Inter-and Intra-Rater Reliability of the Back Range of Motion Instrument (BROM II) for Measuring Lumbar Mobility in Persons with Sedentary Lifestyle

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Abstract

The study was aimed to examine the inter-rater, intra-rater reliability, standard error of measurement (SEM) and minimum detectable change at 95% confidence level (MDC_{95}) of the Back range of motion device (BROM II) for measurement of active lumbar spine range of motion in persons with sedentary lifestyle. Single-group repeated measures for inter-rater, intra-rater reliability and SEM, as well as the MDC_{95} were computed for BROM II. Ten sedentary lifestyle persons (Gender: 2 men and 8 women; Age range: 22-31 years; Period of sitting per day: 6-10 hours) participated in this study. Two raters, who were a physical therapist with at least 5 years of clinical experience, measured lumbar mobility in all directions by using the BROM II instrument for 4 trials (each rater measured for 2 trials). Intra class Correlation Coefficients ($ICC_{3,3}$) were used to determine inter-rater and intra-rater reliability. The SEM and MDC_{95} were also calculated. The Intra-rater reliabilities for all directions of lumbar movement were high to good (ICC for lumbar flexion = 0.94-0.95, lumbar extension = 0.98-0.99, right side bending = 0.98-0.99, left side bending = 0.97-0.99), right trunk rotation = 0.95-0.97 and left trunk rotation = 0.96-0.97). The inter-rater reliabilities were high (ICC for lumbar extension = 0.91, right trunk bending = 0.91), good (ICC for left trunk bending and right trunk rotation = 0.88), fair (ICC for forward flexion = 0.79) and poor (ICC for left trunk rotation = 0.66). The SEMs for all directions ranged from 0.51 to 1.02 degrees. The MDC_{95}s for all directions ranged from 1.40 to 2.83 degrees. The BROM II supplies a reliable means of measuring lumbar motion in persons with sedentary lifestyle when measured by the same examiner.

Keywords**:** *BROM II, lumbar spine, range of motion, reliability, sedentary lifestyle*

บทคัดย่อ

เพื่อศึกษาค่าความน่าเชื่อถือภายในตัวผู้ประเมิน, ความน่าเชื่อถือระหว่างผู้ประเมิน, ค่าความคลาดเคลื่อนมาตรฐานในการวัด (standard error of measurement, SEM), ค่าชี้วัดการเปลี่ยนแปลงที่น้อยที่สุด (minimal detectable change, MDC_{95}) ของเครื่อง Back range of motion (BROM II) เพื่อวัดช่วงการเคลื่อนไหวของหลังส่วนล่าง ในผู้ที่มีรูปแบบการดำเนินชีวิตแบบอยู่กับที่ หาค่าความน่าเชื่อถือภายในตัวผู้ประเมิน และระหว่างผู้ประเมิน ในการใช้เครื่อง BROM II, หาค่าความคลาดเคลื่อนมาตรฐานในการวัด, หาค่าชี้วัดการเปลี่ยนแปลงที่น้อยที่สุด ประชากรที่ศึกษาในงานวิจัยนี้เป็นผู้ที่มีรูปแบบการดำเนินชีวิตแบบอยู่กับที่ จำนวน 10 คน เป็น ผู้ชาย 2 และผู้หญิง 8 คน อายุระหว่าง 22-31 ปี โดยนั่งนาน 6-10 ชั่วโมงต่อวัน ซึ่งจะมีการวัดช่วงการเคลื่อนไหวของหลังส่วนล่างใน 6 ทิศทาง โดยผู้ประเมินผู้ซึ่งเป็นนักกายภาพบำบัด ที่มีประสบการณ์การทำงานเป็นระยะเวลาอย่างน้อย 5 ปี จำนวน 2 คน ผู้เข้าร่วมงานวิจัยจะได้วัดช่วงการเคลื่อนไหวจำนวน 4 ครั้ง ในแต่ละทิศทางโดยผู้ประเมินคนที่ 1 และ 2 คนละ 2 ครั้ง นำค่าที่ได้มาคำนวณโดยโปรแกรม SPSS 17.0 เพื่อหาค่าความน่าเชื่อถือโดยใช้สถิติ $ICC_{3,3}$ เพื่อคำนวณหาค่าความน่าเชื่อถือภายในตัวผู้ประเมิน, ความน่าเชื่อถือระหว่างผู้ประเมิน, ค่าความคลาดเคลื่อนมาตรฐานในการวัด และค่าชี้วัดการเปลี่ยนแปลงที่น้อยที่สุด ค่าความน่าเชื่อถือภายในตัวผู้ประเมินมีค่าอยู่ในเกณฑ์สูงถึงดี ในทุกทิศทาง ดังนี้ ทิศทางก้มหลัง มีค่าเท่ากับ 0.94-0.95, แอ่นหลัง มีค่าเท่ากับ 0.98-0.99, เอียงตัวไปทางขวา มีค่าเท่ากับ 0.98-0.99, เอียงตัวไปทางซ้าย มีค่าเท่ากับ 0.97-0.99, หมุนตัวไปทางขวา มีค่าเท่ากับ 0.95-0.97 และหมุนตัวไปทางซ้าย มีค่าเท่ากับ 0.96-0.97 ความน่าเชื่อถือระหว่างผู้ปะเมินมีค่าสูง ในท่าแอ่นหลัง และท่าเอียงตัวไปทางขวา โดยมีค่าเท่ากับ 0.91, มีค่าดีทิศทางเอียงตัวไปทางซ้าย และท่าหมุนตัวไปทางขวา โดยมีค่าเท่ากับ 0.88 ความน่าเชื่อถือระหว่างผู้ประเมินมีค่าปานกลาง ในทิศทางก้มหลัง โดยมีค่าเท่ากับ 0.79 ความน่าเชื่อถือระหว่างผู้ประเมินมีค่าต่ำในท่าเอียงตัวไปทางซ้าย โดยมีค่าเท่ากับ 0.66 นอกจากนี้ค่าความคลาดเคลื่อนมาตรฐานในการวัดของเครื่องมือในทุกทิศทางมีค่าระหว่าง 0.51 – 1.02 และค่าชี้วัดการเปลี่ยนแปลงที่น้อยที่สุดของเครื่องมือ มีค่าระหว่าง 1.40 ถึง 2.83 องศาการเคลื่อนไหว เครื่อง BROM II มีค่าความน่าเชื่อถืออยู่ในระดับสูง โดยเฉพาะอย่างยิ่งค่าความน่าเชื่อถือภายในตัวผู้ประเมิน เหมาะสำหรับการนำมาใช้วัดช่วงการเคลื่อนไหวของหลังของผู้ที่มีรูปแบบการดำเนินชีวิตแบบอยู่กับที่

