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ORIGINAL ARTICLE

**Interrater Reliability of Physiotherapy Students on Leg Length Discrepancy among Healthy Individuals**

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**ABSTRACT**

*The leg length discrepancy measurement is one among the essential clinical assessment for musculoskeletal conditions. Tape measurement is a common clinical method to measure it. Tape measurement method is popularly used to evaluate leg length discrepancy (LLD). To give appropriate treatment reliability of the method of measuring is important. In this study interrater reliability of the physiotherapist are assessed to know how reliable the tape measurement method is. This study was a reliability study. As we find the reliability of the tape measurement method. A Total of 30 healthy subjects included, 9 were males and 22 were females. The age of the subjects was in the range of 20-25. Out of the 30 individuals no one have leg length discrepancy, the subjects have less than 1.5 cm of discrepancy which is considered normal. The results states that the Fleiss kappa for true length is 0.37 and for apparent is 0.472. The Krippendorff's alpha for true length is 0.257 and for apparent is 0.173. Both the values show no significance for tape measurement method. The poor interrater reliability of physiotherapy students is due to the systemic and random errors these should be taken into consideration when physiotherapist is doing this method.*

**Keywords:** Interrater reliability, Leg Length Discrepancy, Pelvic squaring, Physiotherapist

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**INTRODUCTION**

The condition in which any two appendages are uneven and we can find the difference by observing then can be termed as discrepancy or disparity. If we find this difference in both lower limbs it is known as Leg length discrepancy (LLD). LLD is due to congenital conditions (e.g.: hemi atrophy) or acquired (e.g. Tumors). In Apparent LLD fixes/debilitates of the muscle or snugness in the lower point of spine. (e.g. lumbar scoliosis) are the causes [1]. Nearly 70 % of the general population has LLD of up to 1 cm [2]. It is suggested that the mean of at least two measures be used for clinical purposes [3]. Some basic etiologic variables are idiopathic formative abnormalities fracture and injury to the epiphyseal development plate before skeletal maturity [4]. The leg length discrepancy has effect on low back, pelvis, postural problems, gait problems and osteoarthritis [5]. There are clinical methods [6] which is of low cost, easy and not time taking and also there are radiological methods which make patient prone to radiation, costly and time taking but give accurate values compared to clinical methods. The clinical method consists of indirect and direct methods. With direct methods the objective is to determine the anatomical length of each limb first and then calculate the difference between 2 sides [7]. General method of assessing LLD uses tape measurement method. True length is also called as direct method as we take measurement from ASIS to medial malleolus and umbilicus to medial malleolus for apparent length. Pelvic squaring is one of the important factors which we over look and it is done for taking true length measurements. While taking reliability measurements for TMM to get accurate values we have to take the reading near to 5 mm [8]. Taking measurements in supine position gave better results than in other positions [9]. In the indirect method, instead of evaluating the difference, it measures the difference directly by measuring the blocks which are placed on the shorter side until the iliac crest is levelled [10]. Radiographs also play a major role in assessing LLD by three methods (1) Orthoentgenogram (2) scanogram and (3) computerized digital radiograph [11]. The topic of consistency, or understanding

among the people gathering information promptly emerges because of the inconstancy among human onlookers. All around planned research considers should in this way incorporate strategies that measure understanding among the different information gatherers. Study structures regularly include preparing the information gatherers, and estimating the degree to which they record similar scores. Impeccable understanding is only occasionally accomplished, and trust in study results is somewhat a component of the measure of contradiction, or mistake brought into the examination from irregularity among the information authorities. The degree of understanding among information among the individuals is interrater reliability" [12]. Reliability of measurement gives the confidence of how similar results can be reproduced when either the same subject is evaluated by the same examiner on two different occasions or the same subject being evaluated by two different examiners at the same time. Reliability of tape measurement method was seen by authors [13] but no still there is a controversy in using Tape measurement method. The goal of this study is to evaluate how the systemic and random errors affect the inter-rater reliability of measurements taken by tape by different physiotherapist.

## **MATERIAL AND METHODS**

The present study was carried out in the Department of Physiotherapy, Krupanidhi College of Physiotherapy for a period of 1 week.

