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Article *in* The Journal of Strength and Conditioning Research · May 2018

DOI: 10.1519/JSC.0000000000002585

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Strength and Sprint Time Changes in Response to Repeated Shuttles Between the Wickets During Batting in Cricket

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Abstract

Christie CJ, Sheppard B, Goble D, Pote L, and Noakes TD. Strength and sprint time changes in response to repeated shuttles between the wickets during batting in cricket. *J Strength Cond Res* XX(X): 000–000, 2018—No studies have investigated the impact of repeated sprints between the wickets on lower-limb strength and sprint performance. Therefore, the purpose of this study was to assess changes in knee extensor (EXT) and flexor (FLEX) strength after repeated sprints between the wickets and to relate these to changes in sprint times. Twenty batters completed 2 conditions: one was high-volume running (HVR-twelve sprints per over) and the other, moderate-volume running (MVR-6 sprints per over) between the wickets (42 deliveries in both). Peak isokinetic torque was measured before and after each condition and sprint times were recorded. Eccentric and concentric peak torque decreased significantly ($p < 0.05$) at 1.05 rad·s^{-1} for knee EXT in both conditions. There was an 18% (HVR) and 10% (MVR) decline in concentric and eccentric knee EXT peak torque. Peak FLEX torques were significantly ($p < 0.05$) reduced after HVR (16.7%) but not after the MVR condition (8%). There were similar declines in eccentric FLEX peak torque. Sprint times increased significantly ($p < 0.05$) during the HVR condition but not in the MVR condition; sprint times in the HVR condition were compromised as early as the third over. We conclude that a high volume of runs significantly reduces muscle function in the lower limbs, partly explaining the impairment in sprint performance. However, because batters slowed as early as the third over in the HVR condition, there may be some form of strategy used in anticipation of a higher overall workload. More middle wicket practices, focusing on repeat shuttle sprints while batting, should be included in the coaching program.

Key Words isokinetics, sprinting, performance

Introduction

Repeat sprint activities involving repetitive eccentric muscle actions cause changes to skeletal muscle structure (14,25) and function (18,21) and are a predisposing factor for muscle fatigue (13,14,21). Studies in soccer players found declines in eccentric knee flexor strength with minimal changes in concentric strength during intermittent soccer play (27,28,31). This might predispose to hamstring injuries due to the known association between strength and hamstring injuries (28). Batters are particularly prone to lower-limb muscle injuries; thus, understanding the mechanisms in the cricketing context are important (7,24). According to the authors' knowledge, changes in isokinetic parameters during cricket have not previously been studied.

Like soccer, cricket also involves intermittent high-intensity activity, especially when batting. One method of scoring runs is by sprinting between the wickets intermittently (distance between creases of 17.68 m). This movement pattern is composed of 3 stages: (a) "Setting off" (accelerating rapidly), (b) "Hitting your stride" (reaching maximum speed), and (c) "Decelerating and turning" (decelerating rapidly to change direction). All these movements involve frequent eccentric actions and could cause fatigue in batters (13,21). It is well established that shuttle running, which simulates acceleration, deceleration, and turning, is sufficient to induce muscle damage (30). It is further proposed that substantial muscle strength would be needed to cope with this type of eccentric load (13,21). If this is correct, it is probable that reduced strength over time, while batting, will impact fatigue and injury risk.

Exercise-induced muscle damage significantly reduces peak torque development while increasing sprint times and reducing agility (14). Furthermore, reductions in peak torque are reportedly dependent on the angular velocity of the

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contraction performed (20), with greater reductions in peak torque (23% reduction) at slower angular velocities compared with faster velocities (10% reduction in peak torque). In addition, these reductions have been correlated with slower sprint times (5% increase) after muscle-damaging exercise.

However, the association between strength decrements (particularly in the lower-limb musculature) and performance has not been researched in depth and not in batters (10). Previous research has examined the correlation between muscle strength and sprint performance (10,17); there are no studies on exercised-induced changes in isokinetic strength produced by repeated sprinting. Dowson et al. (10) and Misjuk et al. (17) showed that faster sprint times were correlated with higher peak torque (for a 15-m sprint), but not for distances of 30–35 m. Therefore, higher force-producing–capabilities of the knee flexors and extensors result in faster sprinting times, a finding that has been supported by Newman et al. (20) These studies predict that maintaining sprint times during cricket batting requires that eccentric muscle strength be maintained. However, there are no studies to test this hypothesis.

Therefore, the purpose of this study was to determine the relationship between changes in isokinetic muscle strength and sprinting performance during repeated shuttle sprints in cricket batters. We hypothesized that reductions in isokinetic muscle force production, as a result of repeated sprints, would produce slower sprint times and that this would be more pronounced after a greater volume of sprint efforts.