คำสำคัญ: *เครื่อง BROM II กระดูกสันหลังส่วนเอว ช่วงการเคลื่อนไหว ค่าความน่าเชื่อถือ ผู้ที่มีรูปแบบการดำเนินชีวิตแบบอยู่กับที่*

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1. Introduction

A sedentary lifestyle was defined as a type of lifestyle having excessive sitting and lack or irregular amounts of physical activity in daily life (Owen et al., 2010). A sedentary lifestyle was found around the world both in the developing, and developed countries. Approximately 60-86% of all worldwide populations have a sedentary behavior (World Health Organization (WHO), 2011). People with sedentary lifestyle have an excessive sitting, lying down and little energy expenditure (approximately ≤1.5 metabolic equivalents (METS) in one day (Owen et al., 2010; Pate et al., 2008). Sedentary activities (i.e. sitting, using computer, reading, watching television, driving personal vehicles socializing, reading and playing video games) is a commonly found in all around the world, especially in the developed countries. They spend the enormous amounts of time watching the screen (mobile device, computer monitor, and television) (Owen et al., 2010). The lack of physical activity, exercise, and prolonged sitting are the risk factors which contributed to the mortality and many conditions such as obesity, cardiovascular disease, type 2 diabetes, metabolic syndrome, mental health, osteoporosis, some cancers, chronic illness and musculoskeletal pain. These conditions may lead to disability (American college of sports medicine (ACSM), 2016; Williams and Hopper, 2015; Hamilton et al., 2008; US Department of Health and Human Services, 2008). The sedentary lifestyle can also cause back pain (Jones and Macfarlane, 2005; Corlett, 2006; Pope et al., 2002). It is because the prolonged sitting time decreases core stability muscles strength, reduces posterior lumbar stability (Beach et al., 2005; Corlett, 2006, Hedman and Fernie, 1997) and increases intradiscal load (Nachemson, 1981). These circumstances lead to a reduction of flexibility, mobility, and endurance (Spine and Scoliosis specialists, 2015). Moreover, the prolonged sitting can cause back stiffness, back muscle tightness and decrease back range of motion (Beach et al., 2005).

