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# The influence of cricket leg guards on running times and stride parameters

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## Introduction

Professional sport has become increasingly competitive over the past two decades, resulting in professional teams, governing bodies and equipment manufacturers constantly striving to maximise performance. Equipment design has been highlighted as an area which can have a significant affect on performance, which could ultimately be the difference between winning and loosing. Within the majority of sports, research has focused on maximising athlete performance, however, for protective equipment (PPE) in sport a greater emphasis has been placed on preventing injury, as a result, traditional PPE is often cumbersome and ill fitting and in sports such as cricket, where large amounts of PPE are worn, there is an opportunity to improve performance without sacrificing protection through the development of new equipment. Previous work by Webster and Roberts (2009) has demonstrated that cricket leg guards are perceived by the player to have a negative influence on running performance. An earlier study by Looke et al. (2006) found that different batting pads did not affect running and turning speed relative to each other, but this study did not consider their influence on running speed compared to running without leg guards. Therefore, this study aims to determine if batting pads have detrimental affects on performance, and whether this is predominantly caused by the added mass to the legs of the athlete or as a result of changes in running gait.

## Methods

This study analysed the effect of cricket leg guards on running and turning speeds, as well as stride characteristics across five conditions, including 3 different types of batting leg guards (P1, P2 and P3) weighing 500g, 740g and 900g per leg guard respectively, a weighted comparison (where a 900g weight was attached to each leg), and a no pad condition. The initial study measured running and turning times through SMART speed timing gates placed at each crease and 5 meters before the crease to calculate turning time, individual splits and total time. Ten male subjects were used for this initial study with a mean age of 19.8 ±1.3 years, and all played county 1st or 2nd team level or equivalent. Each participant completed 4 sets of 3 runs for each condition, with a 15 minute rest between conditions. Condition order was randomised to prevent any order affects.

A secondary study was conducted to analyse running stride parameters utilising a 4 CODA CX1 system, with 2 integrated force plates (Kistler 9281C) to determine heel strike and toe off. A full lower body marker set was used to capture the running motion, and was analysed using Visual 3D to allow stride width and length to be calculated. For this secondary study, 9 cricketers were used with a mean age of 19.4 ±1.1 years and again all played county level cricket or equivalent.

## Results and discussions

Within the initial study a set of repeated measures ANOVAs were used to determine if different batting leg guards affect running times and whether any detrimental affects could be solely attributed to additional weight. From the results it was identified that all three pads (P1, 2 and 3) and the weighted comparison significantly impeded running performance ($P<0.05$) increasing time taken to run 3 runs by 0.2s, 0.25s, 0.53s and 0.28s respectively when compared to running without pads, which at top speed could equate to as much as 3.5m of ground covered. It was also determined that P3 was significantly ($P<0.01$) more detrimental to performance than P1, P2 and the weighted comparison (Figure 1A). These results suggest that although weight does influence running speed it is not solely accountable for the increase in time, as P3 was equal in weight to the weighted comparison. Turn times were also analysed through a repeated measures ANOVA but no significant differences between conditions ($P>0.05$) were found with the maximal difference in time of 0.029s (Figure 1B), suggesting the difference in times is due to negative affects on straight line running.

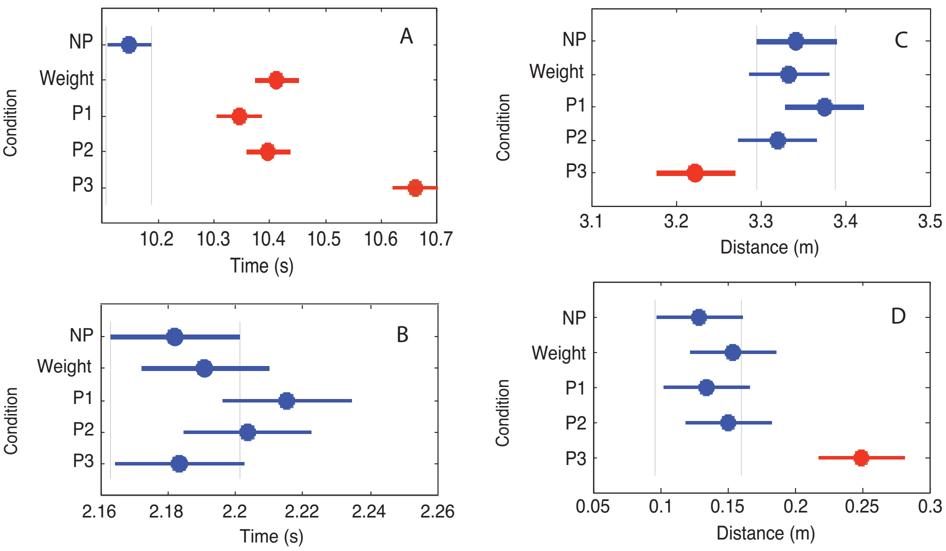


**Figure 1:** Mean ± one standard deviation for A) overall time, B) time taken to turn, C) stride length and D) stride width for the 5 conditions of no pads (NP), weighted comparison (900g), pad type 1 (P1) (500g), pad type 2 (P2) (740g) and pad type 3 (P3) (900g).

