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GENDER DIFFERENCES ON LOWER LIMB COORDINATION DURING ELITE PLAYERS JUMP

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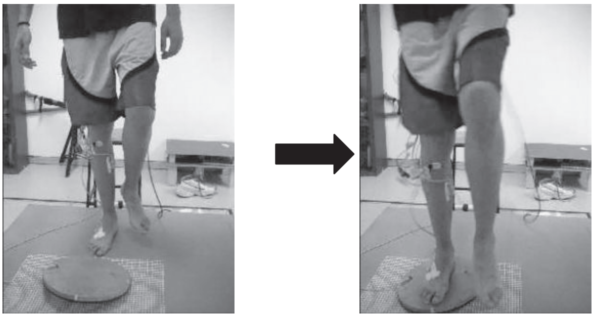
The results from an experimental analysis of the jump in basketball female and male players are presented. Coordination of seventeen lower limb is analyzed in a high risk movement frequently performed by athletes during jump It is showed that on the sample studied several differences on relative phase are found entailing particularly transverse movement plane of knee. These results show that during some core moments of the jump, gender can influence the lower limb joint coordination. The comparison of relative phase shows a female propensity for moving in less synergy on jump reception. Such findings highlight the need for including on preparation program of athletes a prevention plan that is not necessarily identical on both genders.

KEY WORDS: motor behaviour, basketball athletes, injury.

INTRODUCTION: The lower extremity mechanics found in both gender landing strategies during a jump has been identified as potential injury cause (Huston, Vibert, Ashton-Miller, & Wojtys, 2001; Russell, Palmieri, Zinder, & Ingersoll, 2006). Ankle and knee are most injured joints on several sports and particularly on basketball. Apparently one of the protective mechanisms against injury depends on the capacity that a structure (joint, muscle etc.) has to carry out motor behaviour that contradicts the injury load it is subject to during movement. Some of these mechanisms depend on the ability to create an adjusted motor response, like for instance, interlimb coordination (Bullock-Saxton, Janda, & Bullock, 1994; Hamill, vanEmmerik, Heiderscheit, & Li, 1999). The aim of this study is to identify motor behaviour variables that distinguish athletes based on gender.

METHODS: Experimental development takes place in the laboratory, analysing lower leg motor behaviour, especially the ankle and knee, when subjected to an injury load, reproduced by jumping onto an unstable surface.
Seven female and ten male elite basketball players' lower limbs were analyzed during jump on barefoot. The inclusion criteria were absence of symptoms in lower limb evaluated and having at least three years of basketball experience. All subjects with any type of injury on lower limb evaluated, during the preceding two months, or persistence of symptoms from a prior injury longer than two months or with symptoms in either lower limb or any other anatomical region were excluded.
The experimental device consisted of a unipodal jump onto an unstable surface, the round Freeman board. This board permits movements in all directions, but the amplitude is controlled, never exceeding 20º. The choice of task was based on prior identification of the most frequent injury mechanism in Portuguese basketball. Landing on another player's foot represents a temporarily unstable surface, which is a movement constraint that facilitates loss of balance and moments during which there are forces that are difficult for the anatomical structures and the rest of the body to recover from. Lower limb injuries result from a dynamic movement that is initiated by the athlete – jumping – and although they can be

influenced by external factors that facilitate moments of excessive force, they normally occur when the athlete is in movement. These facts moulded the task chosen, so that it represented as closely as possible, albeit artificially and in a safe environment, the most frequent injury mechanism in basketball players, and allowed movement analysis.
The task entailed a series of 5 jumps in unipodal stance. The jumps were carried out barefoot, from a stable surface onto an unstable surface. The unstable surface was comprised of a circular Freeman board, placed 30 cm anterior to the athlete. The board had a central circle drawn on it indicating where the athlete should land, to make sure the experimental procedure was identical among all athletes. Before each jump the board was balanced so that the support surface was a sagittal line running from the centre of the board to point closest to the athlete. All athletes were allowed 3 practice jumps prior to executing the task. The jumps were carried out in a square space measuring 100 x 100 x 15 cm (wooden floorboards) that allowed the task to be carried out in a safe environment. To eliminate a learning effect alternate evaluation of the right and left lower limb was performed. In order to reproduce the natural movement of an athlete on court as much as possible athletes were instructed to jump as naturally as possible, using a strong impulsion moment and to land on the circle in the centre of the board. After landing on the board they should balance themselves in unipodal stance. Before the jumps, to try and increase athlete motivation and achieve more exact reproduction of on-court performance, athletes were instructed to imagine that the jumps were for defending their basket, at a decisive moment in the game that would lead to victory for their team. Figure 1 a) and b) illustrate the experimental task.



