INFLUENCE OF AGEING ON PERFORMANCE DURING DYNAMIC MOVEMENT: COMPARISON OF YOUNG AND ELDERLY SUBJECTS.

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INTRODUCTION

To our knowledge, very few studies have focussed on lower limb coordination alterations during dynamic movement in the elderly [1]. As people get older, the muscle strength and torque produced during muscle contraction tends to decrease. Motor coordination is driven by the natural tendency of dynamic systems to achieve stable low-energy configurations and adaptations of musculo-articular capacity. This muscular weakness may be caused by an age-related reduction in number of muscle fibres in the cross-sectional areas of muscle or decrease of voluntary activation [2]. Maximal vertical jump height is related to the ability of a subject to generate maximal work during the push-off phase and to produce maximal force at the peripheric system in a short lap of time. This assessment is commonly used to determine changes in muscle performance in the lower limb due to strength and conditioning and/or physiotherapeutic interventions. Most of the everyday tasks and recreational activities require a physiological capacity to perform and adapt specific patterns of interjoint coordination [3].

Therefore this study aimed to identify the ageing modifications in lower limbs during dynamic motion, and the relationship between some metabolic parameters related to the current level activity and kinematic and dynamic experimental data.

METHODS

Twenty one healthy and physically active elderly subjects (mean ± SD ; 74.31 years ± 4.7, 79.78 kg ± 10.2, 1.7m ± 0.046) and eighteen young men (21.9 years ± 2.8, 70.19 kg ± 9.5, 1.78 m ± 0.05) volunteered to participate in this study. All subjects subsequently performed three maximal SJ on an AMTI force plate sampled at 1200Hz, after a 5 min of warm up session. Subjects were simultaneously filmed in a sagittal plane using a 100 Hz (Ueye, IDS UI-2220SE-M-GL) camcorder. Landmarks were located on the left fifth metatarsophalangeal, lateral malleolus, lateral femoral epicondyle, greater trochanter and acromion. From the digitalization of the landmarks' center, a four rigid segments model (foot, shank, thigh and upper body, i.e. head, arms and trunk: HAT) was obtained.

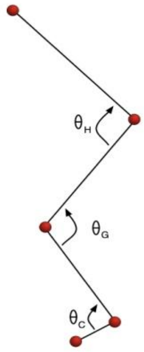

Figure 1: Joint angles convention : Hip (θ_H), Knee (θ_G), and Ankle (θ_A),

Joint coordination was assessed through the sequential order and the timing of the start of joint extensions. The jump height (Hmax) was calculated from the difference between the height of the CG at the apex of the jump and its height when subject was standing upright. Only the push-off of the highest jump was selected for the study. The metabolic parameter were assessed through VO_{2max} (ml/min/kg) and daily energy expenditure (METs), estimated from a validated questionnary (PAQAP) [4]. All tests were statistically analysed with a paired student's t-test (two-tailed). All analyses were executed using the "R commander package" software (R.2.7.2., R Foundation for Statistical Computing, Vienna, Austria). The level of significance for all tests was set at $p < 0.05$.

RESULTS AND DISCUSSION

Vertical Jump (VJ) heights ranged from 0.12 to 0.29 m in elderly and from 0.35 to 0.51 m in young men. The elderly jumped on average 0.216 m lower than young men ($p < 0.001$). The total duration of the push-off phase was significantly ($p < 0.01$) longer in elderly (0.427 ± 0.07s) than in young men (0.354 ± 0.07s).

Initial hip and ankle joint angles were similar between young and elderly, while elderly flexed more the knee joint ($p < 0.01$) (table 1) At take-off, in comparison to the young men, elderly subjects were significantly less extended for all the lower-limb joints, $p=0.007$ for hip, $p=0.0001$ for knee and $p=0.003$ for ankle joints. Moreover in the elderly, the range of motions (RoM) during the push of phase were similar for the hip and knee joints. Ankle RoM was significantly lower for the elderly compared to the young men (*p=0.009*). Besides, vertical peak force (PF)(young, 254.65 ± 15.64 $N.BW^{-1}$; elderly 171,62 ± 19.89 $N.BW^{-1}$). and average rate of force development (ARFD) (young, 4375.9 ± 1255.3 $N.s^{-1}$; elderly 2725.6 ± 1627.1 $N.s^{-1}$) values were significantly lower for elderly than young. Also, vertical peak force had tendency to correlated to vertical jump height (r=0.432 *p=0.0505).* Estimated VO_{2max} tended to be correlated to the jump height and to the vertical peak force (r=0.4247, p=0.054; r=0.4132, p=0.062, respectively).

From our results, it can be noticed that ageing altered the motor performance in dynamic movement, the jump height being decreased in elderly. This performance impairment is related to the decrease of the peak vertical force, pointing out the weakness of the muscular strength and the difficulty of the elderly to generate explosive strength. A reduction in size and number of type II muscles and motor units activation due to sarcopenia could explain this change [5]. At the same time, an increase of the push-off duration is observed and could be the result of a "compensatory" strategy to the lack of muscular strength.
Contrary to the younger subjects, the seniors presented a joints start extension sequence characterized by a simultaneous hip and knee joints extension, preceding the ankle one. This particular joints sequence highlighted the fact that the older subjects may favoured the contribution of distal joints and may minimized the contribution of proximal ones. This jump strategy could be used in order to decrease energetic cost of this movement.
Additionally, the capacities of adaptation of joints start extension sequence movement seemed to be correlated with the level of daily activity. Indeed, the conservation of an energy status (estimated VO_{2max} and level of daily energy expenditure) in the elderly is related to the conservation of motor performances and joint adaptations.

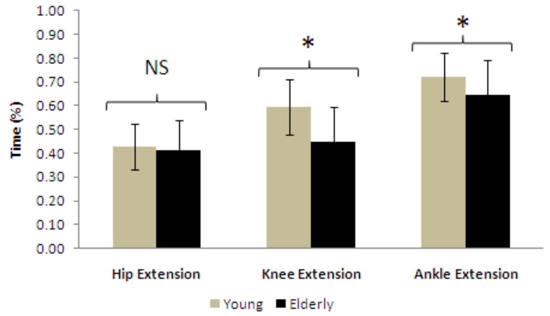

Figure 1: Mean and standard deviation values for the instant of hip, knee and ankle starting extension during the push-off phase. **p<0.05*

CONCLUSIONS

These first results are the initial findings of a more complete study including a dynamic and electromyographic examination of the effects of the ageing on an explosive movement, in order to get a better understanding of this process.

Table 1: Mean and standard deviation values of initial angles (t=0), take-off angles and range of motion of the hip, knee and ankle for elderly and young men. **p<0.05, **p<0.01, ***p<0.001*

	Elderly		Young	
	mean	SD	mean	SD
Range of Motion				
θ_H (rad)	1.31	0.34	1.44	0.23
θ_G (rad)	1.28	0.2	1.26	0.14
θ_C (rad)	0.83*	0.15	0.96*	0.15
At t=0				
θ_H (rad)	1.49	0.28	1.49	0.25
θ_G (rad)	1.61*	0.18	1.75*	0.14
θ_C (rad)	1.54	0.11	1.53	0.12
At takeoff				
θ_H (rad)	2.81**	0.15	2.93**	0.07
θ_G (rad)	2.88***	0.11	3.01***	0.12
θ_C (rad)	2.37**	0.11	2.49**	0.12

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