### **Participants**

A total of 31 (22 females and 9 males) from Krupanidhi College of Physiotherapy volunteered to participate in this study. 30 raters took the measurements from the subjects. Among 30 raters 20 raters are post graduate students and 10 are from bachelor of physiotherapy students. Before data collection All participants (N=31) provided written informed consent forms.

### **Procedure**

The supine tape method direct measurement of LLD was performed using tape measures with patients in supine position. The anterior superior iliac spine (ASIS) and medial malleolus were used as landmarks for true length and umbilicus to medial malleolus for apparent length. In flat lying position on the examination table pelvic squaring was done to find whether two ASIS of both legs are in alignment to get accurate measurement. The subject was then asked to remain relatively motionless until all 30 examiners had made their assessments. For each examiner was given the assessment form marked "right" and "left" leg for both true and apparent measurements. The examiners were not allowed to see each other assessment so that the measurements are not influenced.

## **RESULT AND DISCUSSION**

A total of 30 subjects who filled the consent form were selected through convenience sampling in to the study. In this study it was observed that the highest significance of less than 0.05 was seen in therapist 3 and therapist 4 for true measurements we observed that these physiotherapist's have done pelvic squaring for true length measurement and therapist 1 and therapist 16 have highest significance for apparent measurements. The therapist 3, therapist 5, therapist 6, therapist 8 and therapist 9 haven't shown any significance no significance for apparent measurement. In our study we used Fleiss kappa and Krippendorffs alpha to assess the inter-rater reliability of 30 physiotherapist. The use of the Fleiss kappa is to know the interrater rater reliability between more than 3 raters whereas Cohen's kappa is used between 2 raters only. Even though we don't have any missing measurements we are evaluating inter-rater reliability using K a which is meant for measuring reliability between multiple subjects with sparse data [14]. In our study Fleiss kappa value for true length is 0.371 which states the inter-rater reliability is significantly low. Fleiss kappa value for apparent is 0.472 which is also low. Krippendorffs alpha value for true is 0.257 and apparent is 0.173 which states that inter-rater reliability is low among physiotherapist while using tape measurement.

## **DISCUSSION**

Our objectives are to assess the inter-rater reliability of leg length discrepancy measurement and to compare the scoring by 30 raters on 30 subjects on one session. The poor inter rater reliability showed caution should be taken when comparing tape measurement method to asses' leg length discrepancy. The potential difficulty in assessing these measurements and the low ICCs in our study are not due procedure of tape measurement method but because of the errors. Systemic and random errors should be taken care while performing this tape measurement method. Systemic errors are errors which obtain due to the calibrated inch tape. The random errors are the errors happen when the therapist is performing the assessment. According to Stein et al., [15] the functional leg-length inequality decreases when subject is lying supine which is due to the pressure on anterior superior iliac spine decrease in pelvic torsion.

Inclined lying (right) doesn't alleviate pelvic torsion coming about because of it, on the grounds that the ASISs are suspended off the table. So recumbent strategy is increasingly solid to do the measurements. According to Asim et al., the use of tape measure requires an appropriate clinical experience, protocol and palpation skills [16]. As we have to palpate ASIS for true length. As for taking this leg length measurement pelvic squaring is important to get accurate values for true length. Which was also the main reason for low reliability which we observed in our study without aligning the ASIS in same line the measurement is not valid. We can align by taking measurement from the umbilicus to the ASIS on both sides and if both values are same then the ASIS of both legs are in alignment. By doing pelvic squaring we can avoid random errors. Because of current set of examiners and the narrow area of testing it is not possible to draw conclusions as to whether professional experience affects the inter-rater reliability. And future studies can be done on pelvic squaring as well. How pelvic squaring is important for true length measurements. The pelvic squaring is done by the therapist 3 and therapist 4 of highest significance level of less than 0.05 compared with others which show that pelvic squaring for true length measurements is important which make the results come To avoid these errors the combination of the 4 measurements provides a more valid and reliable measure than 1 measurement [7].