Methods

Subjects

Twenty male specialist (top 5) batters (mean ± *SD*; age 22.6 ± 4.7 years; stature 179.5 ± 6.4 cm; mass 80.8 ± 11.8 kg) playing at university or subelite level were recruited. Players were eligible if healthy at the time of testing and with no current or past injuries reported in the 6 months before the initial date of testing. Before the investigation, the testing battery was approved by the Rhodes University (Grahamstown, South Africa) Ethical Standards Committee for research engaging human participants and informed consent was signed by each player.

Experimental Approach to the Problem

A randomized crossover design was used to compare the changes in sprint performance and isokinetic parameters within and between 2 experimental conditions, using the same 7-over protocol (42 deliveries) (6). One condition represented a high number of repeated sprints (high-volume running [HVR]) between the wickets, whereas the other represented a moderate number–moderate-volume running (MVR). The HVR condition required players to sprint a double-shuttle every ball totaling 12 runs per over and 84 runs in total. By contrast, the MVR condition required players to sprint a double-shuttle every second delivery, thereby accumulating 6 runs per over for a total of 42 runs. The experimental work bout was conducted on an indoor cricket pitch (17.68 m). Players were instructed to sprint at an "all-out pace," and received verbal encouragement throughout. Balls were delivered as "throw downs" and players wore match day cricket kit and protective gear, comprising box, pads, gloves, thigh and arm guards, and used their own bat. The high run rate of 12 runs per over for 7 consecutive overs was implemented to simulate an extreme batting scenario.

The protocol was formulated from time-motion analyses of high-scoring (greater than 260 runs per innings) limited overs matches of major cricket-playing nations, including South Africa, West Indies, Pakistan, India, New Zealand, Australia, and England. High-scoring matches were defined as innings' in which 260 runs or more are scored in a single innings within the allocated overs. Observations included time between bowling deliveries, time between overs, and mean runs per over (rpo). For each of these analyses, 60% (30 overs) of each innings was observed to exclude the fielding restrictions during batting and bowling powerplays. Thus, the overs included in the analyses were those that required batters to run more, rather than hit boundaries. The time-motion data revealed a mean duration of 32.7 and 79.8 seconds between ball deliveries and overs, respectively, and so, these time intervals were adopted.

Procedures

Players were required to attend 3 sessions: the first, an information and familiarization session, explained the experimentation process. This session included anthropometric and morphological measurements. On arrival, body mass was measured to the nearest 0.01 kg using a calibrated Toledo electronic scale (model 8142; Worthington, OH, USA). Stature was measured to the nearest centimeter using a Harpenden stadiometer (Holtain Ltd., Crymych, United Kingdom). Skinfolds of 7 sites, namely chest, tricep, subscapular, suprailiac, abdominal, thigh, and medial calf, were measured using a Harpenden skinfold caliper (Holtain Ltd.). Players' body density was calculated according to the equation for males developed by Jackson and Pollock (15). The Siri equation was used to calculate percentage of body fat. Each player performed familiarization trials on the dynamometer in each testing mode (concentric and eccentric) and at each testing speed (1.05 and 4.71 $rad \cdot s^{-1}$). No visual feedback was provided, but participants were encouraged to produce a maximal effort. Players were then taken to the area where the experimental sessions would take place and were given an opportunity to acquaint themselves with the surface and the intensity of sprinting required. For recovery purposes, the experimental sessions were separated by 6–8 days. Each player was tested at the same time of day for both sessions in an attempt to negate time-of-day effects. Players were randomly assigned to do either the HVR condition or the MVR condition first. Simple random sampling was used; so, half the sample completed the HVR condition first, whereas the other half completed the MVR condition first.

