Do people with mental impairment present jumping gain during drop jumps from various dropping heights?

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Abstract:

The purpose of this study was to examine the possible jumping gain when drop jumping from various dropping heights in people with mental impairment. For this purpose, 11 adults with mental impairment participated in this study. Participants performed drop jumps on a force plate from three dropping heights that represented 75%, 100% and 150 % of the maximum squat jump height. The following parameters were analyzed: Jumping height, contact time and vertical Ground Reaction Force. One-way analysis of variance with repeated measures was used for the statistical analysis. The obtained results showed that the different dropping height did not affect all the examined parameters. Additionally, all drop jump heights did not exceed the squat jump height. In conclusion, it seems that adult people with mental impairment were not able to procure jumping gain at the examined dropping heights. This finding requires further research concerning the mechanisms lagging behind this phenomenon.

Key words: Mental impairment, drop jump, contact time, ground reaction force.

Introduction

Stretch-shortening cycle (SSC) is a complex movement where the muscle tendon unit (MTU) is initially stretched and afterwards is contracted concentrically. SSC causes an initial storage of elastic energy on the elastic tissue which is recoiled during the concentric phase causing thus an enhancement in the performance (Bosco, Komi, & Ito, 1981; Bosco, Tihanyi, Komi, Fekele, & Apor, 1982). SSC is characteristic for action like the drop jump (DJ) which is a very common task and training modality in various organized sport activities. Relevant studies (Komi & Bosco, 1978) have showed that jumping height of a DJ is in many cases higher than a squat jump (SJ). This difference is called jump gain (JG) and is depended on several factors such as MTU stiffness, preactivation, agonist activity and stretch reflex (Taube, Leukel, & Gollhofer, 2012). Additionally, among these factors, JG depends on the dropping height (DH). It has been found that that up to a certain DH, jumping height is increased, then it is stabilized and from a certain DH upwards it is gradually decreased (Komi & Bosco, 1978; Voight, Simonsen, Dyhre-Poulsen, & Klausen, 1995) due to various peripheral and central inhibitory factors (Leukel, Taube, Gruber, Hodapp, & Gollhofer, 2008). Moreover, JG is also depended on performance level, gender and age (Komi & Bosco, 1978; Bosco, & Komi, 1980; Horita, Komi, Hamalainen, & Avela, 2003). Specifically, it has been reported that women achieve JG in lower DH than men (Komi & Bosco, 1978; Bosco & Komi, 1980), while athletes achieved JG in higher DH than untrained persons. Additionally children do not present any JG from various DJ (Bassa, Patikas, Panagiotidou, Papadopoulou, Pylaniadis, & Kotzamanidis, 2012; Lazardis, Bassa, Patikas, Hatzikotoulas, Lazaridis, & Kotzamanidis, 2013).

The research related with people with mental impairment (MI) is not extensive. Generally speaking, MI have a deficit compared to typical population for fitness parameters such as strength and motor skill (LeClair, Pollock, & Elliott, 1993; Vuijk, Hartman, Scherder, & Visscher, 2010). This has been attributed to a failure of central drive (Haier, Jungb, Yeoc, Head, & Alkired, 2004; Yu, Li, Liu, Qin, Li, Shu, N., et al. 2008) and to environmental parameters such as inactivity (Horvat & Franklin, 2001). The majority of studies regarding jumping performance are related with horizontal jumping (Skowronski, Horvat, Nocera, Roswal, & Croce, 2009). Nevertheless, few studies have addressed vertical jumping in MI (Hassani, Kotzamanidou, Fotiadou, Patikas, Evagelinou, & Sakadami, 2013; Hassani, Kotzamanidou, Tsimaras, Lazaridis, Kotzamanidis, & Patikas, 2014). These studies found that the jumping deficit in MI could be attributed to parameters such as lower power, poorer coordination, lower agonist activity, lower stiffness and to a higher antagonist activity.

According to our best knowledge, there are no studies which investigated the possible JG from various DH in MI. This fact is very important considering that plyometric training is gradually involved in MI (Harries,

Lubans, & Callister, 2012; Johnson, Salzberg, & Stevenson, 2011). Due to the above, the selection of DH in plyometric exercises for PMI seems to be a crucial question. Thus, the purpose of this study was to investigate the JG after various DH in MI.

Method

Participants

Eleven ($n = 11$) adult males with MI participated voluntarily in this study (Height: 173.7 ± 14.4 cm, Body mass: 73.7 ± 19.3 kg, Age: 25.9 ± 6.5 yrs). The intelligence quotient in the MI group was 54.6 ± 11.2 , as estimated by Wisk III test.

No neurological deficit and injuries history that could influence lower extremity performance was reported by the participants. Before testing, the participants were familiarized with the laboratory environment. They read and signed a written informed consent statement. The participants were asked to have no exercise activity for 48 h before the study. The experimental procedures were performed according to the Ethics Committee of the Aristotle University Thessaloniki, Greece.

Experimental Procedure

During their visit, participants were informed verbally about the experimental procedure. Before testing the anthropometric characteristics (body height and mass) were collected. Afterwards, the participants performed a general warm up in which included 5 min pedaling with a self-selected pace on a cycle-ergometer and warming up exercises for lower and upper body segments, followed by a specific warm up, which included sub-maximal squat jumps (SJ) and DJ with increasing intensity. Before the final assessment, three maximal SJ and DJ for each selected DH were performed for familiarization. DH was defined to correspond to 75%, 100% and 150 % of the maximum squat jump height. After that, three extra jumps were performed for all selected jumping tests randomly. The best trial based on jumping height was collected for further evaluation. The interval between tasks was 3 min to avoid any fatigue effect. During the test, no verbal motivation or any kind of feedback about their performance was provided. In many cases, more trials were given when the trial was not performed according to the instructions. In specific, participants were instructed to jump as high as possible, with their hands placed on their hips.