The back range of motion in the person can measure by many measurements such as radiography techniques, tape measurement, flexible curve device, inclinometer, goniometer and back range of motion instrument (BROM II) (Kachingwe and Phillips, 2005; Atya, 2013). Radiographic techniques (Evick and Yucel, 2003; Strokes et al., 1987; Portek et al., 1983) are the standard measurement for the lumbar sagittal plane. However, the ability to measure other planes of motion is limited (Evick and Yucel, 2003; Strokes et al., 1987; Portek et al., 1983). Also, the radiographic is an expensive, time-consuming, unapproachable for many clinicians and the subjects who received the radiation from this procedure (Evick and Yucel, 2003; Kachingwe et al., 2005). A ruler or tape measure (Waddell and Main, 1984; Kachingwe and Phillips, 2005) is used to measure lumbar motion in two directions (forward flexion and trunk bending) by recording the distance between the subject’s fingertips to the floor (Kachingwe and Phillips, 2005). It is easy to use, but the degrees of lumbar motion in this method cannot be separated from combined thoracic and hip movement (Kachingwe and Phillips, 2005). The flexible curve device or the flexible ruler (Waddle et al., 1987) measure is used to measure lumbar lordosis and the motion in a sagittal plane. A tracing of the subject’s lumbar curve in this device is made with the flexible ruler on paper after that the flexible ruler measure has been molded to the subject’s lumbar spine (Youdas et al., 1995; Stokes et al., 1987; Salisbury and Porter, 1987). Then, the degrees of lumbar spine curve were calculated from the mathematical calculation (Walker et al., 1987; Youdas et al., 1995). This measurement is high to good intra-rater reliability, but it was complicated method and time consuming (Mayer et al., 1985). Inclinometer (Rainville et al., 1994) can measure lumbar motion that separated from the combined thoracic and hip movement, but it can measure in the only sagittal plane of motion (i.e. forward flexion and extension) (Kachingwe and Phillips, 2005; Loebl, 1967). Goniometer or protractor can measure the lumbar motion in the frontal and sagittal plane (Kachingwe and Phillips, 2005) but it difficult to locate anatomical reference points for measurement. Whenever the subjects have a small oscillation in the position of measurement, it can impair the levels of analysis using the goniometer (Fitzgerald et al., 1983; Kachingwe and Phillips, 2005; Chaves et al, 2008).

A back range of motion (BROM II) device (Figure 1) was developed by the Performance Attainment Associates, United States of America in 1992. It was developed for measuring the lumbar spine mobility. BROM II device (Performance Attainment Associated, 1992) is a less well-known method for measuring a lumbar mobility. BROM II is a combination inclinometer and goniometer; it can measure lumbar motion in all planes and separates the lumbar motion from thoracic and hip motion (Nitchke et al., 1999; Paul, 1992). Furthermore, this measurement is easy to use and time-saving. BROM II is a reliable instrument of lumbar mobility in the sagittal and coronal planes in asymptomatic subjects (Breum et al., 1995; Kachingwe and Phillips, 2005; Madson et al., 1999) as well as chronic low back pain persons (Atya, 2013). Nevertheless, no study has used BROM II to measure back movement in the individuals with a sedentary lifestyle.

From the current literature, the reliability of BROM II is still inconclusive. Besides, no study has investigated the standard error of measurement (SEM) and minimum detectable change at the 95% confidence interval (MDC_{95}). To the best of our knowledge, no study has involved in the persons with a sedentary lifestyle. Hence, our study was designed to investigate the interrater and intrarater reliability of the BROM II for measuring lumbar mobility in individuals with a sedentary lifestyle.

2. Objectives

To examine the inter-rater, intra-rater reliability, standard error of measurement (SEM) and minimum detectable change at 95% confidence level (MDC95) of the BROM II for measurement of active lumbar spine range of motion in persons with a sedentary lifestyle.

3. Materials and methods

Participants

The sample size (N=10) was calculated based on sample size calculator version 1.7.1 update on October 2015 (Significance level (α) = 0.05, Power (1-β) = 0.80, Acceptable reliability (ρ0) = 0.70, Expected reliability (ρ1) = 0.90 and Drop- out = 10%) (Arifin, 2015 and Walter et al.,1998). Ten volunteers (2 men and 8 women) were recruited from sedentary lifestyle graduate students. The participants ages ranged from 22-31 years (mean±SD = 27.1 ± 3.70 years). Exclusion criteria included recent back and pelvic surgeries, traumatic injury to the back and complained of mechanical low back pain at the time of the study. All participants read and signed an informed consent document approved by the Ethics Review Committee for Research Involving Human Research Subjects, Health Science Group, Chulalongkorn University.