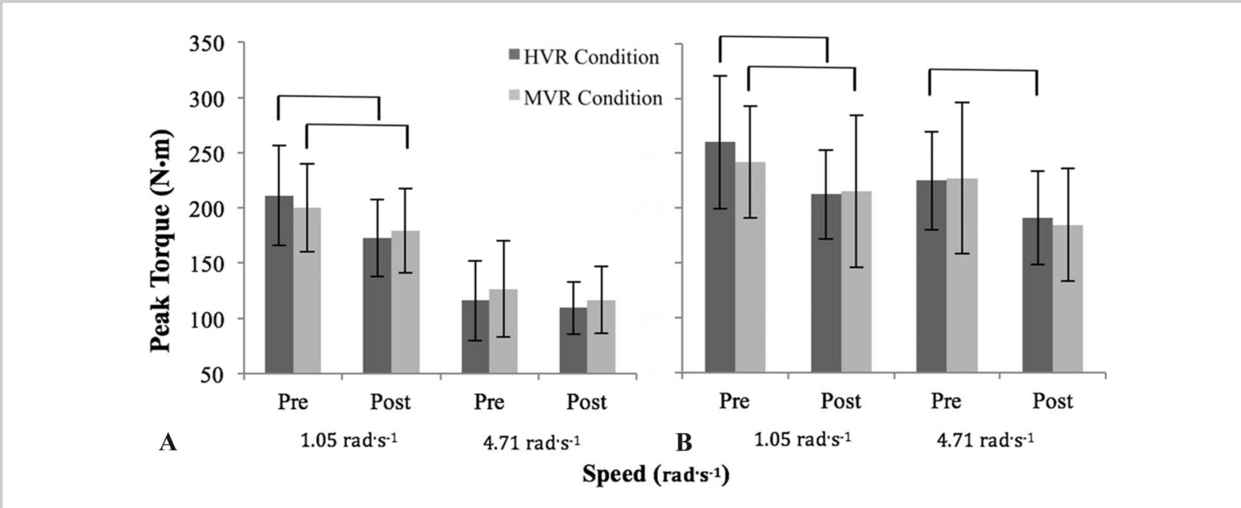

Figure 1. Comparison of peak torque (N·m) during (A) concentric and (B) eccentric actions of the knee extensors. All values are mean ± *SD*. Represents significant differences pre and post ($p < 0.05$). HVR = high-volume running; MVR = moderate-volume running.

The second experimental session then required them to do the condition they had not yet completed.

On arrival for the experimental sessions, players performed a warm-up, which included cricket-specific stretching (specifically the hamstrings and quadriceps) and 3 submaximal isokinetic trials at each testing speed. Changes in concentric and eccentric isokinetic strength in the dominant limb were determined by comparing maximal prework vs. postwork bout strength measures. The post-test measure was performed immediately after the completion of the protocol (approximately 5 minutes after completion). Standard knee flexion and extension protocols were used according to the manufacturer's instructions (CYBEX; Division of Lumex, Inc., Rononcoma, NY, USA, 11779) and were gravity-corrected. The strength-measurement protocols occurred in random order. Peak torque and hamstring:quadriceps (H:Q) ratios were assessed at isokinetic speeds of 1.05 and 4.71 $rad \cdot s^{-1}$. These speeds were selected to include muscular strength measures (1.05 $rad \cdot s^{-1}$), as well as that representative of speeds attained during functional activities (4.19–5.24 $rad \cdot s^{-1}$) (8,23,34). The randomization protocol did not follow previous recommendations but was similar to that reported by Greig (27) who reported that a progressive increase in isokinetic testing speeds created a perception of accommodation with increased importance attached to the latter trials. The dynamometer was customized for the specific anthropometric measures of each individual. The crank axis was aligned with the axis of rotation of the knee joint, and the cuff of the dynamometer's lever arm was secured around the ankle, proximal to the malleoli. Restraints were applied across the quadriceps muscle proximal to the knee joint and across the torso. The range of motion was preset from full extension to 90° of flexion. These values were then recorded to minimize set-up time in the subsequent experimental session.

Sprint times were recorded using an infrared light-emitting device timing system developed internally by the Department of Human Kinetics and Ergonomics, Rhodes University, South Africa (20). Two devices were positioned at the level of the player's torso at either end of the 17.68 m "crease" (2 m from the popping crease) and sprint times were recorded when the torso passed the beam at the end of each shuttle sprint. With the all-out sprint efforts, batters were instructed to turn to their stronger side. Research assistants ensured that each batsman placed part of the bat beyond the crease when turning. Netting (2 × 2 m) was used as a target for batters to block the ball with each shot played.

Data Analyses. Data were analyzed to quantify the gravity-corrected peak torque at each of the isokinetic testing speeds for concentric and eccentric knee extension and flexion. The highest value of 3 repetitions was taken as the player's peak torque. The test-retest reliability for peak torque was determined during the familiarization trial. Peak torque was used to calculate the concentric hamstring:concentric quadriceps peak torque as well as the functional strength ratio of eccentric hamstring:concentric quadriceps peak torque at each testing speed. Isokinetic values are presented according to the testing speed, the mode of exercise, the primary muscle group involved, and whether before or after exercise.

Statistical Analyses

Statistics software (StatSoft, Inc. (2011) STATISTICA. Version 10.0) was used to perform all statistical analyses. The Shapiro-Wilk test determined that the data were