a) b)

Figure 1: a) and b) – Experimental task performed by athletes: front view

During the latter 5 jumps performed by athletes (each athlete jumped a total of 8 times) 3D kinematic data was recorded using an electromagnetic tracking device (100 Hz) with 3 sensors located in each lower limb segment (foot, shank and thigh). The extent of segments synchronization in motion (continuous relative phase: φ) was calculated for ankle and knee joints (Stergiou, 2004). Data was analyzed with regards to jump phase, based on movement analysis. Angular displacements and velocities were time normalized. The phase portraits (angular position versus angular velocity) for both segments were calculated (Kurz & Stergiou, 2002) in accordance with movement freedom degrees allowed in each joint: Knee Flexion *vs* angular velocity, Knee Rotation *vs* angular velocity; Foot Flexion *v*s angular velocity, Foot Inversion *vs* angular velocity, Foot Abduction *vs* angular velocity. Continuous relative phase was defined as the difference between the phase angles of two segment motions throughout every phase [Φ = Φ distal segment (t) – Φ proximal segment (t)] where Φ segment (t) = tan-1 (d θ segment / d(t)). The transition between phases depended on the foot's movements on the frontal axis (dorsal and plantar flexion). In this model phase 1 refers to movement preparation (preparatory phase), starts with the beginning of ankle dorsal flexion (P1), and finishes with maximum ankle dorsal flexion (P2). Phase 2 starts with the beginning of plantar flexion (P2) and finishes with maximum flexion (P3), representing all jump impulsion that takes place with the foot still on the floor. Phases 3 and 4 are sub-divisions of the flight phase – initial and final. To start phase 3 the ankle reverses plantar

flexion (P3) and to start phase 4 there is a moment of dorsal flexion (P4) in preparation for landing (P5) which reflects the moment the foot contacts the board.
Relative phase values of the two groups (women vs. men) were compared with T-test, using SPSS 17 for Windows. Significance level was set at α = 0.05.

RESULTS: In order to learn about the coordination occurred on several movement planes of motion we analyzed all the possible combinations between the ankle and the knee. That analysis was performed separately in each phase and results of the continuous relative phase mean value are shown on the table 1.

