LONG-TERM TRAINING-INDUCED CHANGES IN JUMP AND SPRINT PERFORMANCE IN COLLEGE BASKETBALL PLAYERS

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INTRODUCTION: Vertical jump is a common feature of offensive and defensive movements in basketball competition (Mclnnes et al., 1995). Similar to the vertical jump, an athlete's sprint ability has been linked to playing time (Hoffman et al. 1996) and level of competition (Drinkwater et al., 2007). Considering the importance of these measures in basketball and the frequency that they occur in the competitive environment, both countermovement vertical jump (CMJ) ability and sprint ability are considered important qualities contributing to game performance by basketball players. Recent cross-sectional study (Hoare, 2000) have examined the difference between non-elite and elite basketball players, highlighting the importance of training lower body explosive strength, sprint speed, and agility in developing athletes to aid in the successful progression from lower to higher competitive levels. Despite the acknowledged contribution to performance, little is known as to the trainability of CMJ, sprint ability and other potentially related physical qualities over the collegiate career of basketball players. The magnitude of improvement possible with athletes is poorly understood (Hunter et al., 1993), as is the interplay of these trainable aspects. The purpose of this investigation was to examine potential changes in anthropometry, vertical jump ability, and sprint ability over a 2-year time period in male collegiate basketball players to gain insight into the trainability of these performance measures.

METHODS: Twelve Division I Japanese college basketball players began and completed this study. All performance assessments were part of the athlete's normal preseason testing routine. During seasons, participants typically engaged in 5–6 court and 2–4 strength sessions per week, with game involvement varying by player from 20–40 games per season. Strength training sessions typically consisted of variations of the Weightlifting, squats, pressing exercises, upper-body pulling exercises. Each session typically consisted of 4–6 exercises performed for 5–8 sets of 1–6 repetitions. All included participants provided written informed consent for testing and data analysis. Approval for this investigation was granted from University of Tsukuba Institutional Human Ethics Committee.

Anthropometry (stature and body mass), vertical jumps [squat jump (SJ), CMJ], and repeated rebound jump (RRJ), 20m-sprint were tested before and at the conclusion of the investigation period. The RRJ consisted of 5 repeated vertical jumps with a rebound movement similar to bouncing a ball and were performed with 2 legs. The athletes were instructed to jump as high as possible and to minimize the amount of time in contact with the ground. RRJ-index was calculated by dividing the jump height by the corresponding contact time (jumping height / contact time) as an indicator of jump power. All jumps were performed with hands on the hips. The 20m-spint were videotaped with two high-speed video cameras (CASIO, EX-F1, 300 fps, Tokyo, Japan) with interval distance markers placed at 5 m, 10 m and 20 m. Athletes started by signal gun, which was used for synchronization with the high-speed video cameras, and split times (ST) were calculated for 0-5-m, 5-10-m, 0-10-m, and 10-20-m (ST0–5, ST5–10, ST10–20, ST0–10, and ST0–20, respectively) using the interval distance markers. Stride length (SL) was calculated by dividing the distance covered by the number of steps. The number of the steps completed at 5 m, 10 m and 20 m were calculated by Overlay method (Mochida et al., 2007). Stride frequency (SF) for 0-5 m, 5-10 m, 10-20 m, 0-10 m, 0-20m was calculated by dividing average speed by SL for each interval distance (SF0–5, SL0–5, SF5–10, SL5–10, SF10–20, SL10–20, SF0–10, SL0–10, SF0–20, SL0–20).

Paired t-tests were used to assess changes in the anthropometric, vertical jump, and 20m-sprint variables over the 24-month period with alpha set at $p < 0.05$. Due to the exploratory nature of the study, type-I error corrections were not used. Cohen's effect sizes (d) were calculated to reflect the magnitude of observed with the criteria of < 0.40 as small, 0.40–0.70 as moderate, and 0.70–1.00 as large effects (Cohen, 1988).

RESULTS: Anthropometric changes across the 2-year investigation period are presented in Table 1. Body mass increased significantly with moderate magnitude increase ($d = 0.61$, $p < 0.05$). CMJ height ($d=0.63$, $p<0.05$) and 20-m sprint performance ($d = 0.83$, $p < 0.01$) increased significantly over the 2-year period (Table 2; Table 3). There were no significant differences in SJ height and RRJ-index. SF0–5 ($d = 0.72$, $p < 0.01$) and SF0-20 ($d = 0.83$, $p < 0.01$) increased significantly (Table 3) with large magnitude increases. There were no statistically statistical significant differences in SL for any of the interval distances.

Table 1: Changes (mean±SD) in anthropometric variables over 2 years in college male basketball players (n=12).