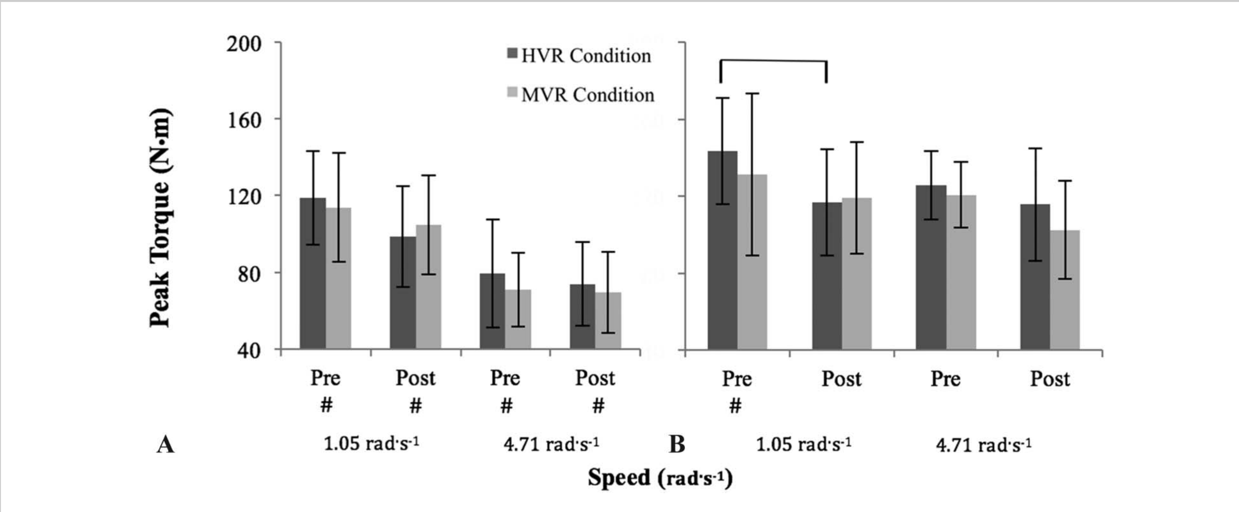

Figure 2. Comparison of peak torque (N·m) for (A) concentric and (B) eccentric knee flexor muscle actions. All values are mean ± *SD*. represents significant differences pre and post ($p < 0.05$). #represents significant differences between conditions ($p < 0.05$). HVR = high-volume running; MVR = moderate-volume running.

normally distributed and an unrelated t test determined that the 2 samples were matched with respect to stature, body mass, and skinfolds. Two-way analyses of variance with repeated measures were selected to identify statistically significant ($p < 0$ 0.05) changes in isokinetic strength measures, heart rate, and sprint times between protocols. A confidence interval of 95% was used to identify significant change in the variables of interest. Tukey post hoc multiple comparison tests

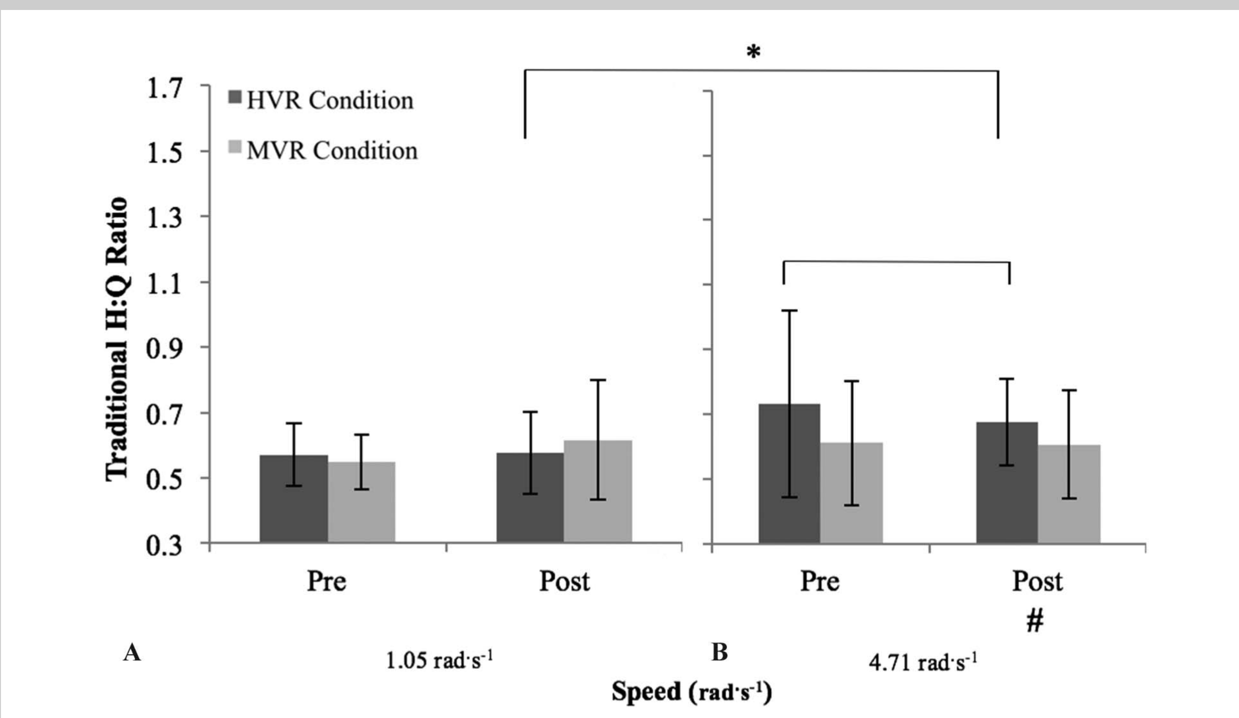

Figure 3. Changes in the concentric hamstring to concentric quadriceps ratio ($H_{(con)}$:$Q_{(con)}$) at (A) 1.05 rad·s^{-1}and (B) 4.71 rad·s^{-1} during both conditions. represents significant differences pre and post ($p < 0.05$). represents significant differences between speeds ($p < 0.05$). # represents significant differences between conditions ($p < 0.05$). All values are mean ± *SD*. HVR = high-volume running; MVR = moderate-volume running.

