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Research article

NUMBER OF FAMILIARISATION SESSIONS REQUIRED FOR AN ISOKINETIC KNEE STRENGTH ASSESSMENT IN FEMALE VARSITY ATHLETES

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Abstract

Journal of Sports Science and Physical Education 5(2): 1-8, 2016 - The objective of this study was to determine the number of familiarisation sessions required for isokinetic knee extension and flexion in female varsity athletes. Thirty right footed dominance female varsity athletes (n=30; age: 21.73 ±0.22 years, body mass index (BMI): 22.58 ±0.52 kg/m2), with no history of knee injuries were recruited. The design started with either with the dominant or non-dominant limb, followed by the opposite limb. Four sets of isokinetic maximal voluntary contraction at 60 ^{o}/s were performed for each limb. The results showed that for knee extension regardless of which limb starts first is 2 sessions, however for knee flexion, 3 sessions is required for dominant limb while 2 for non-dominant. In addition, the presence of cross-education effect is observed for knee flexion from non-dominant to dominant limb, where the number of session was reduced from three to two. In conclusion, we propose that two sessions of familiarisation are required for female varsity athletes and should begin with the non-dominant limb followed by dominant limb.

Keywords: familiarisation, isokinetic knee extension and flexion, cross-education limb dominance

Introduction

Muscular strength is one of the health-related fitness components, and it is important to provide an accurate assessment particularly when evaluating performance, designing training programmes, and for rehabilitation purposes. One factor that contributes to this accurate assessment is having had sufficient familiarisation session prior to actual testing; failing so may contribute in under-estimation of the results. The familiarisation enables one to reach maximum capacity to generate force which is observed when a plateau in force generation has been achieved (Ritti-Dias et al., 2005; Ploutz-Snyder & Giamis, 2001).

Over the years' studies have examined the number of familiarisation sessions required prior to strength assessment. However, the main focus of these studies were on isotonic contractions specifically on one-repetition maximum (1-RM), (Ritti-Dias et al., 2005; Ritti-Dias et al., 2011; Soares-Caldeira et al., 2009), while few on isometric contractions (Calder & Gabriel, 2007; Green et al., 2013), and none on isokinetic contraction. Ironically, there is no consensus on the time frame (single-day or multiple-day) for isotonic and isometric contractions to be familiarised. The number of familiarisation sessions required for 1-RM test ranges from 1-9 in a multiple-day session (Ritti-Dias et al., 2005; Ploutz-Snyder & Giamis, 2001; Ritti-Dias et al., 2011; Soares-Caldeira et al., 2009), while 2-3 sessions for isometric contractions which was carried out in a single-day session (Green et al., 2013). The differences observed in the studies could be attributed to the mode of contraction (isotonic, isometric), muscle group tested, and subject's characteristics such as age and training experience. The importance of familiarisation for trained individual has yet to be investigated by isokinetic contraction.

Thus, the objective of the study was to determine the number of familiarisation sessions required for isokinetic knee extension and flexion at 60 °/s required for female varsity athletes. In addition, the design of this study also allows us to investigate if ever cross-education effect was presence following contralateral contractions during familiarisation.

Methodology

Participants

Thirty healthy young female varsity athletes (n=30, age: 21.73 ±0.22 years; BMI: 22.58 ±0.52 kg/m^2) who were moderately active (trained 3 times per week), had previous experience in resistance training, and no experience on isokinetic device were recruited. All subjects were right-footed, determined by the lateral preference inventory (Coren, 1993), and they all provided their written informed consent forms. Table 1 illustrates the demographic of subject's characteristics (mean ±standard error). The subjects were randomly assigned into 2 familiarisation groups: dominant (D) and non-dominant (ND). This study was approved by the University Human Research Ethics Committee (UM.TNC2/RCH/UMREC) and conducted according to Declaration of Helsinki.

Table 1. Demographic of subject's characteristics (mean ±SE)

	Group D (n=15)	Group ND (n=15)	t-test p <0.05
Age (years)	21.53±0.22	21.93±0.38	0.37
Height (m)	1.60±0.02	1.61±0.02	0.79
Weight (kg)	56.53±2.89	60.27±2.74	0.36
BMI (kg/m2)	21.94±0.70	23.22±0.75	0.22

Note: BMI (Body Mass Index)

Procedure

Prior to the test, all subjects performed a general cardiovascular warm-up on a cycle ergometer for five minutes between 55-60rpm at a low resistance setting (about 30% of heart rate reserve), followed by a guided dynamic stretching to prepare the prime movers of the muscle involved. Upon completion of the warm-up session, subjects were introduced to the isokinetic device, Humac Norm (CYBEX Medical, CSMi). All subjects were instructed to complete 5 contractions of 4 sessions of knee extension (quadriceps) and knee flexion (hamstrings) on each limb, whereby the D group started familiarisation with the right limb and the ND group the opposite limb (Figure 1). A rest period of 3 minutes was given between each session. Verbal encouragement and visual feedback were given to all subjects to motivate them to achieve the maximal drive of the movement.