Instruments and testing

Vertical ground reaction forces (vGRF) were recorded with a ground mounted 40×60 cm force plate (Bertec Type 4060, Bertec Corporation, Columbus OH, USA). For the SJ test, the participants were positioned on the force plate with their knees flexed slowly at a self-selected knee joint angle. They stayed at this position for approximately 2 s before jumping.

The DJ test was performed as follows: participants stood on the box, which was placed approximately 8 cm behind of the force plate box. DJ started by projecting slowly one foot forward, while the other left the box without pushing upwards or forwards, aiming to land with both feet on the force plate and to immediately execute a vertical jump.

Data analysis

After recording, data were further analyzed using Matlab 6.1 scripts (The Math Works Inc., Natick, MA). Jump height was estimated taking into account the impulse which was recorded from the vGRF–time curve. Only the best trial in jump height was further analyzed.

The following parameters were evaluated:

- Contact time during the braking and propulsive phases. It was defined is the period between the initial and last 10 Nt of the GRF
- Jump height.
- Peak vGRF.

Statistical Analysis

For the statistical analysis, the Statistica 8.0 software (StatSoft Inc., Tulsa, OK) was used. The dependent variables were the jump height, the contact time and the vGRF. One-way analysis of variance with repeated measures was used to examine the effect of three different DH (75%, 100% and 125%). A post hoc analysis was conducted using the Tukey test. Statistical significance was set at $p < 0.05$.

Results

Results revealed that the increment of the DH did not alter any of the dependent variables (Fig. 1, Fig. 2, Fig. 3). In detail, no statistically significant effect of the three different DH on jump height, contact time and vGRF were found ($p > 0.05$). Additionally, no DJ height exceeded the jump height of the SJ, since DJ heights were significantly lower than squat jump height.

Fig 1. *Jumping Gain* developed during jumping from various jumping heights

Fig. 2. *Contact* developed during jumping from various jumping heights

Fig. 3. *GRF* developed during jumping from various jumping heights

Discussion

The obtained results indicated that no gain in jumping height was observed in MI dropping from various normalized jumps. Further analysis of the obtained results revealed a tendency for contact time to decrease while vGRF to increase in parallel to DH increase.

Relevant studies in this field have shown that both contact time and vGRF to decrease and increase respectively jumping from various dropping heights (Hoffren, Ishikawa, & Komi, 2007). In our study, these parameters followed the same pattern than the differences were not significant. This case is observed sometimes, when specific population such the elderly people participates in jumping activities (Hoffren et al 2007). The only

relevant data related with contact time and vGRF during jumping are coming from CMJ (Hasani et al 2014) where contact time was longer while normalized vGRF was higher in people with MI compared to normal ones.

No jumping gain (JG) was observed after jumping from the selected jumping heights. No comparable data exist for this case related with people with MI. This case has been observed in some cases in healthy adult people, where no differences were noted in jumping heights after dropping from various DH. For example, Bobbert, Huijing, and van Ingen Schenau (1987) observed no JG when male adults performed drop jumping from 20, 40, and 60 cm. Furthermore, Quatman, Quatman, and Hewett, (2009) did not observe any JG when young female basketball players executed DJ from 15, 35 and 45 cm. No jumping gain was also observed in children jumping from 10 up to 50 cm (Bassa et al 2012). However, there is strong evidence and widely accepted that JG up to a certain DH level, increases and then it is stabilized in trained and untrained adults (Komi & Bosco, 1978; Voigt et al., 1995). So this study indicates that for JG history in people with MI further research is necessary, possibly with higher number of participants.

The above mentioned studies (Bobbert et al., 1987; Quatman et al., 1987; Bassa et al 2012) cannot provide explanation for the obtained data regarding JG, because in the current study we used DH normalized to maximal squat jump heights while they did not. Possibly the non existence of JG could be explained on the peculiarities related with people with MI during jumping. Generally speaking people with MI present a deficit in all types of jumping (Skowronski et al 2009, Hasani et al 2013,14). The only relevant study which examined a similar case giving thus an indirect support to the current study is the one by Hassani et al. (2014), where the vertical countermovement jump examined in young adolescent MR. Our assumption is based on the fact that both DJ and counter movement jump are classified into the group of SSC jumps, where muscle activation, storage and recoil of elastic energy and stiffness regulation occur (Kurokawa, Fukunaga, Nagano, & Fukushima, 2003). In the Hassani et al. (2014) study, it was observed that junior MI presented lower countermovement jump height, while they developed lower muscle activation, power and stiffness. Estimating the importance of the above mentioned neuromuscular and mechanical parameters for DJ as well (Horita et al 2003) we could suggest that the above mentioned information may offer a partial support for the obtained JG data of the current study. However the most important finding in the Hasani et al. (2014) study was that the MI group presented a non-immature jumping style. Specifically, MI adopted the immature style of jumping which was observed by Wang, Lin & Huang (2004), in 6 year old children. Specifically, during the braking phase MI people, as children, bent in a lower extend and develop lower angular velocity in their knee joint. This means for people adopting this style that their MTU cannot store and recoil the appropriate elastic energy, since from one side they did not stretch in the appropriate distance their MTU and from the other side they did not develop possibly the appropriate optimal joint velocity in their knee joint. Thus another explanation for the obtained data could be learning factors as well. It is important also to mention that the selected people with MI did not follow any specific program including jumping tasks. However further study is important to identify the mechanisms which could explain the non JG in people with MR.

Conclusion

People with MI do not present any jumping gain, jumping from various jumping heights and this could be attributed to neuromuscular and learning factors. Furthermore this study indicates further research discovering mechanisms explaining this phenomenon.

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