Instrumentation

The Back range of motion device (BROM II; Performance Attainment Associates, 1992) was used to measure a lumbar range of motion (ROM) in all six directions, i.e., lumbar flexion, extension, right lateral bending, left lateral bending, right trunk rotation and left trunk rotation. The BROM II device (Figure 1A) consists of two plastic units: a modified inclinometer (Figure 1C) for measuring sagittal plane motions and a combination gravity goniometer (Figure 1B) for measuring side bending and trunk rotational movements. For measuring lumbar flexion and extension ROM, the modified inclinometer (Figure 1C) fixed on a base unit was placed on the skin over the participant's sacrum (S1 spinous processes). The L-shaped movable arm (Figure 1D) was extended and placed at T12 spinous process (Figure 2A). The participants were asked to stand in an upright position. The pelvis was not fixed and the feet were placed apart for shoulder width. The unit was then positioned so that the level is centered and recorded the initial reading in degrees. During flexion (Figure 2B) and extension (Figure 2C) movements, the L-shaped movable arm was held at T12 to guide the plastic protractor while the device places over S1. Then, the examiner read and recorded the final degree (marked in 1º increment) from the scale on the protractor side of the device.

The second unit was composed of a combination gravity goniometer and the BROM R/L unit (Figure 1B). During lumbar rotation, the subjects sat on a non-rotating bench, place the belt between S1 and T2 and suspend the magnetic at the level over the sacrum (below S1). Then, the BROM R/L unit was placed on the horizontal line of T12, hold the center of the unit firmly against the patient's back, then zero the compass and check that the scale on the superior part of the BROM R/L was still zero. When the subjects moved to the full range of rotation (Figure 2D), the range of rotation (marked in 2º increments) was read and recorded. During lateral bending (Figure 2E), the ROM was read posteriorly from the gravity goniometer (marked in 2º increments).

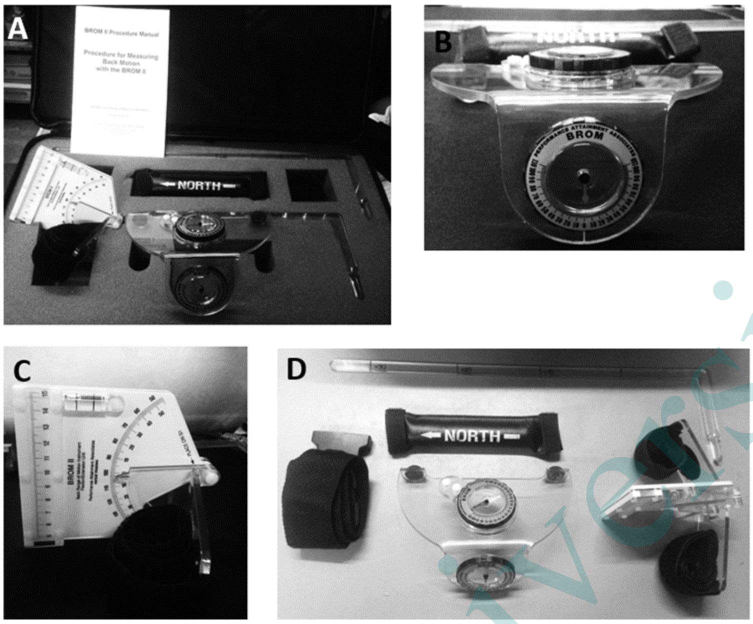

Figure 1 Back range of motion device (BROM II): A) BROM II, B) a combination gravity goniometer and the BROM R/L unit, C) a modified inclinometer and a plastic protractor D) a modified inclinometer, the L-shaped movable arm , a combination gravity goniometer and the BROM R/L unit, belt and magnetic

