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Championship interseason period did not reduce knee peak moment: A 10-years retrospective study of 467 elite soccer players

Robson Dias Scoz[1], Ricardo Lima Burigo[1], Isabella Christina Ferreira[1], Ana Paula Silveira Ramos[2], André Filipe Teixeira Judice[3], Jose Joao Baltazar Mendes[3], Luciano Maia Alves Ferreira[3], César Ferreira Amorim[1,3,4,5,6]

[1] Master and Doctoral Programs in Physiotherapy, University City of São Paulo (Unicid), SP, Brazil; [2] Physiotherapy Department, University of South Santa Catarina (Unisul), São Jose-SC, Brazil; [3] Laboratory of Physical and Functional Assessment in Physiotherapy (LAFFFi), Interdisciplinary Investigation Center Egas Moniz (CiiEM), Caparica, Portugal; [4] Human Performance Laboratory, Florida International University (FIU), USA; [5] Research Laboratory BioNR, University of Quebec, Saguenay, Canada; [6] Lab Corinthians R9, Sport Club Corinthians Paulista, Sao Paulo, Brazil

Abstract

Study aim: To compare knee moment profiles of professional soccer players from different playing positions before and after an interseason period.

Material and methods: Retrospective study of 467 healthy, professional elite Brazilian soccer players before and after an official championship interseason period during 10-years. Main outcome measures were isokinetic peak moment from knee extensors and flexors from concentric and eccentric contractions. A Two-way ANOVA analysis was used to compare each playing position before and after interseason period.

Results: It was found no statistical difference in Ext.CPT (from $p = 0.11$ to $p = 0.97$), Ext.EPT (from $p = 0.07$ to $p = 0.85$), Flx.CPT (from $p = 0.14$ to $p = 0.90$) or Flx.EPT (from $p = 0.10$ to $p = 0.91$) between End-Season and Pre-Season evaluations for all playing positions (from Goalkeepers, Defenders, Backsiders, Midfielders and Forwards).

Conclusions: Isokinetic peak moment did not have significant differences after an interseason period of 4 to 6 weeks, allowing trainers and coaches to focus their pre-season period on other performance concerns than strengthening.

Keywords: Isokinetic – Strength – Training – Performance – Sport

Introduction

Normative muscle strength data for specific athlete populations are of most importance to sport coaches, athletic trainers, sports physicians, physical therapists, and others health allied professionals who are responsible for an athletes' health and its safe return-to-play [28]. Establishing reference values, or a profile, for muscle strength in soccer, allows comparison of an individual's values to his peers; identifying excessive decrease in strength with consequent reduction in performance [32]. Normative values may also provide a better understanding of normal variation within sports specific function in a team, as power, speed and other variables who are directly or indirectly dependent from muscular strength are important for sports-health professionals who must prepare and recover these athletes for different specific functions and tasks on the field [4, 20].

Isokinetic peak moment (PT) assessment is one of the most commonly applied evaluation methods of muscle strength of the lower extremities in soccer [11, 19, 23, 26]. Some authors even use it as a diagnostic tool for sports injury prevention and rehabilitation [19, 25, 27, 33]. However, little information is available about the decrease of professional soccer players' isokinetic strength after an interseason period of no matches or intensive training. Also, to the best of our knowledge, there is no scientific report about this strength decrease according to players position on the field. Although the existing reports in this area mainly confirm the varied profile of isokinetic strength between players in various positions, some studies have found contradictory results and these differences may affect strength losses differently accordingly each players role. Most importantly, few studies assessed eccentric muscular contractions (an important factor involving muscular injuries in soccer) or included goalkeepers in

Author's address Robson Dias Scoz, Ferreira Lima 238, Florianópolis/SC, Zip 88015420 robsonscoz@icloud.com

the study. Also, to our best knowledge, no study screened more than 120 athletes, limiting statistical power for stablishing normative data [3, 8, 16, 21, 30, 35].

Further studies with larger sample sizes are needed, in order to identify an isokinetic muscle profile in soccer players of the professional elite level, aiming the improvement of training strategies. Therefore, the purpose of the current study was to compare isokinetic Peak Moment profiles of quadriceps and hamstrings, from concentric and eccentric muscle contractions in elite Brazilian soccer players across different field positions before and after the championship interseason period. Our hypothesis is that soccer players from different field positions loose similar muscle strength levels after the interseason period and this decrease wouldn't be significant for a period of 4 to 6 weeks.

