

## Intrarater reliability of cervical range of motion device among adults with and without chronic non-specific neck pain

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### Abstract

**Objective:** To evaluate the intrarater reliability of the cervical range of motion device among adults with and without chronic non-specific neck pain.

**Method:** The analytical, cross-sectional study was conducted from January to March 2019 at the Sindh Institute of Physical Medicine and Rehabilitation, Karachi, and comprised healthy adults with no neck pain in the preceding 6 months in Group A, and adults of either gender with chronic non-specific neck pain for >3 months in Group B. The two groups were further divided into age groups 21-30 years, 31-40 years and 41-50 years. A cervical range of motion device was used to measure the range of flexion, extension, right and left lateral flexion and right and left rotation of all the subjects. The measurements were taken by a single tester on day-1 and day-3 to assess the intrarater reliability. Data was analysed using SPSS 26.

**Results:** Of the 60 subjects, there were 30(50%) in each of the two groups. Within the groups, there were 10(33.3%) subjects in each of the 3 age subgroups. Overall, there were 27(45%) males and 33(55%) females. In Group A, the intraclass correlation coefficient values for all cervical ranges were between 0.81 and 0.99, whereas in Group B, the values ranged from 0.64 to 0.88. The intraclass correlation coefficient values yielded good to excellent agreement in both groups (>0.75) except for left lateral flexion in Group B ( $p=0.64$ ), and all the values were statistically significant ( $p<0.05$ ).

**Conclusion:** There was good to excellent intrarater reliability of cervical range of motion device in adults with and without chronic non-specific neck pain.

**Keywords:** Reliability, Range of motion, Spinal column, Non-specific neck pain. (JPMA 73: 2017; 2023)

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### Introduction

The cervical spine plays a central role in the human kinetic sequence by supporting the skull and fulfilling high mobility demands.<sup>1,2</sup> However, the unique biomechanical arrangement of the cervical spine and the exposure to high functional demands makes it susceptible to musculoskeletal impairments, such as neck pain which is considered to be among the most prevalent musculoskeletal conditions globally. The burden of neck pain among all musculoskeletal conditions is estimated to be about 14.6%.<sup>3</sup> Neck pain commonly leads to restricted cervical movements that result in functional limitation and disability.<sup>4,5</sup> Therefore, the cervical range of motion (CROM) is indicative of the severity of cervical dysfunction and is thus an important constituent in the assessment of the cervical spine.<sup>6</sup> Various methods available for measuring

CROM include eyeball observation, tape measurement, inclinometer, goniometry, motion analysis systems, and digital smartphone applications.<sup>6</sup>

However, the frequent reliance of these methods on various reference points on the cervical spine, which themselves are subject to variation, introduce biases in ROM measurement, limiting the clinical application of these methods. For the same reason, a universal goniometer would not be an ideal solution for measuring CROM, especially when the multiple motion segments are not static.<sup>7</sup>

Furthermore, despite their apparent operational ease, goniometers and inclinometers as well as other such devices are rendered less reliable in measuring CROM since they yield measurements in a single plane.<sup>8</sup> In this regard, a multiplanar tool, such as a CROM device, has been shown to be more suitable for the assessment of CROM as it captures all three planes of ROM i.e. sagittal, coronal, and horizontal, without the need for dedicated computing systems.<sup>9,10</sup> This property not only affords it the desired ease in measuring the cervical movement, but also makes it cost-effective and ideal for day-to-day clinical assessments.

Previously, the tool has demonstrated excellent psychometric properties.<sup>11</sup> Several studies have been

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conducted to investigate the reliability of the CROM device both in healthy populations and individuals with neck pain of different origins.<sup>12</sup> Because reduced CROM is the foremost impairment in patients with chronic non-specific neck pain, evaluating the reliability of the CROM device in such patients is vitally important. Limited evidence with regard to intrarater reliability of the CROM device in patients with chronic non-specific neck pain warrants further investigation. The current study was planned to evaluate the intrarater reliability of the CROM device in adults with and without chronic non-specific neck pain.