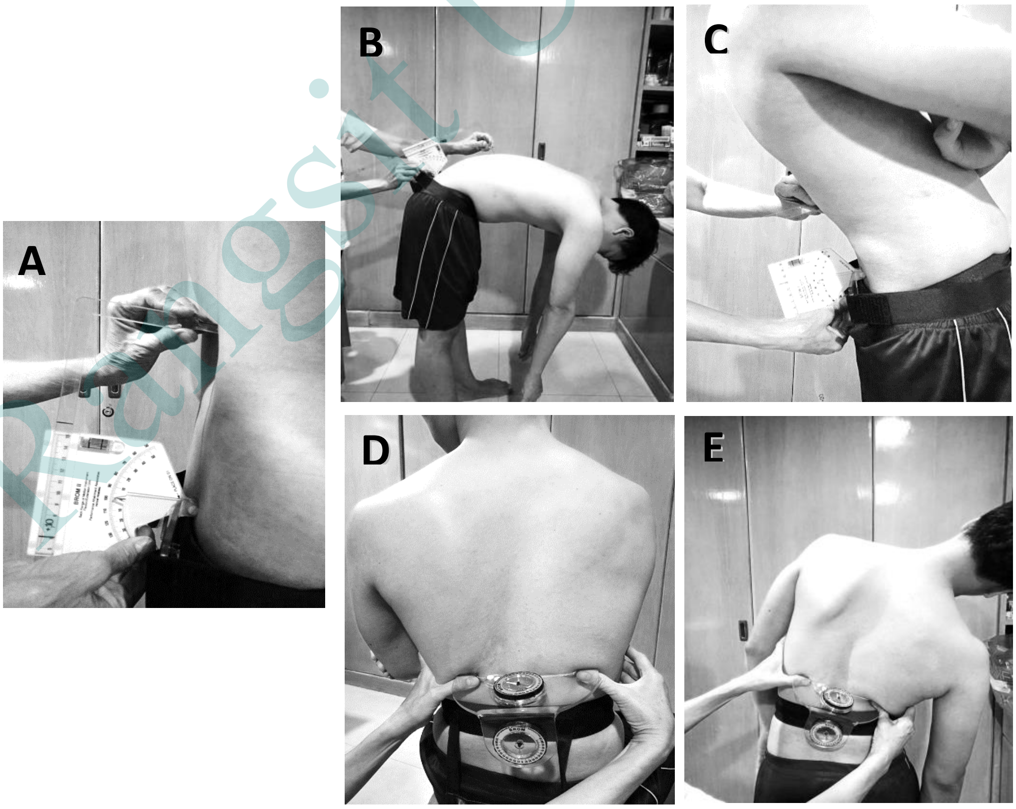

Figure 2 Measuring positions for BROM II: A) neutral position, B) flexion, C) extension, D) trunk rotation and E) trunk lateral bending

