed to explore the validity of applying current reference ranges of the enzyme creatine kinase (CK) when analysing the medical status of professional footballers and to offer a more functional CK reference range for professional footballers.

Methods A sample of 27 professional male footballers competing in The Football League Championship was analysed. The single sample Wilcoxon signed-rank test was used to compare the CK distribution of the study group with that of a control group of military personnel reported in the literature.

Results The median values for study group and the published control group were 284 U/L and 124 U/L, respectively (P<0.001) suggesting that the average CK activity of professional footballers is higher than that of the normal healthy military population.

Conclusion Ethnicity, sex, age and physical exercise are factors that likely influence CK levels among various populations. From our analysis, we recommend a new 95% reference interval of 64.9 U/L to 1971.7 U/L for professional footballers.

INTRODUCTION

Creatine kinase (CK) is the key enzyme responsible for the catalysation of the interconversion of creatine phosphate and ATP in the human body, both of which are vital for a cell to metabolise healthily. However, studies suggest that high levels of CK present in the body can be a strong indicator of serious health issues such as myocardial infarctions and muscular dystrophy.

CK levels in professional athletes are naturally higher than in the average person; however, a clear explanation for this difference is yet to be determined.

Reference intervals of average levels of CK in the body for the general population can be found based on gender and age from multiple reference sources, however, references specific for elite athletes are not readily available. If long-term elevated CK in the body is as dangerous as some studies suggest, the role of CK in the health of elite athletes may be important.

What are the new findings?

- Current reference intervals for creatine kinase (CK) in the general population are not accurate for professional footballers.
- We recommend a new reference interval of 64.9 U/L to 1971.7 U/L for CK in male professional footballers.
- The proposed reference interval agrees with the limited published studies of football players.

It is clear that although multiple factors can influence the varying levels of CK across an entire population, ‘naturally’ higher levels can be found in elite athletes; however, it is not clear exactly by how much values may differ from those of the general population. Footballers in particular, due to the nature of their profession, experience excessive physical outputs throughout their sporting calendar, but it is unclear how much this workload influences their CK level.

We aimed to discover whether higher CK values were found in professional footballers than in the healthy, military population and to create an accurate reference range for healthy CK among professional footballers.

METHODOLOGY

Subjects

A total of 27 male subjects participated in this study, all of whom belonged to the same English League Championship football team. Twenty-five of the players are of European descent and the other two are of African descent. Seven of the 27 are black whereas the other 20 are white. The age of the participants was 24±3.7 years (mean±SD).

Procedures

Players who had not fully recovered from any form of musculoskeletal injuries were excluded from the study so that the injuries did not influence the baseline CK activity. All of the subjects trained to a high volume and intensity each week with only 1 day of total rest allocated in a week period. All
CK samples were obtained at the beginning stages of preseason training.

**Statistical analysis**

Data were imported into SPSS. The data obtained by Lev et al's (1999) study observing CK activity in Israeli army personnel was chosen as the control group because the profile of the participants in that study closely match the profile of the footballers', in terms of their gender, age and levels of physical fitness. The distribution of CK values in the study sample was positively skewed and not normally distributed (figure 1); therefore, a non-parametric test statistic was required.

A 'single sample Wilcoxon signed-rank test' was chosen to test the null hypothesis that the median CK value in this study sample would equal the median value (124 U/L) reported by Lev et al. The level of statistical significance was stated as α=0.05. Descriptive statistics were calculated including the mean, median, range, 95% CI for the mean and SD. Analyses were conducted using SPSS software. A 95% reference range was derived from the data based on the normal distribution. CK data were log transformed and then checked for normality with the Kolmogorov-Smirnov test.

**RESULTS**

One of the subjects was further analysed due to their CK activity being unusually high (2067 U/L). This subject is of black ethnicity and was also analysed separately after a series of CK readings were taken over a 5-week period.

**Group study**

Results are shown in table 1 for the study group of 27 male professional footballers.

### Table 1 Descriptive statistics for the study group

<table>
<thead>
<tr>
<th>Creatine kinase (U/L)</th>
<th>Mean</th>
<th>Median</th>
<th>Range</th>
<th>SD</th>
<th>95% CI of the mean</th>
<th>95% reference interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years±SD)</td>
<td>24±3.7</td>
<td>518.6</td>
<td>284</td>
<td>496.3</td>
<td>322.2 to 714.8</td>
<td>64.9 to 1971.7</td>
</tr>
</tbody>
</table>

**Hypothesis test**

Our observed sample median CK value of 284 U/L was statistically significantly higher than the value reported by Lev et al of 124 U/L, P<0.001.

**Reference interval**

The log transformed CK values were acceptably normally distributed (Kolmogorov-Smirnov statistic=0.123, df=27, P=0.200). Based on the normal distribution the 95% reference interval was derived as 64.9 U/L to 1971.7 U/L.

**Outlier player**

CK values for the player were recorded with his activity level. Literature exists displaying a strong link between intensive exercise and elevated CK. The results of the outlier are displayed in table 2.

### Table 2 Values showing CK activity of the outlier

<table>
<thead>
<tr>
<th>Day</th>
<th>Days between samples</th>
<th>CK (U/L)</th>
<th>Prior activity level</th>
<th>Change in CK (U/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>2067</td>
<td>Training</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>5269</td>
<td>Training</td>
<td>+3202</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>3994</td>
<td>Rest</td>
<td>−1275</td>
</tr>
<tr>
<td>13</td>
<td>7</td>
<td>338</td>
<td>Rest</td>
<td>−3656</td>
</tr>
<tr>
<td>35</td>
<td>22</td>
<td>2929</td>
<td>Training</td>
<td>+2591</td>
</tr>
</tbody>
</table>

Marked in the table is ‘training’ if the subject took part in a training exercise the previous day or ‘rest’ if the subject rested, withholding from training.

**DISCUSSION**

The mean value of CK activity attained from the sample (518.6±SD) was considerably higher than the mean value of the sample reported by Lev et al (162.9 U/L). Our analyses focused on median values because for skewed data, the median better represents the middle of the data than does the mean. From figure 2, the median CK value for professional footballers (284 U/L) is far larger than that of the control group (124 U/L) (P<0.001). This implies that footballers at the start of a season have a higher value of CK activity compared with the healthy military population (P<0.001).

A 2009 study that investigated CK activity among professional male footballers in Brazil showed similar mean values of CK (n=128) (493±315 U/L) when compared with this study (518.6±496.3 U/L) (values for both studies illustrated in ‘mean±SD’ format). The cultural diversity among the footballing study group meant that a control group similar in ethnicity to the footballers could not be found. The ethnicity of
the subsequent CK value had substantially decreased. Taken by the outlier before a study sample was extracted, explain this raised CK value. Found to be 5269 U/L. All medical examinations failed to 5000 U/L in this study. The highest elevation of CK was one outlying individual study exceeded the CK value of for concern for the development of renal failure. Only olysis, only CK elevations above 5000 U/L are a cause which gave a bench-to-bench overview of rhabdomy-

CONCLUSION

CK activity amid the professional footballing population is at a significantly higher level to those of the compared healthy population. Our data suggest that current CK reference values for the ‘normal population’ do not accurately represent CK values among professional footballers. We propose that the 95% reference range for CK in professional footballers be 64.9 U/L to 1971.7 U/L.

REFERENCES

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