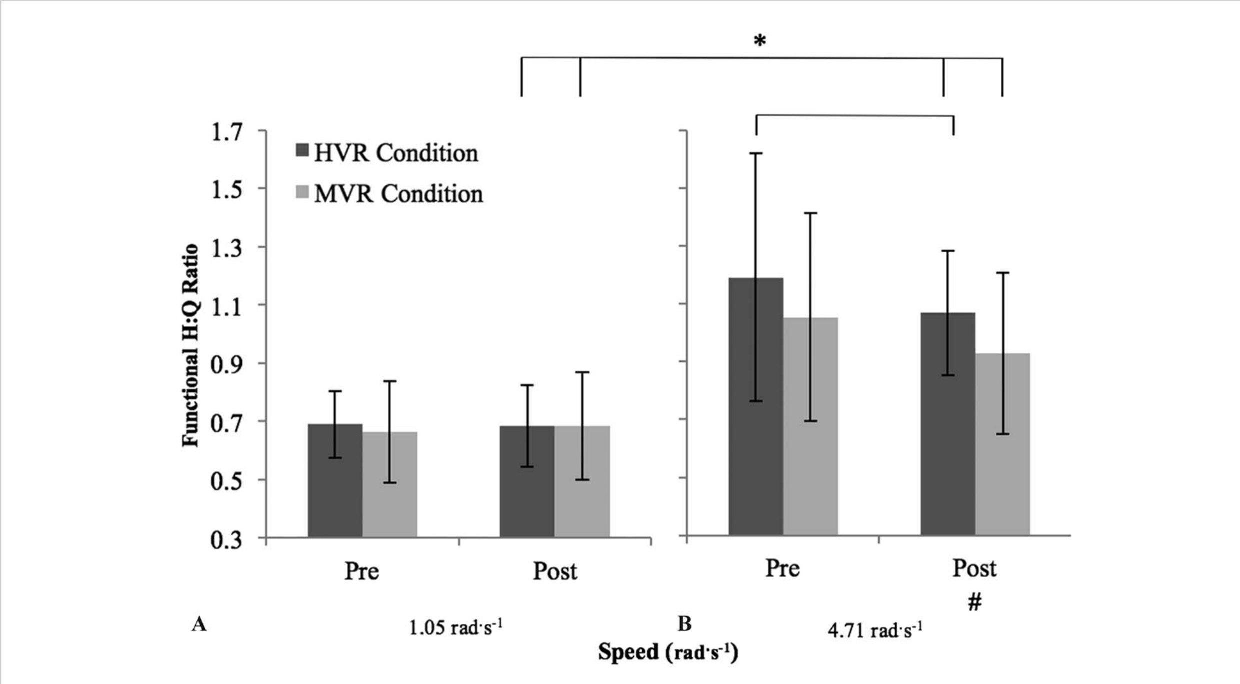

Figure 4. Changes in the eccentric hamstring to concentric quadriceps ratio ($H_{(ecc)}$:$Q_{(con)}$) at (A) 1.05 rad·s^{-1} and (B) 4.71 rad·s^{-1} during both conditions. represents significant differences pre and post ($p < 0.05$). represents significant differences between speeds ($p < 0.05$). # represents significant differences between conditions ($p < 0.05$). All values are mean ± *SD*. HVR = high-volume running; MVR = moderate-volume running.

were further performed where significant differences were identified. Data were presented as mean ± *SD*.

Results

Peak Torque

Eccentric and concentric peak torque of the knee extensors decreased significantly ($p < 0.05$) at 1.05 rad·s^{-1} in both conditions (Figure 1). ~~By contrast,~~ the MVR condition saw no change in eccentric peak extensor torque (Figure 1B) decreased significantly ~~at 4.71 rad·s^{-1}~~ after the HVR condition). There was an 18% decline in concentric knee extensor peak torque (1.05 rad·s^{-1}; from 211.3 ± 45.4 N·m to 172.9 ± 34.9 N·m) after the HVR condition (Figure 1A). The decline in concentric knee extensor peak torque was 10.3% after the MVR condition (200.1 ± 40 to 179.5 ± 38.2 N·m).