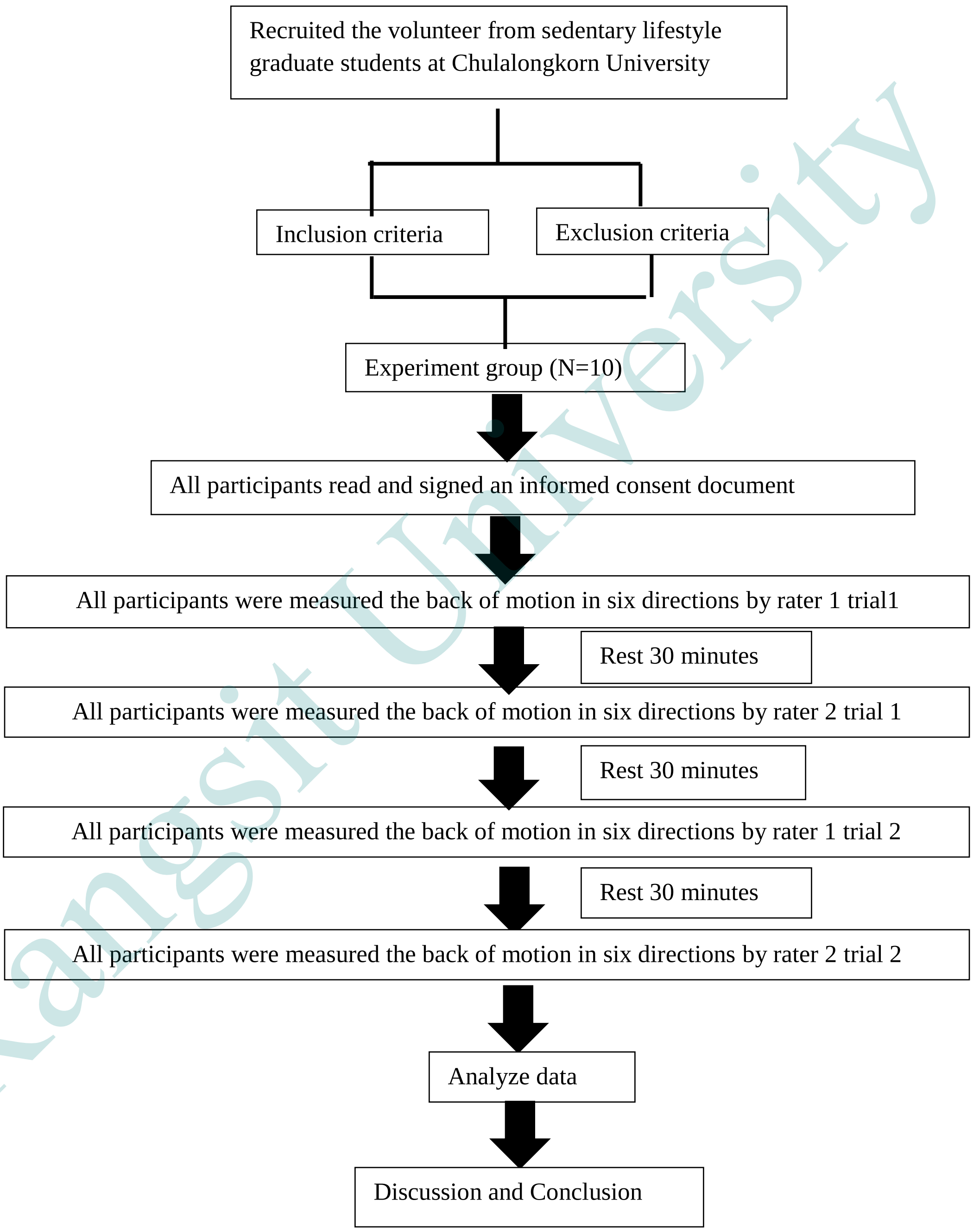

Figure 3 Flow Chart of Methodology

Procedure

Two examiners in this study were a physical therapist (5 years of physical therapist clinical experience). Both examiners read the instrument manual and practiced using the BROM II until familiar with the testing instrument. Participants were asked to answer the self-administered questionnaire. After that, they performed the three repetitions of a warm-up session in all testing motions before the beginning data collection. All movements were tested in standing position except lumbar rotation, in which subjects were seated on a non-rotating bench with the feet flat on the floor. Each examiner palpated and marked the spinous processes of T12 and S1 with a non-permanent marker for instrument placement at the beginning of every trial and removed the mark after each trial. Each participant has measured four trials on the same day. The first trial by examiner A (EP) or B (MP), then by another examiner, followd by examiner A or B again and then by another examiner again. The resting times between trial was at least 30 minutes. This study was investigated on November 2016 to January 2017.

Data analysis

Data were analyzed by using the Statistical Package for the Social Sciences (Version 17.0). Descriptive statistic including mean, standard deviation and ranges were computed for participant characteristics. Means, 95% confidence intervals (95%CI), and ranges were computed for a lumbar ROM in all directions. Test-retest reliability of the BROM II was calculated using $ICC_{3,3}$ (Two-way mixed model), a measure of relative reliability. The standard error of measurement (SEM) was calculated. The SEM is a measure of absolute reliability expressing measurement error in the same units as the original measurement (Shrout and Fleiss, 1979; Statford and Goldsmith, 1997). The following formula was used, SEM = SD x $\sqrt{(1-ICC_{3,3})}$ (Golberg et al., 2012) while SD is the highest SD of all trials, and $ICC_{3,3}$ is the test-retest reliability coefficient. The MDC at the 95% confidence level (MDC_{95}) was computed as 1.96 x SEM x $\sqrt{2}$ (Golberg et al., 2012). SEM and MDC_{95} were also expressed as a percentage (SEM% and MDC_{95}%) to enhance interpretation of the absolute values of measurement error and minimum change. The following formulas were used: 1) SEM% = (SEM x 100)/mean and 2) MDC_{95}% = (MDC_{95} x 100)/mean (Wagner et al., 2008 and Golberg et al., 2012). Statistical significance was set at $p \leq 0.05$. The Scheme for defining the amount of reliability with ICCs has the following values: 0.90-0.99 is high reliability; 0.80-0.89 is good reliability; 0.70-0.79 is fair reliability; and 0.69 and below is poor reliability (Madson et al., 1999).

4. Results

Characteristics

Table 1 presents the characteristics of the participants. The periods of sitting of all participants is 7.4 ± 1.17 (range from 6 - 10 hours per day).

Table 1 Demographic data

Characteristic	Mean (SD)	Range
Age (yr.)	27.20 (3.70)	22-31
Height (cm.)	163.30 (3.30)	158-170
Weight (Kg.)	60.32 (7.91)	51-75
Body Mass Index (Kg/m^2)	22.67 (3.42)	18.73-27.88
The period of sitting / day (Hrs.)	7.4 (1.17)	6-10

Intra- and Inter-rater reliability

For sagittal plane of motion, the intra-rater reliability for lumbar forward flexion and lumbar extension were high (ICC range = 0.94-0.95 and 0.98-0.99, respectively). For frontal plane of motion, the intra-rater reliability was also high (ICC range for right trunk bending = 0.98-0.99 and for left trunk bending = 0.97-0.99). Whereas for transverse plane of motion, the intra-rater reliability for right and left trunk rotation were high (ICC range = 0.95-0.97 and 0.96-0.97, repectively) (Table 2).