**Patients and Methods**

The analytical, cross-sectional study was conducted from January to March 2019 at the Sindh Institute of Physical Medicine and Rehabilitation (SIPMR), Karachi. After approval from the institutional ethics review board of the University of Lahore, Lahore, Pakistan. To justify the sample size of 60 participants the power of the test was calculated. Total of 30 participants in each group by using PASS version 15 (NCSS Statistical Software, Kaysville, UT, USA), based on intraclass correlation with 95% confidence of interval, two observations per subject, flexion measurement with an effect size of (H0: ICC=0 vs H1: ICC=0.99). It was found to be more than 99%. The same power of the test was found for other CROMs and for each study groups.<sup>13</sup>

The initial screening was performed by the designated consultants and informed consent was taken from all participants, then participants were equally divided into groups A and B by using non-probability purposive sampling technique. The sample comprised healthy adults of either gender with no neck pain in the preceding 6 months in Group A, and adults of either gender with chronic non-specific neck pain for >3 months in Group B. The two groups were further divided into age groups 21-30 years, 31-40 years and 41-50 years. Those with specific causes of neck pain, such as whiplash-associated disorders, disc dysfunction, radiculopathy, instability of the spine, cervical spondylosis, rheumatoid arthritis and facial injury, were excluded.

All participants underwent an assessment of CROM using a CROM device)-(Performance Attainment Associates, USA) TM in all six planes in an upright seated position on a chair with arms resting on the armrest, and feet flat on the floor. The device was placed and secured on the participant's head by fastening straps. The device comprised three inclinometers, of which two were fixed or nonadjustable. The fixed and nonadjustable inclinometer was gravity-dependent and measured the movement of flexion and extension in the

sagittal plane, and lateral flexion in the frontal plane. The third adjustable inclinometer operated upon a compass, and measured neck rotation in the transverse plane. This arrangement relied on a magnetic collar secured around the participant's upper trunk.<sup>14</sup>

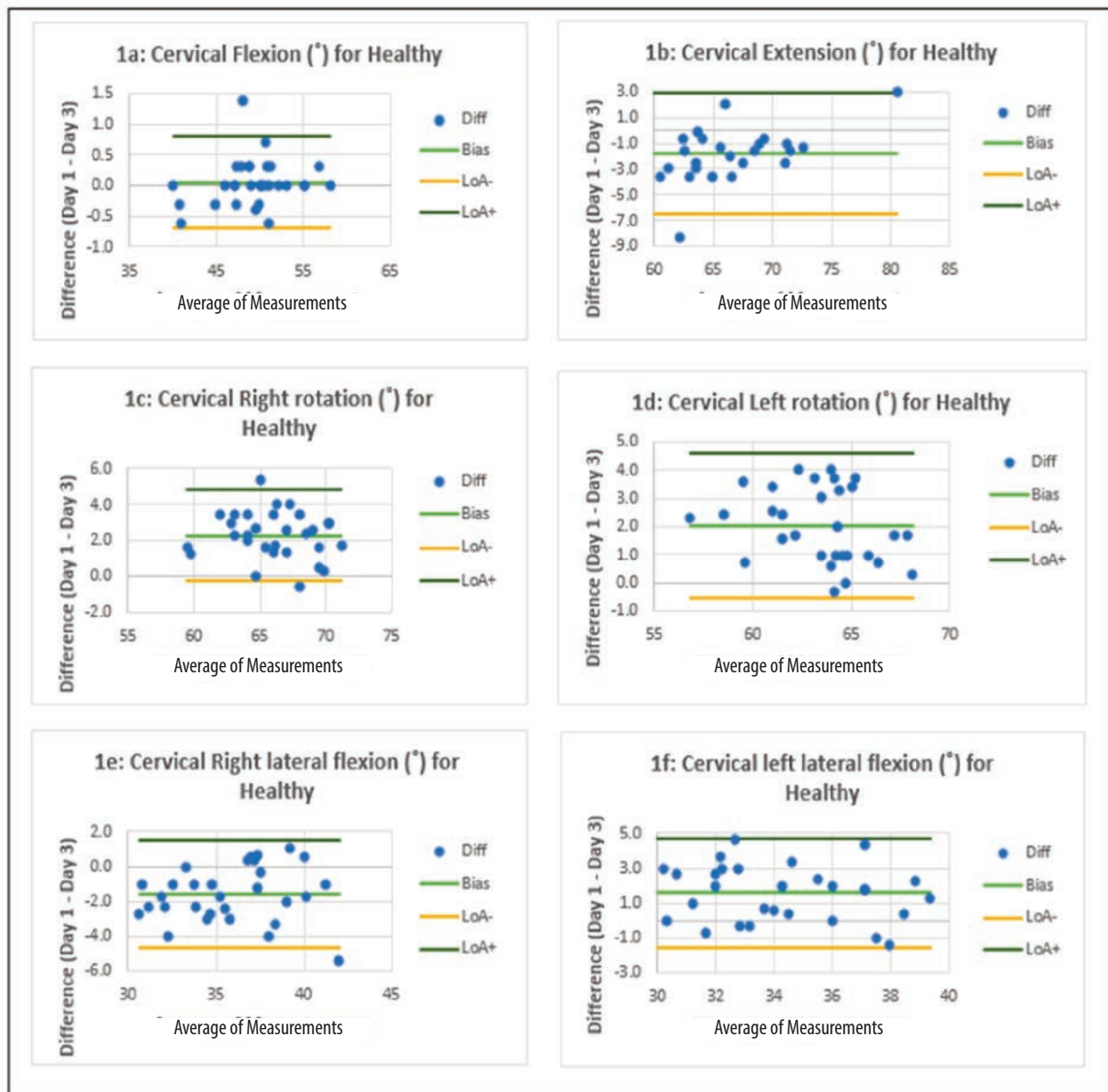
A senior physical therapist with over 15 years of experience served as the tester to assess the intrarater reliability of the CROM device. Uniform and concise instructions were given to each participant to ensure CROM measurement in isolated planes. A total of three measurements were taken with an interval of 60s for CROM on day-1. The procedure of measuring the cervical movements in each plane was repeated on day-3 by the same tester in a similar environment. Prior to performing these measurements, one practice trial was performed in each direction to familiarise the subjects with the entire procedure.

