Differences in vertical jumping performance between untrained males and advanced Greek judokas

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B Data Collection
C Statistical Analysis
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Abstract

Background and Study Aim: Judo is categorized among events which develop apart from technical aspects many physical abilities such as explosive strength, speed and co-ordination. One representative task which involves the above mentioned abilities when performed from any athlete is the vertical jump. Purpose of this paper is to answer the question: if there are differences between untrained young males and advanced level Greek judo athletes in jumping ability in four different vertical jumping tasks.

Material/Methods: Twenty male [(10 untrained/10 advanced ones), mean age: 19.4±1.6 years/ 17.3±1.2 years respectively] performed squat jumps, countermovement jumps and drop jumps from 20 and 40 cm height (DJ20 and DJ40, respectively). Kinetic data for further analysis were collected by a ground mounted 40×60 cm force plate.

Results: Advanced young judokas presented higher scores in all examined jumping tasks compared to untrained ones, revealed shorter duration of examined contact times of all tasks and as a result better utilisation of stretch-shortening cycle mechanism. Total neuromuscular activation that adopt judokas reveals a more mature and skill dependent strategy compared to untrained ones.

Conclusions: Vertical jump does not characterizes from a technical point of view a judo athlete but it seems that performance in vertical jumping tasks is affected by the participation and years habituation to ballistic and explosive strength training. Judo specific training in advanced-level judokas improves and induces specific neuromuscular alterations as well as performance in various jumping tasks.

Key words: judo • jump • stretch-shortening cycle • martial arts • combat sports

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Background

Maximizing jumping performance during a task involves a complex movement sequence, which requires an optimal interlimb coordination of lower limbs. This actually indicates an efficient energy transfer across the involved joints during the jumping [1–5]. Throw techniques are a dominant factor in the complex fighting movements of judo. The effective development of throw techniques is an important technical factor and marks a significant part of judo training and performance. Competitive judo is described as a multi-joint and of high intensity task in which the specific throwing techniques during a match require good physical fitness [6–8]. Explosiveness and

Judo – an educational system established by Kano which in fact means the "gentle way", but for the purposes of article is referring to the competitive martial art event called Judo.

Jump – A multi-joint movement of lower extremities mainly task, which raises the centre of gravity and in fact the whole body from the level of surface, vertically or horizontally.

Stretch-shortening cycle – A mechanism involving an eccentric contraction of muscles before the concentric one.

Martial arts – Systems including physical practises and elements from ancient combats created for self-defending purposes and in nowadays for competitive conditions.

Combat sports – Competitive sports between two participants who fight one each other with restricted rules or even without ones and with the aim of winning a match or event.

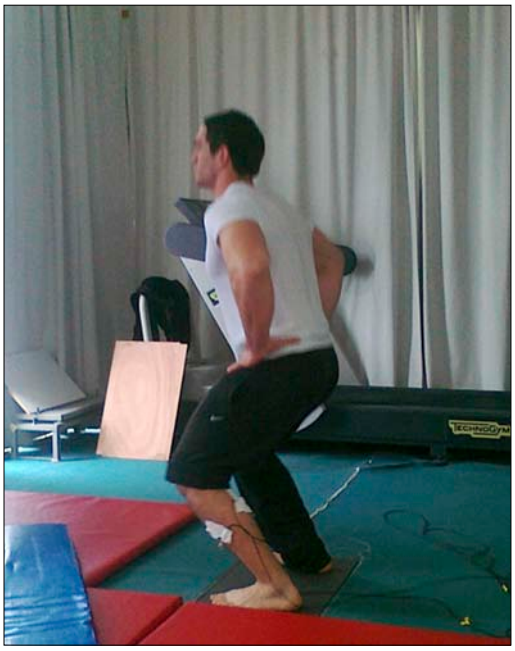

Figure 1. A representative judo athlete during the execution of SJ task.

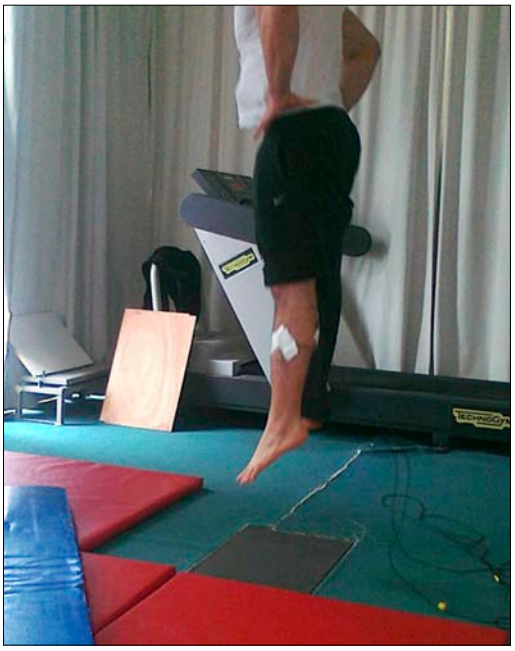

Figure 2. A representative judo athlete during the execution of SJ task.