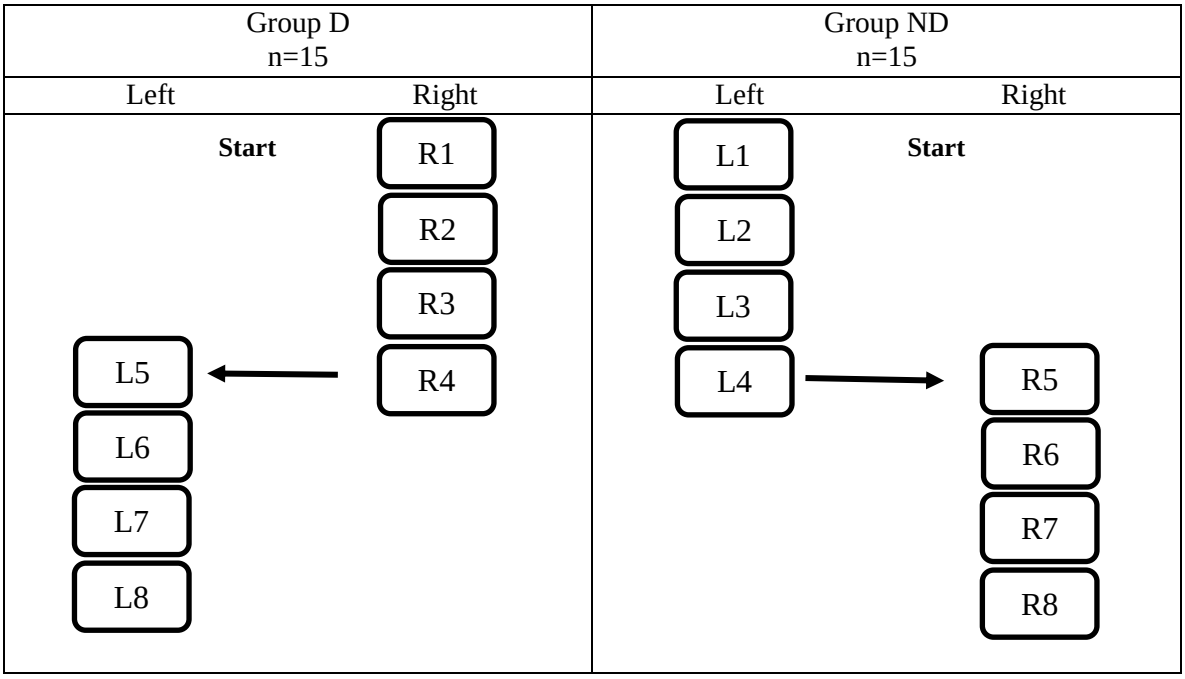


Figure 1: The two experimental groups, D and ND, which D started familiarisation with dominant limb, then switch and ended the sessions on the non-dominant limb. In the opposite order, ND started familiarisation with the non-dominant limb.

Isokinetic test

Before the testing began, the dynamometer was gravitationally corrected based on the manufacturer's recommendations. A standard protocol to position the subjects appropriately was followed: The chair and dynamometer rotation scale was fixed at 40 ° and tilted at 0 °, the subjects sat upright in a chair back angled at 85 ° with up chair seat position, secured using seat belt, shoulder belts and thigh stabilizer strap. All subjects performed concentric isokinetic knee extension and flexion at 60 °/s. All the testing was conducted by the same tester to reduce measurement error. Average peak torque (AvePT) is defined as the mean of the peak torque values during the five contractions.

Statistical Analyses

Data were analysed using Graphpad Prism 6 software. All data were presented as mean ±SE. To compare the strength between sessions in the ND group; familiarisation started with L1-L4, followed by R5-R8, while D with R1-R4, followed by L5-L8 respectively, one-way repeated measure analysis of variance was applied separately for each limb. Significant level was set at $p < 0.05$. In determining the number of familiarisation session required is when stabilisation of AvePT is achieved (no significant difference between subsequent sessions (Ritti-Dias et al., 2005; do Nascimento et al., 2013).

Results

For knee extension (quadriceps), the number of sessions required to familiarise were similar for both D (first contraction; dominant limb) and ND (first contraction; non-dominant limb) group, where two sessions were sufficient. In the D group, significance differences ($p < 0.05$) were found between R1 and R2 for the dominant limb, while in the ND group between L1 and L3-L4 for the non-dominant limb.