Data was analysed using SPSS 26. Frequencies with percentages were calculated for gender and age. Mean with standard deviation values were used for flexion, extension, right lateral flexion, left lateral flexion, right rotation and left rotation CROM measurements on day-1 and day-3. Inter-item correlation analysis was also done to measure the reliability between the measurement days.

The agreements were observed using ICC with 95% CI, and Bland-Altman plot were used with control limits. To support the results of the plots, regression analysis was performed and reported with regression coefficients and p-value. Data was compared within the groups with respect to gender and age by using paired sample t-test as per appropriate normal distribution checked via the Shapiro-Wilk test. P<0.05 was considered statistically significant.

**Table:** Reliability of cervical range of motion (CROM) readings between days 1 and 3 in the two groups.

Cervical range of motion	Day-1	Day-3	ICC	95% C.I L.L – U.L	p-value
	Mean ± SD	Mean ± SD			
<b>Flexion (°)</b>					
A	49.3 ± 4.3	49.2 ± 4.2	0.99	0.99 – 0.99	<0.01
B	36.9 ± 5.4	33.5 ± 4.9	0.85	-0.08 - 0.96	<0.01
<b>Extension (°)</b>					
A	63.7 ± 6.3	65.5 ± 5.7	0.93	0.76 - 0.97	<0.01
B	47.2 ± 4.6	45.8 ± 5.7	0.88	0.73 - 0.94	<0.01
<b>Right lateral flexion (°)</b>					
A	35 ± 3.3	36.6 ± 3.2	0.88	0.34 - 0.96	<0.01
B	30.3 ± 2.3	28.4 ± 2.4	0.75	-0.13 - 0.92	<0.01
<b>Left lateral flexion (°)</b>					
A	35 ± 2.8	33.4 ± 3.1	0.85	0.26 - 0.95	<0.01
B	29.1 ± 1.9	31.1 ± 1.9	0.64	-0.22 - 0.88	<0.01
<b>Right Rotation (°)</b>					
A	67.2 ± 3	64.9 ± 3.2	0.83	-0.15 - 0.95	<0.01
B	52.4 ± 3.5	49.2 ± 4.3	0.74	-0.10 - 0.91	<0.01
<b>Left Rotation (°)</b>					
A	64.4 ± 2.5	62.4 ± 2.9	0.81	-0.15 - 0.95	<0.01
B	50.8 ± 4.5	53.6 ± 4.6	0.86	-0.05 - 0.96	<0.01