In our study we got poor reliability may be because we haven't taken average values (by 30 examiners) but 31 measurements (by 30 examiners) on 31 subjects. Limitations of the study is only finding the inter-rater reliability but not doing intra-rater reliability. Intra-rater reliability gives how reliable the method is when performed by one person itself. In our study we are not able to find leg length discrepancy patients as we have done only on students.

**Table 1: ICC values for true length measurements.**

| Therapist | Corr | Ap T1  | Ap T2  | Ap T3  | Ap T4  | Ap T5  | Ap T6  | Ap T7  | Ap T8 | Ap T9 | Ap T10  | Ap T11 | Ap T12 | Ap T13 | Ap T14 | Ap T15  | Ap T16 | Ap T17 | Ap T18 | Ap T19 | Ap T20 | Ap T21 | Ap T22 | Ap T23 | Ap T24 | Ap T25 | Ap T26 | Ap T27 | Ap T28 | Ap T29 | Ap T30 |  |  |
|-----------|------|--------|--------|--------|--------|--------|--------|--------|-------|-------|---------|--------|--------|--------|--------|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|--|
| Ap T1     | R    | 1      |        |        |        |        |        |        |       |       |         |        |        |        |        |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T2     | R    |        | 1      |        |        |        |        |        |       |       |         |        |        |        |        |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T3     | R    |        |        | 1      |        |        |        |        |       |       |         |        |        |        |        |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T4     | R    | .433*  |        | .502** | 1      |        |        |        |       |       |         |        |        |        |        |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T5     | R    |        |        |        | .1     | 1      |        |        |       |       |         |        |        |        |        |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T6     | R    | .398*  |        | .482** | .718** |        | 1      |        |       |       |         |        |        |        |        |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T7     | R    |        |        |        |        |        |        | .414*  | 1     |       |         |        |        |        |        |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T8     | R    |        |        |        | .566** |        |        |        |       | 1     |         |        |        |        |        |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T9     | R    |        |        |        |        |        |        |        |       |       | 1       |        |        |        |        |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T10    | R    |        |        |        |        |        |        |        |       |       |         | 1      |        |        |        |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T11    | R    | .721** |        | .416*  |        | .380*  |        | .411*  |       |       |         | 1      |        |        |        |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T12    | R    | .571** |        |        |        |        |        |        |       |       |         |        | 1      |        |        |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T13    | R    |        |        | .372*  |        |        |        | .493*  |       |       |         |        |        | 1      |        |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T14    | R    |        |        |        | .816** |        |        |        |       |       |         |        |        |        | 1      |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T15    | R    | .956** |        | .426*  |        | .495** |        |        |       |       | .715**  | .540** |        |        |        | 1       |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T16    | R    |        |        | .552** |        |        |        | .562** |       |       |         |        | .922** |        |        |         | 1      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T17    | R    |        |        |        | .795** |        |        |        |       |       |         |        | .971** |        |        |         |        | 1      |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T18    | R    | .658** |        | .417*  |        | .410*  | .403*  |        |       |       |         | .849** |        |        | .632** |         |        |        | 1      |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T19    | R    | .688** |        | .367*  |        |        |        | .451*  |       |       | .846**  |        | .438*  |        | .662** | .683**  |        |        |        | 1      |        |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T20    | R    |        | .583** |        | .603** |        |        |        |       |       |         |        | .732** |        |        | .745**  |        |        |        |        | 1      |        |        |        |        |        |        |        |        |        |        |  |  |
| Ap T21    | R    | .571** |        |        |        |        |        |        |       |       | 1.000** |        |        | .540** |        | .849**  |        |        |        |        |        | 1      |        |        |        |        |        |        |        |        |        |  |  |
| Ap T22    | R    | .753** |        | .515** |        | .361*  | .459** |        |       |       | .824**  | .411*  |        | .728** | .704** |         |        |        | .966** |        |        |        | 1      |        |        |        |        |        |        |        |        |  |  |
| Ap T23    | R    |        |        |        | .795** |        |        |        |       |       |         |        | .971** |        |        | 1.000** |        |        |        | .745** |        |        |        | 1      |        |        |        |        |        |        |        |  |  |
| Ap T24    | R    | .896** |        |        |        |        |        |        |       |       | .522**  | .836** |        | .852** |        | .720**  | .493** |        | .836** | .489** |        |        |        |        | 1      |        |        |        |        |        |        |  |  |
| Ap T25    | R    | .578** |        | .420*  |        |        | .527** |        |       |       | .695**  |        | .683** |        | .561** | .856**  |        | .956** |        | .919** |        | .428** | .427** |        | 1      |        |        |        |        |        |        |  |  |
| Ap T26    | R    | .619** |        |        | .414*  |        |        |        |       |       | .784**  |        | .513*  | .588** |        | .538**  |        | .758** | .420*  | .739** | .538** |        | .624** |        | 1      |        |        |        |        |        |        |  |  |
| Ap T27    | R    | .567** |        |        |        |        |        |        |       |       | .996**  |        | .996** |        | .535** |         | .848** |        | .996** |        |        |        | .830** |        |        | 1      |        |        |        |        |        |  |  |
| Ap T28    | R    |        | .507** |        |        |        |        |        |       |       |         | .555** |        | .512** |        | .512**  |        |        |        |        |        |        | .381*  |        |        |        | 1      |        |        |        |        |  |  |
| Ap T29    | R    | .600** |        | .360*  | .403*  |        |        |        |       |       | .756**  |        | .474** | .572** | .519** | .465**  |        | .840** | .361*  |        | .816** | .465** | .420*  | .779** | .934** |        |        |        |        | 1      |        |  |  |
| Ap T30    | R    | .559** |        |        |        |        |        |        |       |       | .976**  |        | .976** |        | .531** |         | .827** |        | .976** |        | .819** |        | .819** |        | .981** |        |        |        |        |        | 1      |  |  |

