**ABSTRACT**

Purpose: Untrained subjects often end up with negative values for the fatigue index (FI) on the HUMAC Norm machine when using the pre-existing formula for calculating fatigue. We propose a modified formula that yields a truer picture of fatigue. Methods: The subjects consisted of 22 diabetic men and women over 60 yr. The subjects were tested on the HUMAC Norm machine after a pre-testing. Right knee flexors (RtKFlx) and extensors (RtKExt) and as well as the right elbow flexors (RtEFlx) and extensors (RtEExt) were measured isokinetically at a speed of 180 deg·s⁻¹ for fifteen consecutive repetitions. The initial protocol took the sum of the first three repetitions, subtracted the sum of the last three repetitions and divided it all by the sum of the first three repetitions. Our modified formula uses the sum of the three consecutive highest repetitions and the sum of the three consecutive lowest repetitions rather than the first and last three repetitions. Results: The pre-existing formula for calculating the FI yielded negative values 31.82% and 40.91% of the time for the RtKExt and RfKFlx respectively, and 40.91% and 45.45% for the RtEExt and RtEFlx respectively. The modified way of calculating the FI did not yield any negative values for the knee or the elbow. Therefore, the mean values of fatigue that ranged from 39.38% for the RtKExt to 27.01% for the RtEExt were more reflective of the fatigue state than the HUMAC Norm's calculation of -6.00% for the RtKExt and 0.36% of the RtEExt. The RtKExt fatigued 8.72% more than the RtKFlx: 39.88% compared to 31.16%. The elbow had the opposite effect where the RtEFlx fatigued 26.65% more than the RtEExt: 34.92% compared to 27.01%. The mean FI for the knee extensors changed by 45.38% from -6.00% to 39.38%, and by 30.39% for the knee flexors, from 0.77% to 31.16%. The mean FI for the elbow extensors changed by 26.65% from 0.36% to 27.01%, and by 34.69% for the elbow flexors, from 0.23% to 34.92%. The initial protocol for calculating FI yielded negative values 31.82% and 40.91% of the time for the extensor and flexor of the right knee, respectively. The modified way of calculating FI did not yield any negative values for the knee or the elbow as well as flexors. The Pearson correlation (r) found no statistical significance at the 0.05 level for old and new fatigue indexes.

**INTRODUCTION**

Fatigue is a good indicator of health. As muscles perform repetitive contractions peak strength decreases linearly with the number of contractions performed. The findings of the studies by Patton, Hinson, Arnold, and Lessard (1978) and Barnes (1981) suggest that repetitive contractions cause muscle fatigue. When taking age into consideration with isokinetic exercise, Belloc, and Malone (2000) found that isokinetic exercise could be crucial for the elderly population to prevent injuries such as hip or femur fractures. This study chose to focus on the fatigue characteristics of the elderly population. Specifically, we investigated how appropriate the HUMAC NORM's fatigue index calculation was with this population.

**METHODS**

Participants: The subjects consisted of 13 males and 9 females. The men had a mean age of 66.38 ± 4.44 yr, whereas the women had a mean age of 68.33 ± 3.32 yr. The men’s mean height was 175.32 ± 6.19 cm, and the mean height for the women was 158.93 ± 4.10 cm. The men weighed 87.70 ± 14.99 kg on average, and the women 78.69 ± 18.09 kg.

Procedure: The subjects were tested using the HUMAC NORM Isokinetic Dynamometer. The subjects performed a 5 min warm-up on a stationary bicycle as well as isokinetic and isometric contractions prior to the testing. For the testing the device was set to a speed of 180 deg·s⁻¹ and the subjects performed 15 consecutive maximal repetitions of the knee, and elbow extensor and flexor. The researchers conducted a pre-test 1-3 months prior to testing to familiarize the subjects with the testing program. Both sides of the body were tested, but only the right side results are reported for this study. The initial formula for Calculating the Fatigue Index:

\[
FI = \frac{\sum_{rep} (Rep 1, Rep 2, Rep 3) - \sum_{rep} (Rep 13, Rep 14, Rep 15)}{\sum_{rep} (Rep 1, Rep 2, Rep 3)}
\]

Modified Formula for Calculating the Fatigue Index:

\[
Modified FI = \frac{\sum_{3 consecutive highest reps} - \sum_{3 consecutive lowest reps}}{\sum_{3 consecutive highest reps}}
\]

CONCLUSION

- The new way of calculating fatigue showed over a 30% increase in fatigue for the right knee and elbow extensors and flexors.
- The initial FI is used for motivated and trained athletes.
- The new formula gives better estimates of FI for non-athletes.
- The new FI gives a truer picture of fatigue because most subjects do not typically have their highest value as their first repetition, but rather on repetition 2, rep 3, or rep 4 and the last repetition; rep 15 was often higher than the preceding repetitions.

**RESULTS AND DISCUSSION**

- The mean FI for the knee extensors changed by 45.38% from -6.00% to 39.38%, and by 30.39% for the knee flexors, from 0.77% to 31.16%.
- The mean FI for the elbow extensors changed by 26.65% from 0.36% to 27.01%, and by 34.69% for the elbow flexors, from 0.23% to 34.92%.
- The initial protocol for calculating FI yielded negative values 31.82% and 40.91% of the time for the extensor and flexor of the right knee, respectively, as well as 40.91% and 45.45% for the right elbow extensor and flexor, respectively.
- The modified way of calculating FI did not yield any negative values for knee and elbow extenders as well as flexors.
- The Pearson correlation (r) found no statistical significance at the 0.05 level for old and new fatigue indexes.

**REFERENCES**


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