power-endurance capacities have a central importance among the fitness capacities governing judo training and competition [9,10]. Power-endurance capacities are distinguished by their intensity and near maximal exertion over a certain period (e.g., movement sequences of 10 to 20 seconds), and by the ability to repeat this maximal performance several times during a bout [11]. In addition to this, judo is a martial art classified among those specialties requiring high technical skills along with execution of main technical actions as fast as possible [8,12]. So, it would be interesting to study secondary ballistic and explosive movements such as vertical jumping tasks from a neuromuscular point of view and to give information about the potential different neuromuscular activity patterns adopted as a result of different training level and status.

Material and Methods

Twenty male (10 untrained, 10 advanced level Greek Judokas) participated in this study. Young untrained were 17–21 years old (age 19.4±1.6 years, body mass 72.9±9.6 kg, body height 1.77±0.04 m) and judokas were 16–18 years old (age 17.3±1.2 years, body mass 81.5±1.4 kg, body height 1.76±0.05 m). Judo athletes participated in this study had at least 3 years of national competition experience and in addition to this had international one (participation to Greek National Team). Before testing, all participants read and signed a written informed consent statement. This study met the standards of the local ethics committee on human research in accordance with the Declaration of Helsinki.

Initially, the investigator who assessed all evaluations collected the anthropometric data that are required for ground reaction force normalization. After collecting the anthropometric data the participants were warmed-up for 15 minutes (walking/running on treadmill, hopping/jumping, and performed various warm-up exercises for the trunk and lower limbs. We avoided doing more familiarization because that would alter the original jumping strategy, as reported recently [13]. Then participants performed four types of bilateral maximal vertical jumping tasks (squat jump, countermovement jump, drop jump from 20 and 40 cm., SJ, CMJ, DJ20 and DJ40 respectively). Three maximal efforts at each jumping condition with random order and 2-min rest interval in between were performed (Figures 1, 2). Participants were instructed to jump upwards as high as possible, keeping their hands placed on the hips. For the SJ test, subjects were positioned on the force plate with the knee angle set at 90°. The starting knee angle was recorded using a standard goniometer. For the CMJ, subjects stood erect, and counter-moved until the knee was flexed approximately to 90°, before jumping. Finally, the DJ test included DJs from 20 and 40 cm height. Subjects landed on both feet on the force plate, which was approximately 8 cm in front of the jumping platform edge. During the test no verbal motivation or any kind of feedback about their performance was provided. Trials were further processed as judged from kinematic data and with the typical shape of force – time curve [14]. For kinetics, only the vertical ground reaction forces Fz were calculated. Ground reaction forces (for the estimation of jumping height and contact periods) were recorded with

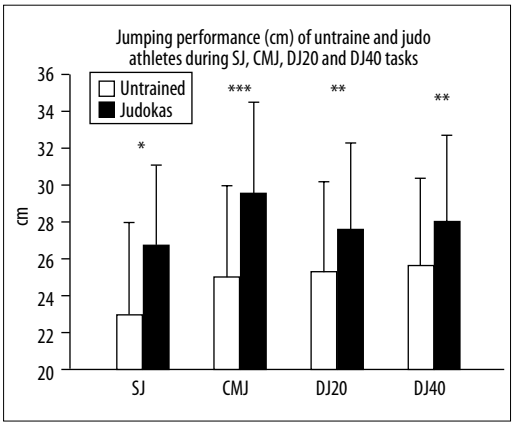

Figure 3. Jumping performance (cm) in all selected jumping tasks in untrained males and advanced level judokas (n=10/10).

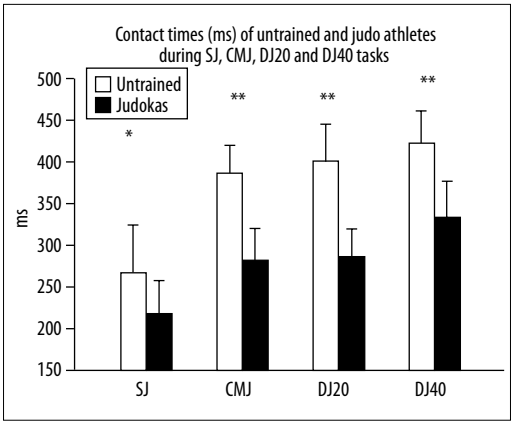

Figure 4. Contact times (total, in ms) in all selected jumping tasks in untrained males and advanced level judokas (n=10/10).

a ground mounted 40×60 cm force plate (Bertec Type 4060, Bertec Corporation, Columbus, OH, USA). The sampling frequency for ground reaction force signals was set at 100 Hz.