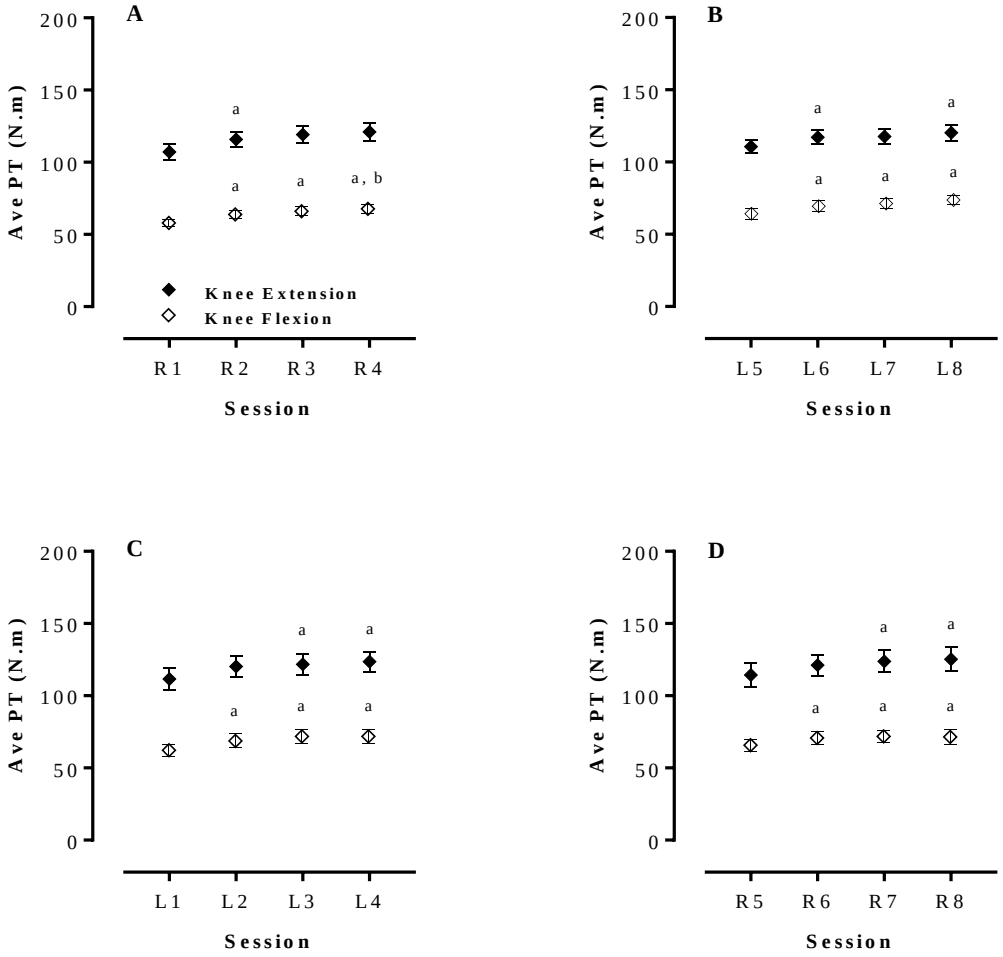
Similarly, for knee extension, when the familiarisation was conducted following contralateral contractions, both D and ND groups also showed two sessions were sufficient to achieve familiarisation. In the D group, significance differences were found between L5 and L6, L5 and L8 for the non-dominant limb, while in the ND group between R5 and R7-R8 for the dominant limb.

While for the knee flexion (hamstrings), the number of sessions required to familiarise were three for both D (first contraction; dominant limb), and two ND (first contraction, non-dominant limb) group. In the D group, significance differences were found between R1 and R2-R4, and R2 and R4 for the dominant limb, while in the ND group between L1 and L2-L4 for the non-dominant limb.

However, for knee flexion, when the familiarisation was conducted following contralateral contractions, both D and ND groups showed two sessions were sufficient to achieve familiarisation. In the D group, significance differences were found between L5 and L6-L8 for the non-dominant limb, while in the ND group between R5 and R6-R8 for the dominant limb.

It is noted that for knee extension, quadriceps two sessions were sufficient to familiarise regardless which limb started first (either dominant started first or second). Similar results was found for knee flexion, hamstring (two sessions) when non-dominant started first or second. However, in knee flexion (hamstring), when dominant limb started

first; 3 sessions were required to familiarise, while only two sessions were required for dominant limb following non-dominant limb contractions; evidence of cross-education effect.



◇ **hamstrings**

◆ **quadriceps**

Figure 2: One-way analysis of variance (Anova) of the average peak torque (AvePT) of quadriceps and hamstring to determine the number of familiarisation sessions required, A, D group on the dominant limb (R1-R4); B, D group on the non-dominant limb (L5-L8); C, ND group on the non-dominant limb (L1-L4); and D, ND group on the dominant limb (R5-R8).