**Figure-1:** Bland-Altman plot of cervical range of motion (CROM) in the healthy group.

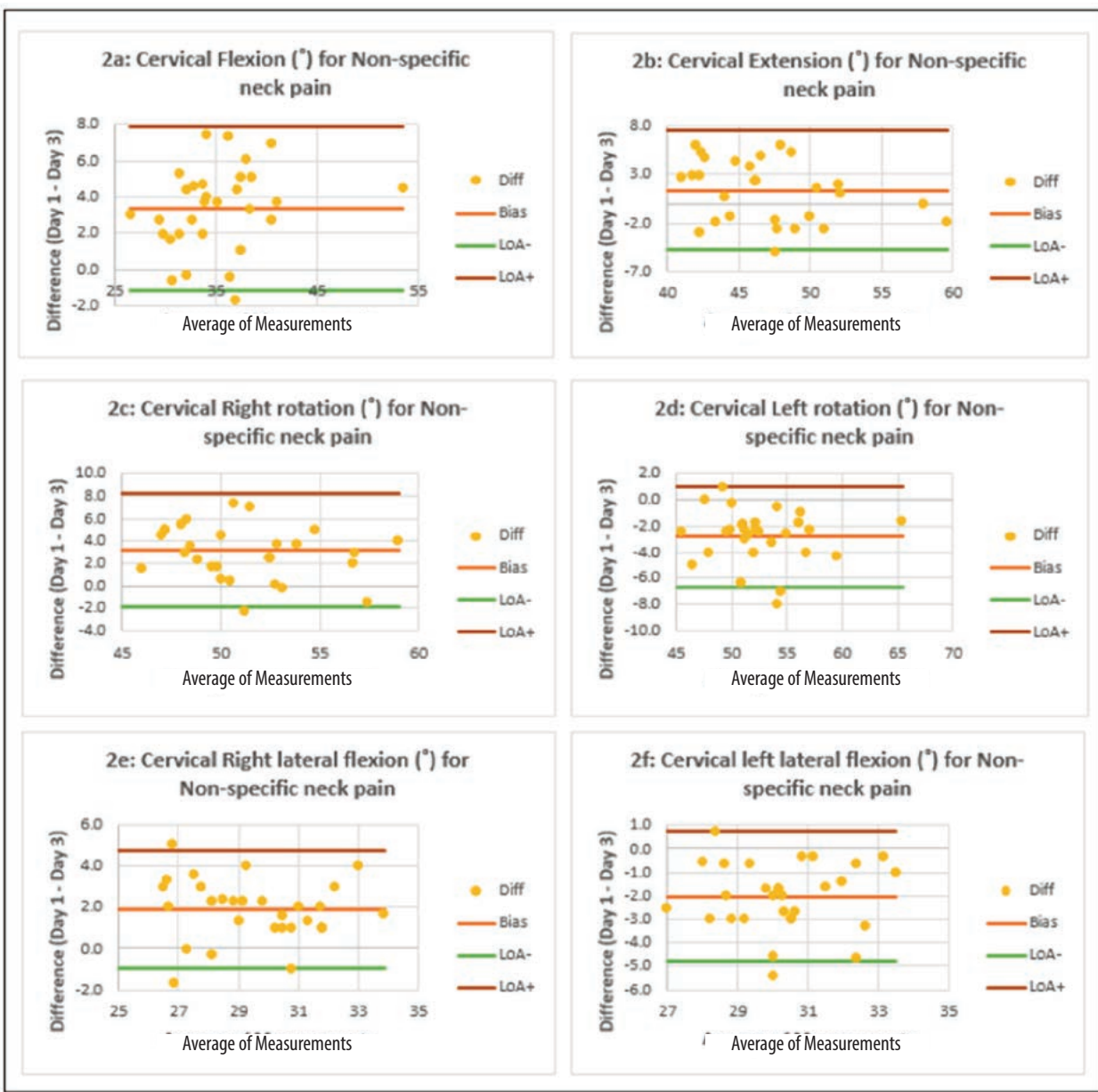
**Results**

Of the 60 subjects, there were 30(50%) in each of the two groups. Within the groups, there were 10(33.3%) subjects in each of the 3 age subgroups. Overall, there were 27(45%) males and 33(55%) females. In Group A, the ICC values for all cervical ranges were between 0.81 and 0.99, whereas in Group B, the values ranged from 0.64 to 0.88. The intraclass correlation coefficient values yielded good to excellent agreement in both groups (ICC >0.75), and all the values were statistically significant ( $p < 0.05$ ). However, ROM for left

lateral flexion showed a moderate agreement in Group B (Table).