Table 1
ϕ values during the jump

		Phase							
		preparatory		push-off		ascending flying		descending flying	
		Mean	sd	Mean	sd	Mean	sd	Mean	sd
ϕ Footflex-Kneeflex	Fem (7)	-0,05	0,88	-0,09	0,98	-0,92	1,61	1,28	1,97
	Male (10)	-0,09	0,98	0,63	1,35	-0,82	1,86	1,23	2,02
	p	0,13		0,09		0,44		0,69	
ϕ Footflex-KneeRot	Fem (7)	0,68	1,61	0,55	1,58	-1,10	1,82	0,82	1,99
	Male (10)	0,55	1,58	-0,31	1,81	-0,92	1,76	0,51	1,92
	p	0,00		0,09		0,18		0,03	
ϕ FootInv-Kneeflex	Fem (7)	-0,57	1,46	-0,62	1,47	-0,06	2,07	1,02	1,88
	Male (10)	-0,62	1,47	1,18	1,61	-0,32	1,94	1,09	1,92
	p	0,31		0,02		0,94		0,60	
ϕ FootInv-KneeRot	Fem (7)	0,16	1,80	0,03	1,82	-0,24	2,05	0,56	1,95
	Male (10)	0,03	1,82	0,24	1,81	-0,41	1,77	0,37	1,90
	p	0,16		0,01		0,23		0,19	
ϕ FootAbd-Kneeflex	Fem (7)	-0,78	1,51	-0,69	1,42	0,06	2,21	1,12	1,94
	Male (10)	-0,69	1,42	0,88	1,76	-0,15	2,18	1,04	1,91
	p	0,02		0,00		0,20		0,59	
ϕ FootAbd -KneeRot	Fem (7)	-0,05	1,80	-0,04	1,75	-0,11	2,12	0,65	1,97
	Male (10)	-0,04	1,75	-0,06	2,03	-0,24	1,96	0,33	1,96
	p	0,83		0,00		0,40		0,02	
ϕ FootAbd -FootInv	Fem (7)	-0,21	1,63	-0,07	1,74	0,13	1,91	0,10	1,55
	Male (10)	-0,07	1,74	-0,30	1,71	0,17	1,68	-0,05	1,76
	p	0,00		0,00		0,74		0,23	
ϕ FootFlex -FootAbd	Fem (7)	0,73	1,55	0,59	1,50	-0,99	1,88	0,16	1,51
	Male (10)	0,59	1,50	-0,25	1,64	-0,68	1,73	0,18	1,72
	p	0,00		0,00		0,02		0,87	
ϕ FootFlex -FootInv	Fem (7)	0,52	1,47	0,52	1,57	-0,86	1,72	0,26	1,64
	Male (10)	0,52	1,57	-0,55	1,58	-0,50	1,53	0,13	1,48
	p	0,96		0,34		0,00		0,26	

DISCUSSION: The purpose of this study was to compare relative phase values between women and men during a self started jump.
We notice the great variability of the results seen on both groups of basketball players: female and male. High variability was found by James et al (James, Dufek, & Bates, 2000) that considered joint moment variability possibly indicating a relationship with overuse injuries. In this case, athletes belong to national teams and data collecting was performed on the end of the competition season which corresponds to a period where the fatigue is usually great. This could contribute to the elevated variability found on relative phase values for men and women.
Although all jump phases were analyzed, push off and landing phases can be considered the most important ones when talking about injury during the jump. During push off phase

muscle is more leaning to injury. The same happens to joint and ligaments during the landing phase. On the push off phase which is the one where more significant differences are found, it is verified that with exception of ϕ FootInv-KneeRot, ϕ FootAbd-KneeRot and ϕ FootFlex-footAbd, female and male have an opposed coordination pattern. In other words, the movement on the sagittal plane is performed in an opposed manner between women and men when they push off for the jump. Most of the times when is the foot is ahead the knee in the phase space for men, the opposing happens with women that show the knee ahead the foot for the same movement.
On the landing phase, that can be considered the most dangerous one for lower limb injury, we find significant differences on relative phase of ankle and knee always when movement on knee transverse plane (rotation) is present, with greater value for female. During this phase whenever knee rotation is present, women have greater dificulty on synchronizing lower limb movements in order to prepare for landing. This aspect can lead them to a less prepared for suport limb and possibly to the injury. In the landing phase, a subject's energy is transformed from potential to kinetic energy. The movements involved on the landing technique should dissipate these forces (Devita & Skelly, 1992).
This difference in inter joint coordination could lead the athlete to a less efficient and more dangerous movement on this usual task also because with less synergy it becomes more difficult to control movement and correct errors ocurring during movent (Latash, Scholz, & Schoner, 2002) and could possible explain some differences on lower limb injury risk between women and men.

CONCLUSION: These results show that during some core moments of the jump gender can influence the lower limb joint coordination. The analysis of relative phase shows a significant difference in coordination particularly when knee rotation is present with a female propensity for moving in less synergy on jump reception. Such findings highlight the need for including on preparation program of athletes a prevention plan that is not necessarily identical on both genders.

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