\*. Correlation is significant at the 0.05 level (2-tailed).  
 \*\*. Correlation is significant at the 0.01 level (2-tailed).

**Table 2: ICC values for apparent length measurements.**

| Therapist | Cor | True1   | True2  | True3  | True4  | True5  | True6  | True7  | True8  | True9  | True10 | True11 | True12 | True13 | True14 | True15 | True16 | True17 | True18 | True19 | True20 | True21 | True22 | True23 | True24 | True25 | True26 | True27 | True28 | True29 | True30 |  |  |
|-----------|-----|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|--|
| True11    | R   | 1       |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True12    | R   | -.536** | 1      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True13    | R   |         |        | 1      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True14    | R   |         |        | .500** | 1      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True15    | R   |         |        | .407** |        | 1      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True16    | R   |         |        | .633** |        | .650** | 1      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True17    | R   |         |        | .370** | .371** | .438** | .546** | 1      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True18    | R   |         | .415** |        |        |        |        |        | .378** | 1      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True19    | R   |         |        |        |        |        |        |        | .514** | .498** | 1      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True110   | R   |         |        |        |        |        |        |        | .580** | .623** |        | 1      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True111   | R   |         |        |        | .429** |        | .663** | .472** |        | .370** |        |        | 1      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True112   | R   |         |        |        | .402** | .588** | .569** | .370** |        |        |        |        |        | 1      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True113   | R   |         |        |        | .685** |        | .621** | .785** | .549** |        | .357** | .392** |        |        | 1      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True114   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        | .452** |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True115   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        | .389** | .478** |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True116   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        | .400** | .433** |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True117   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True118   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True119   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True120   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True121   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True122   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True123   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True124   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True125   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True126   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True127   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True128   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True129   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |
| True130   | R   |         |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |  |  |

\*\* Correlation is significant at the 0.01 level (2-tailed).

\* Correlation is significant at the 0.05 level (2-tailed).



**Figure 1.** Pelvic squaring can be checked by taking measurement from umbilicus to ASIS on both left and right.

**CONCLUSION**

Assessing leg length discrepancy through tape measurement is easy not reliable. We can make it reliable by avoiding the errors we discussed in the study. By taking more than 4 measurements, at least 2 clinicians taking the measurement, by doing pelvic squaring and by choosing the correct method according to the patient.

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