Material and methods

Design

This is a retrospective study based on isokinetic data and clinical records from Brazilian professional elite-level soccer players, collected from 2009 to 2019 national championship seasons. The large volume of data produced other similar studies recently published [4, 32] that used the same time period, isokinetic testing protocol, inclusion or exclusion criteria, instruments and variables. The study was carried out according to the Declaration of Helsinki, following the guidelines of The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement [9] and The Improving Healthcare Decisions Task Force (ISPOR Retrospective Databases) [18]. A protocol was fully approved by our University Human Research Ethics Committee with number #3652668.

Participants

It included 612 isokinetic records of elite professional soccer players who had been playing for at least five years on first and second Brazilian League divisions, training regularly one to two sessions per day, six times per week. The same players were evaluated during the last 4 weeks of End-Season period (End-Season Group), and during the first four weeks of Pre-Season period (Pre-Season Group). Comprising a vacation mean period of 4 to 6 weeks, when (under Brazilian law) players receive a paid-leave and are not obliged to follow team's training regime. As a retrospective study, no sample size calculations were required by our Ethics Committee. Demographic information are in Table 1.

To be included in this study, players had to be able to fully participate in team training sessions and match play. Players who had a hamstrings or quadriceps muscular injury in the past 3 months, a knee surgery in the past 12 months, or currently in treatment from other painful musculoskeletal injuries were excluded from our sample. Players with tendon or muscle injury grade I and without symptoms at rest were allowed to participate since they do not report pain levels above designated threshold (see procedures below). Only players who had played in their usual positions for the last year were included in the sample. Players without a Pre-Season or an End-Season evaluation were excluded. After all criteria was applied, 467 evaluations were selected for statistical analysis (45 Goalkeepers, 84 Defenders, 58 Sidebacks, 156 Midfielders, and 124 Forwards).

The purpose, experimental procedures, possible risks and benefits of the study were explained to the athletes, who provided a written informed consent form to confirm participation in the study. For players younger than 18 years, their parents or legal guardians were informed of the risks and signed an informed consent before investigation enrollment.

Table 1. Demographics and anthropometric characteristics of all 467 players, categorized for each playing position, with means and standard deviations (SD)

End-Season	Goalkeepers n = 45	Defenders n = 84	Sidebacks n = 58	Midfielders n = 156	Forwards n = 124	Overall
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Age [years]	25.35 ± 6.02	23.96 ± 5.30	24.38 ± 3.60	25.08 ± 4.64	23.21 ± 3.55	23.88 ± 3.97
Height [cm]	190.28 ± 2.46	185.58 ± 4.20	174.64 ± 4.56	179.37 ± 5.92	178.55 ± 11.66	182.11 ± 7.40
Body mass [kg]	90.22 ± 7.12	80.96 ± 5.20	71.16 ± 5.13	78.56 ± 6.54	77.16 ± 6.78	80.25 ± 7.58
BMI [kg/cm^2]	25.08 ± 1.55	23.57 ± 0.98	23.50 ± 1.88	24.53 ± 2.03	24.41 ± 8.89	24.24 ± 2.78
Pre-Season	Goalkeepers n = 45	Defenders n = 84	Sidebacks n = 58	Midfielders n = 156	Forwards n = 124	Overall
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Age [years]	25.46 ± 5.90	24.01 ± 5.43	24.86 ± 3.77	25.23 ± 4.48	23.43 ± 3.86	24.59 ± 4.57
Height [cm]	190.37 ± 2.48	185.86 ± 4.185	174.59 ± 4.70	179.30 ± 5.92	178.45 ± 10.51	181.71 ± 7.81
Body mass [kg]	89.32 ± 6.100	81.22 ± 4.273	71.84 ± 5.71	77.44 ± 6.79	76.06 ± 7.42	79.18 ± 8.24
BMI [kg/cm^2]	24.69 ± 1.97	23.6 ± 1.15	23.58 ± 1.68	24.07 ± 1.43	24.40 ± 8.32	24.05 ± 2.52

Procedures

Participants were requested to eat according to their team's nutritionist prescribed diet 48 hours preceding the assessment and then refrain from eating and drinking substances other than water one hour before. The tests of the End-Season period were carried out in November; up to four weeks before Brazilian Championship ends. The tests of Pre-Season period were carried out in the first two weeks of January; up to four weeks before Brazilian Championship restarts again. During interseason, a period usually comprised of 4–6 weeks, Brazilian soccer players are usually on vacation as ruled by national labor law. They return to sport formal activity on the first week of January, when they must be present to their respective teams to health screening, like blood tests and medical evaluations.