Inter-rater reliability for lumbar extension and right trunk bending were high (ICC = 0.91 and 0.91, respectively). Inter-rater reliability for left trunk bending and right trunk rotation were good (ICC = 0.88). Inter-rater reliability for lumbar forward flexion was fair (ICC = 0.79). Inter-rater reliability for left trunk rotation was poor (ICC = 0.66) (Table 2).

Table 2. Intrarater and Interrater reliability of rater 1 and 2 of BROM II device for lumbar motion measurement

Movements	Rater 1		Intrarater reliability of rater 1 ICC (95%CI)	Rater 2		Intrarater reliability of rater 2 ICC (95%CI)	Interrater reliability ICC (95%CI)
	Mean trial 1 Mean ± SD (Range)	Mean trial 2 Mean ± SD (Range)		Mean trial 1 Mean ± SD (Range)	Mean trial 2 Mean ± SD (Range)		
Flexion	24.87±4.57 (19.34-34.67)	25.17±3.87 (19.00-32.67)	0.95 (0.79-0.99)	22.93±3.18 (19.00-27.67)	23.37±2.83 (19.34-27.00)	0.94 (0.76-0.98)	0.79 (0.12-0.94)
Extension	9.77±5.60 (2.34-20.34)	9.50±5.26 (3.67-20.67)	0.98 (0.91-0.99)	10.97±4.94 (5.00-18.34)	10.77±5.21 (5.00-20.00)	0.99 (0.95-0.99)	0.91 (0.65-0.98)
Right trunk bending	24.74±4.43 (16.67-30.00)	25.87±4.68 (18.00-32.00)	0.98 (0.93-0.99)	25.64±5.13 (18.67-34.00)	25.67±4.78 (18.67-30.00)	0.99 (0.96-0.99)	0.91 (0.64-0.98)
Left trunk bending	23.27±4.92 (16.00-32.67)	23.40±5.06 (16.67-33.34)	0.99 (0.94-0.99)	23.87±4.27 (18.67-30.67)	23.77±4.14 (18.67-30.00)	0.97 (0.89-0.99)	0.88 (0.52-0.97)
Right trunk rotation	6.33±4.19 (2.00-15.34)	6.20±3.49 (2.00-13.34)	0.97 (0.89-0.99)	5.93±3.15 (2.67-13.34)	5.60±3.11 (2.67-11.34)	0.95 (0.79-0.99)	0.88 (0.51-0.97)
Left trunk rotation	5.60±2.65 (2.00-10.67)	5.73±2.67 (2.67-11.34)	0.97 (0.85-0.99)	4.80±2.88 (2.00-10.00)	4.93±2.83 (2.00-10.00)	0.97 (0.88-0.99)	0.66 (-0.37-0.91)

SEM, MDC_{95}, SEM% and MDC_{95}%

Table 3 presents the SEM, MDC_{95}, SEM%, MDC_{95}%. The SEM was 0.78-1.02 degrees and MDC_{95} was 2.16-2.83 degrees for lumbar forward flexion. SEM was 0.59-0.83 degrees and MDC_{95} was 1.64-2.30 degrees for lumbar extension. SEM was 0.51-0.63 degrees and MDC_{95} was 1.42-1.74 degrees for right side bending. SEM was 0.62-0.71 degrees and MDC_{95} was 1.72-1.98 degrees for left side bending. SEM was 0.69-0.71 degrees and MDC_{95} was 1.90-1.98 degrees for right trunk rotation. SEM was 0.51 degrees and MDC_{95} was 1.40 degrees for left trunk rotation. SEM% was 3.40-4.11 and MDC_{95}% was 9.42-11.39 for lumbar flexion. In extension, SEM% was 5.52-8.50 and MDC_{95}% was 15.29-23.57. SEM% was 2.00-2.43 and MDC_{95}% was 5.55-6.73 for right trunk bending. Left trunk bending, SEM% was 2.65-3.00 and MDC_{95}% was 7.34-8.30. In right trunk rotation, SEM% was 10.87-12.00 and MDC_{95}% was 30.15-33.24. Left trunk rotation, SEM% was 8.83-10.57 and MDC_{95}% was 24.51-29.27.

