LESS THAN HALF OF YOUTH ATHLETES CAN ACHIEVE 90% LIMB SYMMETRY ON A BATTERY OF SINGLE LEG HOP TESTS

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Background: The incidence of anterior cruciate ligament reconstruction (ACLR) in youth athletes is rising. Current rehabilitation guidelines recommend the use of a battery of single leg hop tests (SLHT) to assess performance and assist in return to sport (RTS) decision making. Although there is agreement on the use of SLHT, the level of required limb symmetry varies. Historically, values of 85-90% were acceptable; however, some experts are now advocating for more strict values of 95 to >100%. While higher performance thresholds are logical, and some data suggests reduced potential for reinjury using these more conservative criteria, previous literature shows that <25% of youth athletes can achieve >90% symmetry more than 1 year after ACLR. Furthermore, no studies have reported normal SLHT symmetry among youth athletes, making it difficult to compare post-rehabilitation values to non-injured peers. The purpose of this study was to report limb symmetry in SLHT performance in healthy youth athletes.

Methods: This was a single episode cross-sectional study of youth athletes between the ages of 8-14 years-old. In order to be eligible for the study, all subjects had to be without any history of ACLR, no current lower extremity injuries, and presently participating in organized competitive sports. All data was collected on-site during practice or games. Consent, demographics, injury history, and sports participation information was obtained prior to testing. Each subject was instructed in a single hop (SH), triple hop (TrH), crossover hop (CH) and timed hop (TH) test and allowed 3-5 practice repetitions. (Figure 1) Successful trials required a controlled landing, with 2 second hold, as previously described. Distance from starting line to the heel was recorded in centimeters for the SH, TrH and CH. TH was recorded in seconds. Limb symmetry index (LSI) of non-dominant to dominant leg (self-reported kicking leg) was calculated for each hop. Descriptive statistics and frequency of pass/fail at 90% LSI threshold were calculated. The relationship between the different components of the SLHT were analyzed with Pearson Correlation Coefficient, while a two-way ANOVA was utilized to analyze whether age and sex affected LSI performance.

Results: A total of 347 athletes were screened and met the inclusion criteria. After excluding those with incomplete data, a total of 340 subjects (54% male (n=184); mean age 10.9±1.5 years) were included in the analysis. The sample was heavily Caucasian (85%), with a mean height and weight of 146.6cm ± 11.2 and 40.7kg ± 10.8 respectively. Although most subjects identified as multisport athletes, the top self-reported primary sports were soccer (52%, n=178), basketball (22%, n=73), and baseball (10%, n=34).

The mean LSI was >95% for each SLHT as follows (mean, standard error): SH=97.9% (0.7), TrH=96.6% (0.6), CH=96.8% (0.8), and TH=96.5% (0.6). When analyzed as a test battery, requiring the subject to achieve >90% LSI on all four components of the SLHT, only 45% of subjects were able to achieve this level of symmetry. (Figure 2) Pearson analysis revealed statistically significant (p<0.01) weak to moderate (r=0.342-0.520) correlations among all hop tests. (Table 1) There were no significant effects (p>0.05) for either age or sex on LSI for any of the individual hop tests.

Conclusions/Significance: SLHT are commonly utilized as a battery, requiring an athlete to achieve
a threshold of LSI (e.g. 90%) on each hop to satisfy RTS criteria. Although the mean LSI in our sample was >95% for each individual component of the SLHT, subject performance across all SLHT components varied, such that less than half of healthy athletes could achieve a standard of 90% LSI when applied as a test battery. These results question the validity of requiring >90% LSI on the SLHT battery in youth athletes after ACLR and highlights the need for further research into the use and interpretation of SLHT during RTS decision making.

**Tables and Figures:**

![Figure 1. Schematic diagram of single leg hop tests.](image)

Single hop: Subjects were to stand on one leg, hop, and land on the same limb. Triple hop: subjects were to stand on one leg, perform 3 consecutive hops, and land on the same leg. Crossover hop: subjects were to hop forward 3 times on the same leg while alternately crossing over a 15cm wide line. For all distance hops subjects were required to maintain their landing position for 2 seconds and distance was measured from starting line to posterior heel. Timed hop: subjects were to perform one-legged hops in series over a 6m distance, with time measured from when the stance heel lifted to when the foot passed the finish line.

![Figure 2. Frequency of success on SLHT battery at ≥90% LSI threshold.](image)

Subjects able to pass battery at 90% LSI (n=153, 45%) vs those that failed to achieve 90% LSI on at least one test (n=186, 55%).
|              | SH LSI      | TrH LSI     | CH LSI     |
|--------------|-------------|-------------|------------|
| **TrH LSI**  | 0.477* (340)|             |            |
| **CH LSI**   | 0.404* (340)| 0.520* (340)|            |
| **TH LSI**   | 0.360* (339)| 0.469* (339)| 0.342* (339)|

**Table 1. Relationship between SLHT components.** Pearson Correlation Coefficients of LSI achieved on the tests that comprise SLHT battery reported as r (N). * denotes p<0.001

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