For data collection were used: an isokinetic dynamometer (Cybex-CSMI, model HumacNorm 2009, Stoughton, Massachusetts, USA) with signal acquisition rate of 500 Hz. To improve participant's test understanding, we used a modified 10-points Borg scale for strength effort [25]; and a visual analogue pain scale (VAS) [30]. For data storage and processing was used a Macbook Pro Notebook (Cupertino, California, USA) equipped with Microsoft Office software package for Mac (version 2011, Redmond, Washington, USA) and Statistical Package for Social Sciences (SPSS) from IBM (Armonk, NY, USA).

Upon arrival, participants were provided with appropriate explanation and demonstration of all procedures. Players informed their playing position, as the most frequently played in the past year. Positional groupings were goalkeepers (G), defenders (D), sidebacks (S), midfielders (M) and forwards (F). Dominant leg was defined as their preferred kicking leg for a penalty kick [4, 32–34]. Anthropometric information was recorded by team's medical staff before players completed a standardized warm-up on the isokinetic machine to minimize error. All players were instructed to refrain from strenuous activities 48 hours before testing.

All subjects were submitted to a testing protocol following the guidelines of APTA – American Physical Therapy Association [1, 13, 15, 22] and soccer-specific studies using isokinetic machines [3, 11, 19]. The same physiotherapist, with 10 years of experience, performed all tests. The isokinetic machine calibration followed manufacturer's manual instructions.

Participants were positioned on the seat of the dynamometer chair with lumbar spine fully supported and hip in 85 degrees of flexion. The knee joint axis of rotation was aligned with the axis of the arm attached to the dynamometer. The dominant leg was tested first. The dynamometer lever arm length was adjusted in order that their contact point (Pad) be positioned one centimeter above the lateral malleolus; allowing free ankle flexion and extension during the test. The subject executed 10 concentric repetitions of knee's extensor and flexors at 90 degrees per second for a 100-degree arc of motion for familiarization and warming up (Borg up to 5, VAS up to 1); following by a rest period of 120 seconds. The warm-up on the isokinetic machine was chosen to improve specificity and familiarization with the following test. The athlete performed five concentric repetitions of knee's extensor and flexors at 60 degrees per second to a second familiarization and warm up, following by another rest period of 120 seconds. Them performed three concentric repetitions of knee's extensors and flexors at 60 degrees per second for a 100-degree arc of motion with maximum effort (Borg 10), receiving standardized verbal encouragement: "Faster." The presence of pain equal or superior to 04 on VAS interrupted the test, canceling it and excluding the subject from sample. To compare our results with other similar studies, the repetition with higher moment value (peak moment) from all three repetitions was used for statistical analysis. Work and Power values were not recorded because of their inter and intra subject variability [11]. Eccentric testing was performed at 60 degrees per second for a 100-degree arc of motion. The subject executed 5 repetitions of warm-up and familiarization followed by 3 repetitions at maximum effort (Borg 10), receiving standardized verbal encouragement: "Hold it." The presence of pain equal or superior to 04 on VAS interrupted the test, canceling it and excluding the subject from sample. Between each set of exercises, subjects had 90 seconds to rest. Between each limb's test, subjects had 120 seconds to rest.

Data analysis

Demographic data as Age, Height, Weight, Dominance, Field Playing Position (Position) were recorded for descriptive analysis [mean ± standard deviation (SD)]. Position was divided accordingly to the most common distribution used by Brazilian's soccer teams: Goalkeepers, Defenders, Sidebacks, Midfielders and Forwards.

Concentric Peak Moment (CPT) and Eccentric Peak Moment (EPT) of knee extensors (Ext) and flexors (Flx) were extracted from the isokinetic machine and normalized by each subject's body weight. From those data, variables were assembled as: Extensor Concentric Peak Moment (Ext.CPT) and Extensor Eccentric Peak Moment (Ext.EPT), Flexor Concentric Peak Moment (Flx.CPT), Flexor Eccentric Peak Moment (Flx.EPT). Peak Moment data were normalized by body mass in kilograms.