Data were further processed online using scripts of Matlab 6.1 (The MathWorks Inc.). Jump height and contact times were estimated taking into account the impulse which was recorded from the vertical ground reaction force (vGRF) – time curve. Only the best trial was further analysed. Lastly, the stretch shortening cycle performance gain as a percentage was calculated using the below equation: SSC performance (%) = [(CMJ-SJ)/ SJ] ×100.

Statistics were performed with the SPSS/PC 19.0 (SPSS Inc.) statistical package. Mean, standard deviation of the mean was assessed for all dependent variables. Two way ANOVA with repeated measures (2×4) has been used to identify significant differences between the groups and the four examined jumping tasks. The significance level was set to 0.05 with Bonferroni correction and significant

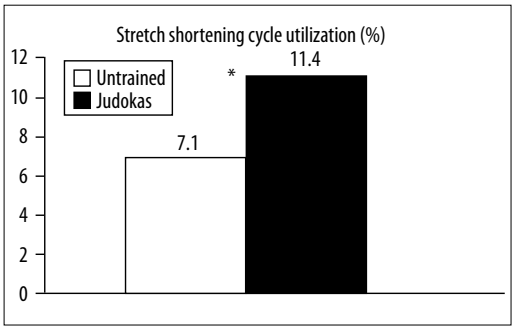

Figure 5. Stretch-shortening cycle utilization (%) in untrained males and advanced level judokas (n=10/10).

difference between boys and men ($p<0.05$, $p<0.01$, and $p<0.001$) were depicted as *, ** and *** respectively.

Results

Regarding jumping tasks, advanced judokas presented higher jumping performance in all examined tasks (SJ, CMJ DJ20 and DJ40) compared to untrained young males ($p<0.05$, Figure 3). Their better performance scored during CMJ task, and this occurred due to the better utilisation of the stretch shortening cycle (11.4 *vs.* 7.2%, $p<0.05$) and its' gain as shorter total contact times revealed as well (Figures 4, 5).

Discussion

During the selected jumping tasks, young judokas presented higher jumping performance, better recoil utilization of the SSC, and shorter contact times at each examined phase. It seems that experienced athletes develop a technique for more optimal storage and reuse of elastic energy and therefore muscle output is higher during the propulsive phase [1,2,15]. Vertical jumping performance is not largely described in the literature concerning judo athletes. However, from the obtained results it seems that this performance is a discriminatory component between the two groups with large differences [16,17]. Young judokas showed superior ballistic performance, indicated by their better jumping score and higher percent of SSC utilization. This finding comes in accordance with previous that refer to martial arts sports and probably comes from neural and muscular adaptations due to their training [9,18,19]. In a similar study [20], relevant kinetic factors such as application of vertical ground reactions forces (VGRF) revealed that, in hip throwing techniques these forces may be the major factor which distinguishes an expert from a novice judoka player and concluded that experts, in a specific throwing technique, generated higher values of vertical impulse compared to novice ones. As well as that, in a recent study and in other combat sport (taekwon-do), it

was suggested that in a specific natural technique of this combat sport which included the vertical jump task, better biomechanical parameters were developed compared to a traditional one technique [21]. In the same manner, natural and simple vertical jump tasks used in our study can be applied to young judokas from their competent coaches in order to maximize and optimize their training process through these biomechanical benefits.

Conclusions

In conclusion, superiority of athletes in jumping performance in all selected jumping tasks could be partially attributed to the immature technique of untrained participants which also is verified with differences in activation of their neuromuscular system. Participation and years of habituation to ballistic and explosive strength training and particularly in judo specific training in advanced-level judokas, may be the major factor which induced specific neuromuscular alterations as previous studies in martial arts sports suggested. Technique of this combat sport is prevail during a match, but definitely these neuromuscular adaptations cannot be omitted. Variables such as better utilization of recoil energy and better jumping performance are not directly connected to the better performance and do not predict this during a judo event. However, the gain in CMJ task which was shown more in athletes was occurred due to the better storage and reuse of elastic energy in their muscle-tendon unit [4]. This in turn can be advantageous in force production [22]. In practice, this can provide a judo player indirectly with an advantage in maximizing its performance and lead him to high level categories by exploiting the biomechanical efficiency that vertical jumps develop and embody this efficiency in his throwing techniques.

Highlights

To our knowledge, this is the first study which recorded and analysed different types of vertical jumps from a kinetic point of view in advanced level judokas and not only, in order to clarify potential neuromuscular adaptations arose from training in these jumping tasks and to better give an optimal training control.

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