Similar declines were evident in the eccentric mode, at the same testing speed (1.05 rad·s^{-1}): 18.3% decline from 260.1 ± 60.5 to 212.4 ± 40.6 N·m after the HVR condition and 10% after the MVR condition from 241.8 ± 50.9 to 215.5 ± 69.5 N·m (Figure 1B).

The only change at the higher testing speed (4.71 rad·s^{-1}) was a significant ($p < 0.05$) decline in peak eccentric extensor torque: 15.2% decline from 225 ± 44.5 to 190.7 ± 42.8 N·m after the HVR condition (Figure 1B).

Although the conditions were randomized, it was noteworthy that peak flexor torque values before the HVR condition were significantly ($p < 0.05$) higher (Figure 2). However, at the speed of 1.05 rad·s^{-1} (Figure 2A), the decline in concentric flexor peak torque was significantly greater after HVR condition when compared with MVR (16.7% compared with 8.0%). Similar declines were observed for eccentric flexor peak torques for the HVR and MVR conditions, 18.5 and 9.3%, respectively (Figure 2B). Also, eccentric flexor peak torque was significantly reduced after the HVR condition at 1.05 rad·s^{-1} (Figure 2B).

Hamstring:Quadricep Ratio

There was a significant ($p < 0.05$) reduction in the $H_{(con)}$:$Q_{(con)}$ ratio from 0.73 ± 0.29 to 0.68 ± 0.13 at 4.71 only after the HVR condition (Figure 3B). The MVR condition showed no change at either speed. The postprotocol ratio was significantly ($p < 0.05$) higher at 4.71 rad·s^{-1} compared with 1.05 rad·s^{-1} after the HVR condition (Figure 3B).

At 1.05 rad·s^{-1} (Figure 4A), there were no changes in the eccentric hamstring to concentric quadriceps functional ratio after either condition. At 4.71 rad·s^{-1} (Figure 4B), there was a significant ($p < 0.05$) decline in the ratio (from 119 ± 0.43 to 1.06 ± 0.21) after only the HVR condition. Postprotocol ratios (Figure 4A, B were significantly ($p < 0.05$) higher for both HVR and MVR conditions at 4.71 rad·s^{-1}. Furthermore, the postprotocol ratio in the HVR condition was significantly ($p < 0.05$) higher compared with the MVR condition.

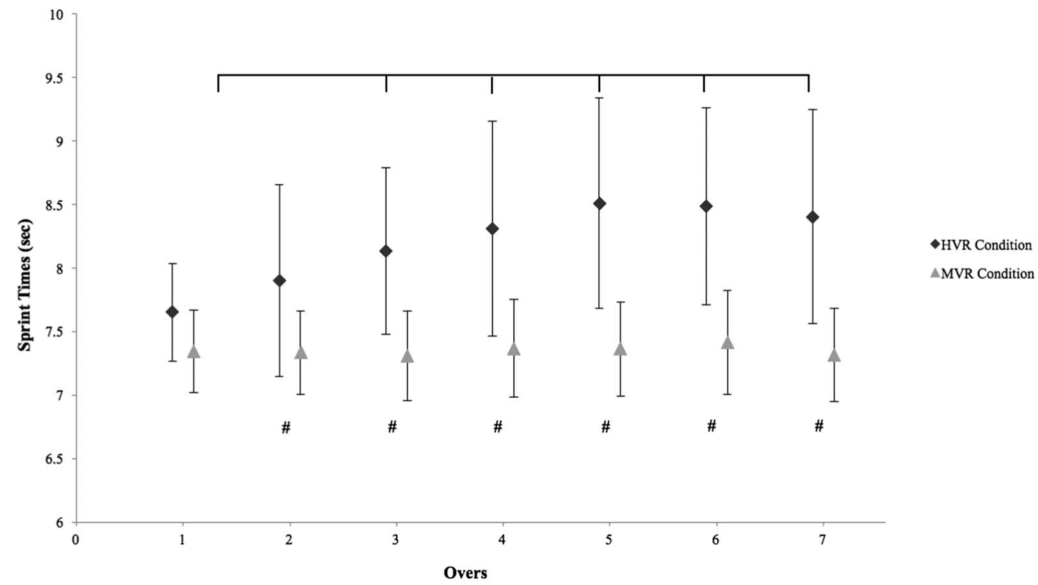

Figure 5. Comparison between sprint times. All values are mean ± *SD*. represents significant differences between overs ($p < 0.05$). # represents significant differences between conditions ($p < 0.05$). HVR = high-volume running; MVR = moderate-volume running.

Sprint Times

After the first sprint, which was similar between conditions, sprint times increased in the HVR condition but not in MVR (Figure 5). In the HVR condition, there was a significant increase in sprint times from the first over to overs 3 to 7 (from 7.7 ± 0.4 to 8.4 ± 0.8). Sprint times were maintained during the MVR condition. In both conditions, there was a nonsignificant decrease in sprint times in the final over. Variability in sprint times was higher in the HVR condition.