Normality of all data was confirmed using visual inspection and the *Kolmogorov-Smirnov* test. Homogeneity of variance was assessed via *Levene's Test*. A two-way analysis of variance (ANOVA) was used to examine for any differences between positions and season periods, applying a *Bonferroni* post-hoc correction when necessary. All data were processed using a SPSS v.20 (IBM, Chicago,

IL, USA) with a level of statistical significance set at alpha level $p < 0.05$. Just as it has been done in similar studies, Partial Eta Square effect sizes may be used to interpret the magnitude of between-groups and between-seasons differences using the following classification: standardized mean differences of 0.2, 0.5, and 0.8 for small, medium, and large effect sizes, respectively [6].

Results

Anthropometric characteristics for all players are provided in Table 1. Results indicated that our sample have significantly differences in weight and height ($p < 0.001$) between all five playing positions; except for Midfielders and Forwards who doesn't show significant differences in height and weight between both groups.

Descriptive analysis from concentric and eccentric contractions, of End-Season and Pre-Season periods, are presented on Table 2. No statistically significant difference in Ext.CPT, Ext.EPT, Flx.CPT or Flx.EPT were found between playing positions or season periods ($p > 0.05$).

The results from inferential analysis are provided in Table 3, showing concentric and eccentric contraction peak moment of extensors and flexors. No statistically significant difference in Ext.CPT, Ext.EPT, Flx.CPT or Flx.EPT were found between season periods ($p > 0.05$). Without significant differences between groups, all effect sizes showed small results (lesser than 0.2) and removed from the tables as they become unnecessary.

Discussion

The aim of this study was to compare isokinetic peak moment profiles of quadriceps and hamstrings, from concentric and eccentric muscle contractions in elite Brazilian soccer players across different field positions before and after an interseason period. Our hypothesis is that soccer players from different field positions loose similar muscle strength levels after the interseason period.

Contradictorily to other published researches [5, 7, 10, 11, 36], no statistically significant difference were found between all playing positions. We believe that, as some studies do not mention it, normalization of raw isokinetic peak moment by body mass was crucial to our results; as a further analysis, of non-normalized data from our sample, revealed significant statistical differences and large effect sizes between all playing positions. Other researchers, however, had similar results to our analysis, showing few small of medium differences between playing positions [35, 37].

Table 2. Descriptive analysis of Concentric and Eccentric isokinetic peak moment of knee flexors and extensors, for each playing position during End-Season and Pre-Season periods, with means and standard deviations (SD) normalized by body mass [kg]

End-Season Group Variables	Goalkeepers	Defenders	Sidebacks	Midfielders	Forwards	Overall
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Knee Extensors						
Ext.CPT	3.07 ± 0.48	3.26 ± 0.52	3.22 ± 0.48	3.05 ± 0.46	3.05 ± 0.43	3.11 ± 0.47
Ext.EPT	3.46 ± 0.62	4.17 ± 0.64	3.82 ± 0.62	3.80 ± 0.81	3.77 ± 0.55	3.85 ± 0.69
Knee Flexors						
Flx.CPT	1.86 ± 0.35	2.00 ± 0.31	1.97 ± 0.25	1.74 ± 0.28	1.98 ± 0.25	1.89 ± 0.32
Flx.EPT	2.09 ± 0.46	2.36 ± 0.38	2.21 ± 0.45	2.13 ± 0.38	2.20 ± 0.33	2.20 ± 0.41
Pre-Season Group Variables	Goalkeepers	Defenders	Sidebacks	Midfielders	Forwards	Overall
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Knee Extensors						
Ext.CPT	3.10 ± 0.50	3.08 ± 0.42	3.23 ± 0.58	3.07 ± 0.52	3.06 ± 0.44	3.09 ± 0.49
Ext.EPT	3.85 ± 0.75	3.98 ± 0.70	3.87 ± 0.77	3.72 ± 0.72	3.76 ± 0.62	3.81 ± 0.70
Knee Flexors						
Flx.CPT	1.84 ± 0.30	1.76 ± 0.29	1.84 ± 0.27	1.81 ± 0.24	1.85 ± 0.26	1.82 ± 0.26
Flx.EPT	2.24 ± 0.51	2.20 ± 0.48	2.17 ± 0.44	2.12 ± 0.35	2.13 ± 0.39	2.16 ± 0.41

Extensor Concentric Peak Moment (Ext.CPT); Extensor Eccentric Peak Moment (Ext.EPT); Extensor Concentric Work (Ext.CW); Extensor Concentric Power (Ext.CJ); Flexor Concentric Peak Moment (Flx.CPT); Flexor Eccentric Peak Moment (Flx.EPT); Values in Newtons (N).