Discussion

The main findings of the present study showed that the optimal number of familiarisation sessions required for female varsity athletes were 2 sessions for both dominant and non-dominant limb knee extensions, and also for the non-dominant limb knee flexion. While for the dominant knee flexion, 3 sessions were required to familiarise. Following contra-lateral contractions, both knee extension and flexion showed similar results where two sessions were

sufficient to familiarise regardless of dominant or non-dominant limb. To our surprise, for knee flexion of the dominant limb, evident of cross education effect was observed, whereby when the starting limb was dominant three sessions were required while only two when non-dominant was the starting limb (following contralateral contractions).

Findings showed that isokinetic maximal voluntary contraction could be achieved in a single day session as values were stabilised when no significant difference was observed between the subsequent sessions. The findings were similar to isometric contractions whereby familiarisation could also be achieved in a single-day (Green et al., 2013). In contrast, most familiarisation studies conducted using isotonic contraction require multiple-day familiarisation session (Ritti-Dias et al., 2005; Ploutz-Snyder & Giamis, 2001; Ritti-Dias et al., 2011; Soares-Caldeira et al., 2009). In terms of number of sessions, despite single or multiple day or mode of contractions (isometric or isotonic), low numbers i.e. 2-3 sessions are generally found. In other words, maximal drive to reach stable force generation can be achieved after a few sessions.

This study was design specifically to investigate familiarisation in two opposing contractions (extension and flexion) in the same siting, the mix findings between knee extension and flexion could be attributed to morphological differences between muscle group tested (quadriceps and hamstrings) and/or dominant effect. Generally, these may include distribution of muscle fibre types (fast and slow twitch fibres) which may affect time to achieve maximal drive (Johnson et al., 1973). In terms of dominant effect, our findings showed that for hamstring there a different rate to achieve maximum drive between dominant and non-dominant limbs. This phenomenon has also been observed in research related to motor control (Goble & Brown 2008). Evidently, bilateral deficit between dominant and non-dominant for hamstring suggests that dominant is relatively weaker which in turn required more sessions to achieve the maximal drive (Daneshjoo et al., 2013).

The increase in the isokinetic maximal voluntary contractions between the sessions during familiarisation may be contributed by similar neural mechanisms to that of early strength gains (Calder & Gabriel, 2007; Ritti-Dias et al., 2005; Ritti-Dias et al., 2011). These mechanisms may include changes in motor units in an agonist muscle, i.e. an increase in recruitment, firing rates, and synchronicity (Kamen & Knight, 2004; Knight & Kamen, 2001; Semmler, 2002), and reduction in antagonist muscle activation (Carolan & Cafarelli, 1992). Recent researches suggest that central mechanisms may also play an important role in early strength gains (Carroll et al., 2011; Selvanayagam et al., 2011).

The reduction in the number of familiarisation for knee flexion in the dominant limb following contralateral contractions, from three to two sessions, shows an effect of cross-education was presence. Cross-education effect is known as contralateral transfer following maximal voluntary contractions observed in the opposite homologous muscles. Though this phenomenon has been investigated in strength training intervention studies (Farthing, 2009; Manca et al., 2015), none has been reported during familiarisation. It is believed that adaptations affect the nervous system either directly to the untrained limb or at supraspinal level which controls movement assessable by the untrained limb (Carroll et al., 2006). These mechanisms are likely to occur as early as during familiarisation, however, this limited to the population tested, muscle group tested, and subject's characteristics.

Based on previous findings, subject characteristics such as age and training experience are factors that could influence the number of familiarisation sessions required. Ploutz-Synder & Giamis (2001) revealed that age had influenced on the number of familiarisation sessions required between older and younger untrained women, where older women required more sessions compared to younger. In contrast, others showed that similar number of sessions was required for young and older women (do Nascimento et al., 2013; Soares-Caldeira et al., 2009). While comparing individuals with and without resistance training, results showed that more sessions were required to those without experience (Ritti-Dias et al., 2011). To date, no study has investigated isokinetic contraction for female athlete in familiarisation study design, hence this adds to body of knowledge.

This study shows that the optimal number of familiarisation sessions for knee extension regardless of which limb starts first is 2 sessions, however for knee flexion, 3 sessions is required for dominant limb while 2 for non-dominant. In addition, the presence of cross-education effect is observed for knee flexion from non-dominant to dominant limb. Therefore we propose that familiarisation for female varsity athletes should begin familiarisation in the non-dominant limb followed by dominant limb. These findings are applicable to strength and conditioning practitioners; athletes and coaches.

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