Discussion

The main aim of this study was to determine whether repetitive sprinting, reflective of running between the wickets during batting in cricket, impacted sprint times and isokinetic strength of the muscles involved in knee extension and flexion. A further aim was to compare the changes when required to run 6 (MVR condition) vs. 12 runs per over (HVR condition). It should be noted that the conditions were reflective of "worst-case-scenario" and, as such, the findings should be interpreted with this in mind.

The first relevant finding of this study was that sprint times were compromised only in the HVR condition. Also, we found that both concentric and eccentric strengths of the quadriceps and hamstrings muscles were compromised in both sprint conditions, although more so in the HVR condition, with the % decline typically twice as much in the HVR condition compared with the MVR condition.

The fact that sprint times were statistically similar during the first over of both conditions suggests that the difference after that can be directly attributed to the differences in the testing conditions. Sprint times were maintained during the 7-over period when batters were required to sprint 6 runs per over (42 sprints in total). Doubling the sprint volume (from 6 to 12 runs per over and 84 sprints overall) had a significant ($p < 0.05$) negative impact on sprint performance (Figure 5). Although an increase in activity duration is known to decrease performance (19,35), in this study, in which the protocols were of equal duration, higher sprint volumes resulted in an adjustment to sprint speeds from as early as the third over. This is important as it is probable that fatigue, at this stage, had not yet maximized. This suggests that an anticipatory response may be critical in regulating the intensity of effort once the work bout begins (2,33) and as early as the third over, in this study. It is acknowledged, however, that when batting, batters are unaware of the end point and so, this may not occur in a real game situation. This suggests that future research should consider using work bouts in which the end point is unknown and in which it is probable that a more conservative pacing strategy will be adopted (29). It is plausible that because the players knew what each work bout entailed, they conserved themselves in the HVR condition to prevent absolute failure of any physiological system or premature fatigue while still trying to maintain their best effort. This approach has previously been suggested in other contexts (3,22,32). Furthermore, this study provides tentative evidence for teleoanticipation as players were able to reduce sprint times as they sped up during the final over of the protocol (more so in the MVR condition), although the effect was small and not significant.

Overall, this observation of reduced speed in the initial part of the HVR condition together with decreased sprint times in the final over of both conditions suggests the presence of reserve capacity. To the best of the authors' knowledge, is the first time this has been observed during repeat sprint efforts between the wickets in cricketers. This end spurt may be due to a conscious decision by players to increase work rate due to the knowledge that the protocol was nearing completion.

Rest intervals were shorter in the HVR condition (60 seconds), which is half the 120 seconds afforded during the MVR condition. Thus, the longer recovery bouts were probably also pertinent to sprint performance as it is well known that during intermittent activities, rest periods are important for recovery (4). Sprint performance over a distance of 40 m after recovery periods shorter than 90 seconds is associated with exaggerated performance decrements (4). The increased sprint times during the HVR condition could, therefore, be explained by the higher sprint volume combined with shorter recovery periods.

Although concentric and eccentric strength of the quadriceps and hamstring muscles were compromised after both conditions, the effect was more pronounced after the HVR (Figures 1 and 2). This was likely due to the higher eccentric loading associated with more frequent decelerations (84 compared with 42 decelerations). It is plausible that this greater muscular stress imposed during the HVR condition could have impacted sprint times. These findings are consistent with the findings of studies in which fatigue was induced using isokinetic repetitions involving greater eccentric loading (11). By contrast, Greig (28) found that both quadriceps and hamstrings concentric strength was maintained in a soccer-specific treadmill protocol that did not include repeated bouts of eccentric muscles actions. This could indicate that eccentric loading is more likely to induce strength decrement and is an important consideration for future research and training for batters.

Similar to the findings of Jaskólski et al. (16) and Highton et al. (14), the higher volume work bout had a more detrimental impact on eccentric extensor peak torque at an isokinetic speed of 1.05 $rad \cdot s^{-1}$ (260.1 $\pm$ 60.5 $N \cdot m$ to 212.4 $\pm$ 40.6 $N \cdot m$). Furthermore, speeds of 1.05 $rad \cdot s^{-1}$ produced identified greater strength decrements for both concentric and eccentric knee flexor actions probably as a consequence of the higher volume of running (118.7 $\pm$ 24.3 to 98.8 $\pm$ 26.3 $N \cdot m$ and 143.3 $\pm$ 27.5 to 116.8 $\pm$ 27.8 $N \cdot m$, respectively). This suggests that strength decrements are accentuated at the slower speed of 1.05 $rad \cdot s^{-1}$ and are not necessarily observed at faster, more functional isokinetic speeds, as also found by Bennell et al. (5) This reduction in both concentric and eccentric strength negatively impacted sprint performance due to the positive relationship between both factors (10). The strength of this relationship confirms that a batsman's ability to score runs rapidly and continuously through repeated sprints must become impaired the more times he has to run (23). The limited time to develop sufficient torque levels during isokinetic testing at speeds of 4.71 $rad \cdot s^{-1}$ could explain the limited strength decrements measured at this speed in the current study. Furthermore, slower isokinetic speeds of 1.05 $rad \cdot s^{-1}$ may be more accurate in identifying the presence of strength decrements than the more functional speed of 4.71 $rad \cdot s^{-1}$.