Table 3. Two-way ANOVA inferencial analysis of Concentric and Eccentric peak torque of knee flexors and extensors, for each playing position comparing End-Season and Pre-Season periods

Field Playing Position	Mean Difference End – Pre	SD	Sig.	95% CI		Partial Eta Square
				Lower Bound	Upper Bound	
Concentric Peak Torque Extensor						
Goalkeeper	–0.03	0.18	0.88	–0.39	0.33	0.01
Defender	0.18	0.11	0.11	–0.04	0.40	0.03
Backside	–0.01	0.13	0.94	–0.27	0.25	0.01
Midfielder	–0.02	0.08	0.84	–0.18	0.14	0.02
Forward	0.00	0.09	0.97	–0.19	0.18	0.02
Concentric Peak Torque Flexor						
Goalkeeper	0.02	0.10	0.85	–0.18	0.22	0.01
Defender	0.23	0.06	0.09	0.11	0.36	0.04
Backside	0.14	0.08	0.07	–0.01	0.28	0.05
Midfielder	–0.07	0.05	0.13	–0.16	0.02	0.04
Forward	0.13	0.05	0.10	0.03	0.23	0.05
Eccentric Peak Torque Extensor						
Goalkeeper	–0.39	0.26	0.14	–0.91	0.13	0.05
Defender	0.19	0.16	0.24	–0.13	0.50	0.02
Backside	–0.05	0.19	0.81	–0.42	0.33	0.01
Midfielder	0.08	0.12	0.49	–0.15	0.31	0.02
Forward	0.02	0.13	0.90	–0.25	0.28	0.01
Eccentric Peak Torque Flexor						
Goalkeeper	–0.15	0.16	0.32	–0.46	0.15	0.02
Defender	0.16	0.09	0.10	–0.03	0.34	0.04
Backside	0.05	0.11	0.69	–0.18	0.27	0.03
Midfielder	0.01	0.07	0.91	–0.13	0.14	0.01
Forward	0.06	0.08	0.43	–0.09	0.22	0.02

Sig.: Statistical Significance ($p < 0.05$); CI: Confidence Interval of 95%; SD: Standard Deviation.

To the best of our knowledge, this is the first study analyzing isokinetic peak moment of professional soccer players after an interseason championship period. Studies concerning other performance and metabolic markers in soccer players were found, but did not use isokinetic evaluation [2, 13, 14]. These researches and systematic reviews agree that after a detraining period of four to six weeks, sports performance decrease in soccer players; contradictory to our findings. Although, it must be highlighted that these studies used functional and field tests, like running or jumping. These activities use a combination of skeletal muscles, different than an isokinetic test, which isolate one muscle group with the objective to remove bias.

Limitations

Unfortunately, standardization of playing positions between different soccer leagues are difficult, as Sidebacks could be considered Defenders, or Forwards could be divided in Strikers and Forwards. Also, standardization of players training regime during their vacation period is difficult. Despite this, sports medicine professionals may use these findings as reference values to guide their clinical and training regime decisions. Also, we did not perform subgroup analysis of 4, 5 and 6 vacation weeks separately as the teams' records did not have this level of precision. Finally, it was considered that during this interseason period (a formal vacation period by Brazilian work law) athletes were not engaged on formal training regime. However, some athletes employ personal trainers or follow their team's coach regular training regime. A recent study of our group [34], found that this strategy was used during COVID-19 lockdown regime by some teams with different results.

Conclusions

Isokinetic peak moment, from concentric and eccentric contractions, of knee extensor and flexors, do not have statistically significant differences between playing positions before or after an interseason period of 4 to 6 weeks, in healthy professional elite-level, Brazilian soccer players. This is strategically important to coaches, trainers and physical therapists as strengthening approaches are imperative at the beginning of a season competition; however, as our results have demonstrated, no strengthening reduction was detected for this period of time. Thus, allowing coaches, trainers and physical therapists to focus their attention on other training strategies and on strengthening programs. This can optimize the short period of training just prior to championship start.

Conflict of interest: Authors state no conflict of interest.

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