Table3. Standard error of measurement and minimum detectable change at the 95% confidence interval

Movement	Rater	Intrarater reliability ICC	SEM (degree)	%SEM (percent)	MDC_{95} (degree)	MDC_{95}% (percent)
Flexion	Rater 1	0.95	1.02	4.11	2.83	11.39
	Rater 2	0.94	0.78	3.40	2.16	9.42
Extension	Rater 1	0.98	0.83	8.50	2.30	23.57
	Rater 2	0.99	0.59	5.52	1.64	15.29
Right trunk bending	Rater 1	0.98	0.63	2.43	1.74	6.73
	Rater 2	0.99	0.51	2.00	1.42	5.55
Left trunk bending	Rater 1	0.99	0.62	2.65	1.72	7.34
	Rater 2	0.97	0.71	3.00	1.98	8.30
Right trunk rotation	Rater 1	0.97	0.69	10.87	1.90	30.15
	Rater 2	0.95	0.71	12.00	1.98	33.24
Left trunk rotation	Rater 1	0.96	0.51	8.83	1.40	24.51
	Rater 2	0.97	0.51	10.57	1.40	29.27

5. Discussion

The BROM II device can measure the lumbar motions independent of the combined thoracic and hip movements. Moreover, it has high intra-rater reliability. Intra-rater reliability of the BROM II device in this study was high for all lumbar direction (ICC range, 0.94-0.99), which was substantially better than the study of Madson et al. (1999); Kachingwe and Phillips (2005); Atya (2013); Madson et al. (1999) reported the intra-rater reliability of lumbar motion is fair to poor for sagittal plane measurement (ICC range, 0.67-0.78) and high to good for the coronal plane (ICC range, 0.88-0.95). Kachingwe and Phillips (2005) reported the intra-rater reliability of lumbar motion is fair to poor for sagittal plane measurement (ICC range, 0.55-0.74) and fair to poor for the coronal plane (ICC range, 0.60-0.79). Atya Azza M. (2013) reported the intra-rater reliability of lumbar motion is high to good for sagittal plane measurement (ICC range, 0.84-0.91) and good for the coronal plane (ICC range,0.81-0.88). Intra-rater reliability was found to be better than intra-rater reliability for measurements in all planes.

Inter-rater reliability of the BROM II in this study was high reliability (ICC= 0.91) in lumbar extension and right trunk bendiong, which was substantially better than the findings of Kachingwe and Phillips (2005). The inter-rater reliability when measuring left trunk bending and right trunk rotation is good (ICC=0.88) and was better than the findings of Kachingwe and Phillips (2005). Inter-rater reliability in flexion is fair (ICC=0.79), it is similar to the previous study (Kachingwe and Phillips, 2005). Inter-rater reliability in left trunk rotation is poor reliability (ICC=0.66). One explanation for lower reliability may be due to the different command and the difference of ability to maintain hand pressure in two examiners. Moreover, when the subjects were measured repetitively, it may stretch back muscles which in turn increase its flexibility (Abelson and Abelson, 2005; Shellock and Prentice, 1985). Thus, the results of 2 examiners may be different from these reasons.

BROM II has a little error of measurement and small measurement error percent values (SEM%) in all lumbar motions especially in lumbar flexion, extension and lateral bending (SEM range, 0.51-1.02) and (SEM% range, 2.00-8.50). It suggests excellent absolute reliability of BROM II device in persons with a sedentary lifestyle. Moreover, MDC_{95} and MDC_{95}% in this study are small in all directions of lumbar motion (MDC_{95} range, 1.40-2.83 and MDC_{95}% range, 5.55-33.24), suggesting that the BROM II may possibly be sensitive to detecting a real change in the back range of motion in persons with a sedentary lifestyle.

Suggestions for further studies of inter-rater, intra-rater reliability, measurement error and minimum change in BROM II device should blind testers to decrease tester bias. Further studies should be randomized the subject to measure to increase the constancy of protocol. Furthermore, the further studies should be focused on individuals who have symptomatic low back pain with a sedentary lifestyle.

6. Conclusion

The results of this study suggest that intra-rater reliabilities were high in all directions. In contrast, the inter-rater reliabilities range from high to poor. The back range of motion device (BROM II) may be a better clinical choice because it has high reliability for measuring the active back range of motion in all directions in the persons with a sedentary lifestyle when performed by the same examiner. So the benefit is directly for the same rater such as doctor or physical therapist to detect the improvement of back motion after a period of treatment. Furthermore, it is uncomplicated for using and lowering error of measurement.

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