Blend-Altman charts showed no trend above and below the mean differences, indicating no proportional biasedness between the groups (Figure 1-2).

Supporting the findings, linear regression analysis detected no significant bias in the healthy group, for most of parameters, cervical flexion ( $\beta = 0.01, p = 0.28$ ), right lateral flexion ( $\beta = 0.04, p = 0.61$ ), left lateral flexion ( $\beta = -0.11,$



**Figure-2:** Bland-Altman plot of cervical range of motion (CROM) in the group having patients with non-specific chronic neck pain.

$p=0.29$ ), right rotation ( $\beta=-0.05$ ,  $p=0.47$ ) and left rotation ( $\beta=-0.14$ ,  $p=0.12$ ) except one cervical extension ( $\beta=-0.23$ ,  $p=0.04$ ).

Linear regression analysis detected no significant bias in Group B for cervical flexion ( $\beta=0.11$ ,  $p=0.19$ ), cervical extension ( $\beta=0.11$ ,  $p=0.13$ ), right lateral flexion ( $\beta=-0.08$ ,  $p=0.50$ ), left lateral flexion ( $\beta=0.00$ ,  $p=0.99$ ), right rotation ( $\beta=-0.24$ ,  $p=0.06$ ) and left rotation ( $\beta=-0.02$ ,  $p=0.81$ ).

**Discussion**

The study showed good to excellent intrater reliability of

the CROM device in adults with and without chronic non-specific neck pain. Despite the significant differences in the measurements of day-1 and day-3, the intrater reliability for the assessment of cervical spine movements was found to be good to excellent, with ICC values ranging 0.81-0.99 in healthy Group A, and 0.64-0.88 in neck pain Group B. The measurements of CROM were represented by ICC values to highlight the variation among the readings. These variations, measurement errors and the number of trials affected the ICC values. The normative values calculated by the CROM device for all ranges in a group of patients aged

20-69 years showed that the average active cervical range for flexion was 46.1°, extension 67.1°, right lateral flexion 37.5°, left lateral flexion 36.0°, right rotation 63.5°, and left rotation 61.3°.9

According to published guidelines for interpreting the ICC values for reliability studies, <0.5 is considered poor reliability, 0.5-0.75 moderate reliability, 0.75-0.9 good reliability, and >0.90 represent excellent reliability.15 According to this criterion, the CROM device was found to be reliable in the current study. The findings are parallel to a previous reliability study conducted on a sample of 60 participants with cervical spine disorders, where the CROMs were measured by a single assessor using the same device, with ICC >0.80.16 In the current study, the ICC values for left lateral flexion and right rotation in patients with neck pain were found to have a moderate agreement (0.64 and 0.74) due to the methodological limitations in measuring the aforementioned ranges; including standardising the data collection and the fact that CROM device sagittal plane inclinometer is located on the left side.17

The good agreement found between the measurements of all cervical movements was also evaluated by mean differences and limit of agreement (LOA). The reported measurements taken by the CROM device indicated that it can substitute for any expensive device. A study revealed the ICC values for all CROM measurements to be between 0.87-0.97.18 Similar results have also been found in other studies.14,16,19 Another study revealed that patients who experienced both chronic neck discomfort and respiratory dysfunction could benefit from using a CROM device to measure their CROM.20

Not much research has been conducted on this topic and no reliability study has been conducted on the South Asian population. The reliability of the CROM device has, therefore, been compared with other tools employing sophisticated technology, and among all the measuring devices, the CROM device yielded the highest ICC values. Therefore, the CROM device has a number of advantages as it offers operational ease in taking measurements, is user-friendly, and is easy to carry in clinical settings as well as at-home environments.9

The current findings have served to fill a void and demonstrated the adequacy of the CROM device in measuring all cervical movements in healthy individuals as well as in individuals with chronic non-specific neck pain. However, the present study has its limitations. The minor inconsistencies observed in ICC values of the sample could have been effectively addressed by increasing the sample size per age group. Future studies should be conducted

with a large sample size per age group while taking into account the various types of CROM devices.

## Conclusion

There was good to excellent intrarater reliability of the CROM device in adults with and without chronic non-specific neck pain.

**Disclaimer:** The text is based on a Ph.D. thesis.

**Conflict of Interest:** None.

**Source of Funding:** None.

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