Although no differences in the hamstring to quadriceps ratio were evident after either condition at 1.05 $rad \cdot s^{-1}$, there was a significant ($p < 0.05$) decline in the functional ratio at 4.71 $rad \cdot s^{-1}$ (0.73 $\pm$ 0.29 to 0.68 $\pm$ 0.13) after the HVR condition. This suggests that greater insight into ratio changes may be obtained at speeds more representative of the activity in question. Similarities were observed between the traditional (Hcon:Qcon) and the more functional (Hecc:Qcon) ratios at 1.05 $rad \cdot s^{-1}$, with values ranging from 55 to 69% and all falling within the accepted normative values (5,16,26). Greater functional ratios were, however, produced at an isokinetic speed of 4.71 $rad \cdot s^{-1}$, with the HVR condition eliciting the highest functional ratio. A functional H:Q ratio (approximately 100%) is indicative of a well-balanced strength profile of the lower limb and enhanced dynamic knee joint stabilization (1). The results, therefore, suggest that the force-producing capabilities of both the hamstrings and quadriceps are relatively well balanced at faster, more functional isokinetic speeds, thus improving dynamic joint stability during forceful knee extensions: a result observed in both the HVR and MVR conditions. The duration of the protocols must, however, be considered because the hamstrings may provide greater stability during high-intensity sprinting of short durations. However, an increase in batting duration/intensity may negatively impact the force-producing capabilities of either the hamstrings or quadriceps muscles, and in turn, impact dynamic joint stability and possibly increase injury risk.

Both traditional (Hcon:Qcon) and functional (Hecc:Qcon) ratios displayed significant ($p < 0.05$) decrements after the HVR protocol at isokinetic speeds of 4.71 $rad \cdot s^{-1}$. Although the functional ratio was closer to 100%, indicating a relative equilibrium in muscle strength, the greater decrements–when compared with the slower speed–suggest an increased risk to stability and hence, injury. Furthermore, with the percentage decrease being significantly higher after the HVR condition, the degree of instability seems to be exacerbated when running volume is doubled. This is important as, when exercise duration is increased, the resultant decrease in the H:Q ratio is likely to cause increased instability of the knee joint (specifically during dynamic, forceful extension activities) with increased probability of injury to the lower limb (1). Furthermore, the higher decrements associated with 4.71 $rad \cdot s^{-1}$ suggest that a more functional speed may provide a greater understanding of functional ability and muscle balance than those observed at speeds of 1.05 $rad \cdot s^{-1}$.

Similarities between the Hcon:Qcon ratios recorded during this study and that measured during professional soccer play (1) were evident. By contrast, Rosene et al. (26) investigating university-level volleyball and soccer players found lower ratios than those in the current study. This could be explained by differences in training levels, or an added requirement for improved hamstring strength due to the repeated eccentric demands of a cricketing activity compared with those of other intermittent sporting disciplines. However, it must be stressed that although studies have suggested a ratio less than 60% may be indicative of increased injury risk, this is yet to be fully supported (5). Muscle strength decrements observed within the hamstring musculature may be of greater importance than changes in these ratios.

In conclusion, the most important finding of this study was that sprint times were significantly compromised when players were required to repeatedly sprint 12 runs per over compared with 6 runs per over. This is likely due to the greater deficits in peak torque after the HVR condition. Furthermore, decrements in eccentric flexor strength, which was only evident after the HVR condition, as well as extensor strength changes greater than 12% (also only evident during the HVR condition) seemed to be an important determinant for reduced sprint times. However, it is also possible that, although greater muscle fatigue was present in this condition, the slowing of sprint times could have been due to a combination of muscle fatigue as well as the adoption of some form of sprinting strategy in anticipation of a higher overall workload.

Practical Applications

AU10 As very little coaching time is focused on the physical demands of repeat sprints between the wickets while batting, this type of middle wicket practice should be incorporated into training schedules. Batters should focus on the combination of cognitive and physical demands that batting places on them and thus, combine both aspects in training. From the results of this study, it would mean that while batting, batters should be required to run and sprint shuttles at set time intervals during a training session.

Acknowledgments

This work was supported by the National Research Foundation (NRF) of South Africa under Grant Number: CPR20100423000010637. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors, and therefore, the NRF does not accept any liability in regard thereto.

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