	Pre-Test	Post-Test	ES (d)	Magnitude	Alpha (p)
Height (cm)	180.3±6.33	180.6±6.73	0.47	Moderate	0.1
Mass (kg) *	74.2±8.3	76.5±9.0	0.61	Moderate	0.03
Age (yrs)	19.3±0.7	21.3±0.7			

* Indicates difference is statistically significant ($p < 0.05$), ES: effect size

DISCUSSION: This study has demonstrated that male collegiate basketball players can improve jump height and sprint speed, which enhance individual competition performance. The moderate to large improvements in CMJ and ST0-20 suggest that these variables that are required for developing basketball players can and should be improved within collegiate athlete populations. Sheppard and Newton (2012) demonstrated the importance of depth jump ability like RRJ in volleyball players and the likely relationship between developing depth jump ability and improving both CMJ and spike jump, and increased force, impulse, and power output during jumping are the result of more effective use of eccentric muscle actions. Although no significant increase in RRJ performance was observed, its maintenance with increased body mass indirectly supports these findings.

Table 2: Changes (mean±SD) in squat jump, countermovement jump, and RRJ over 2 years in college male basketball players (n=12).

	Pre-Test	Post-Test	ES (d)	Magnitude	Alpha (p)
SJ (cm)	35.5±3.6	36.6±5.0	0.35	No change	0.25
CMJ (cm) *	39.2±4.7	42.4±4.2	0.63	Moderate	0.02
RRJ-index (m/s)	2.07±0.21	2.14±0.23	0.33	No change	0.27

* Indicates difference is statistically significant ($p < 0.05$), ES: effect size

While there were no changes in SL, SF0–5 and SF0-20 increased with large effects. In the aforementioned cross-sectional study (Hoare, 2000), no difference between players of the first and second team players was found in 20m-sprint. These results showed that 20m-sprint speed might not be a major factor of success in basketball. In favor of this hypothesis, vertical jump height has been shown to be a strong predictor of basketball performance. Furthermore, moderate correlations have been reported between sprint time and playing time in Division I college basketball players (Hoffman et al. 1996). Many authors and coaches use distances of 20m-sprint to test their players because it is close to the length of a basketball court (Hoffman et al. 2000). The video analyses of competitions have shown that high-intensity runs performed by national level players lasted between 1.7 and 2.1 seconds, which roughly corresponds to distances of 5-10m (McInnes et al., 1995). Sprint tests over shorter distances might be more appropriate to administer to basketball players, and acceleration, rather than speed, might be a better predictor of performance in basketball (Delextrat & Cohen, 2008). Additionally, higher average step frequency during change of direction tasks has been observed (Hewit et al., 2013). Since basketball performance characteristics are associated with more optimal force production and resultant velocities through the acceleration phase of sprinting, an emphasis on technical characteristics associated with faster players, such as decreased ST0-5 and ST0-10 with a concomitant increase in SF, would likely lead to improved change of direction performance. As these could be described as agility skills which are commonly considered important components of basketball performance (Hoffman et al., 1996), SF and SL should be measured in addition to speed during the 20m-sprint test.

Table 3: Changes (mean±SD) in 20-m sprint performance over 2 years in college male basketball players (n=12).

	Distance	Variable	Pre-Test	Post-Test	ES (d)
Time (s)	0-5m	ST0-5 **	1.51±0.07	1.36±0.12	0.75
	5-10m	ST5-10 *	0.77±0.02	0.76±0.03	0.66
	0-10m	ST0-10 **	2.28±0.08	2.12±0.12	0.77
	10-20m	ST10-20 **	1.33±0.04	1.29±0.04	0.83
	0-20m	ST0-20 **	3.61±0.11	3.41±0.10	0.83
Stride Frequency (Hz)	0-5m	SF0-5 **	2.77±0.19	3.10±0.32	0.72
	5-10m	SF5-10	4.16±0.21	4.21±0.21	0.36
	0-10m	SF0-10 **	3.24±0.19	3.49±0.26	0.69
	10-20m	SF10-20	4.17±0.18	4.25±0.18	0.47
	0-20m	SF0-20 **	3.58±0.17	3.78±0.21	0.69
Stride Length (m)	0-5m	SL0-5	1.20±0.08	1.19±0.07	0.16
	5-10m	SL5-10	1.56±0.07	1.57±0.10	0.2
	0-10m	SL0-10	1.36±0.08	1.36±0.07	0.04
	10-20m	SL10-20	1.80±0.08	1.85±0.13	0.41
	0-20m	SL0-20	1.55±0.08	1.56±0.09	0.15

** Indicates difference is statistically significant ($p < 0.01$), * Indicates difference is statistically significant ($p < 0.05$), ES: Effect Size

This investigation provides strength coaches and sport scientists with the evidence that increased jump and sprint ability (with improved high stride frequency) along with increased body mass can be achieved in collegiate basketball players. Strength coaches and sport scientists working with basketball athletes should estimate the magnitude of trainability of these qualities and which specific variables require development to underpin these improvements in basic vertical jump and sprint abilities.

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