The second study focused on determining if different pads directly affected the stride parameters of cricketers when compared to running without pads. The results of the ANOVA suggest that there is no significant differences in stride length caused by P1, P2 or the weighted comparison, however, P3 does appear to significantly decrease stride length by an average of 0.014m ($P<0.05$) as shown in Figure 1C. P3 was also found to have a significant affect on stride width, resulting in players running with a wider gait, whereas no significant difference were found between the other conditions as illustrated in Figure 1D.

## Conclusions

Overall this study has identified that cricket leg guards do have a detrimental affect on running times. This increase in time taken to complete three runs can be attributed to differences in straight line running speed rather than time taken to change direction. A proportion of this increase in running time can be attributed to the added mass of the leg caused by the leg guards, however, this does not fully account for the negative affect on running time caused by P3. The results suggest that heavy bulky leg guards can increase stride width and decrease stride length which can significantly affect running speeds. These findings have practical implications when designing cricket leg guards demonstrating that pads need to be as light and closely fitting as possible to minimise impedance on stride parameters such as width and length.

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# Kinematic analysis of the golf swing

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Golf swing is a very complicated motion that requires coordination of all body segments. The purpose of this study was to describe the movement of body segments using 3D kinematic analysis and to analyse lower limb movement by inverse dynamics during the golf swing of high level players. Studies of golf swing using kinematic analysis have been published [1,2]. The correct movement of body segments, especially those of the shoulders and hips in each phase of the swing is very important for golf swing technique. Weight transfer has a great effect on success of the golf shot. It affects angle of approach, club head address on impact, and if done well will give energy to the ball. Good timing of rotation in the movement of shoulders and hips with correct weight transfer is the key to generating power for impact [3]. The aim of the player is to generate power to achieve maximum distance and accuracy. The position of shoulders on impact affects accuracy and the angle between the hips and shoulders through the whole swing, and especially at the top of backswing (this angle stretches the big muscles in the back and is also known as the x-factor) affects generation of power.

## Methods

Three male golfers aged 19-24 years with handicap between 0-3 were measured. Pressure effects against a ground-sheet were measured by two KISTLER units. BioWare software was used to analyse the recorded force signals. The force plates were synchronised with a 3D movement analysis unit (Codamotion System) situated 4 meters in front of the player. Real golf balls were used and played from an Astroturf ground-sheet into the net situated 6 meters away. Players were asked to play 5 full swings with each of the 3 clubs (Sand wedge, 7 iron, 3 iron). The Codamotion System recorded the segmental movement at 400Hz sampling rate. Markers were put on hips, shoulders, knees, ankles, head (over the right eye) and club (shaft and grip). The data was evaluated in each phase of the golf swing. Separate phases of the swing were identified by club position. To analysis hips and shoulder movement we selected important positions of the golf swing. Set-up, Mid Backswing, Top of the backswing, Mid downswing, Impact, Follow through, and Swing finish were the phases of swing used.

## Results

The angles between shoulders and hips in each phase of the golf swing are presented in Table 1. At Set-up position the player has slightly closed shoulders (aiming right of the target line) and hips aiming to the target. It is most important for the player to generate as much power as possible by stretching the big muscles in the back and reaching an angle as big as possible between shoulders and hips (x-factor). We measured that at the Top of the backswing position in accord with the theory of the golf swing [4]. From there the hips start a fast movement in the target direction which flows through a kinematic chain comprising shoulders-arms-club-club head-ball to deliver maximum energy to the ball. While shoulders are aiming just slightly left of the target, hip rotation is much more forward in Impact position. In Follow Through position the hips stop moving and the shoulders achieve the minimum angle (same angle against target line)

| Phases of the golf swing | Shoulder-hips angle |
|---|---|
| Set-up | -1,38 |
| Mid-backswing | -10,8 |
| Top of the backswing | -52,09 |
| Mid-downswing | -37,89 |
| Impact | -25,51 |
| Follow through | -7,29 |
| Swing finish | -29,15 |

**Table 1.** Shoulders-hips angle in separate phases of the golf swing

| Phases of the golf swing | Angle of shoulders |
|---|---|
| Set-up | -1,33 |
| Mid-backswing | -43,15 |
| Top of the backswing | -94,85 |
| Mid-downswing | -13,97 |
| Impact | 6,66 |
| Follow through | 28,41 |
| Swing finish | 144,36 |

**Table 2.** Angle of shoulders in separate phases of the golf swing

and the hips continue rotation to Finish Swing position.

The angles between shoulders and shot direction are in Table 2. At the Set-up position we found that it is nearly the same angle of shoulders to the shot direction as on impact. In Set-up phase the player has a closed (shoulders are aiming right of the target line) position of the shoulders and on impact has shoulders in open (shoulders are aiming left of the target line) position. Although their shoulders are a little bit open through impact, these results indicate a high level of player because it gives the player good control of accuracy of the shot. This is because the solid shoulder position on impact is the basis for good club head position (normal to the direction of the shot), angle of approach, and good contact between club and ball through impact.

**Conclusion**

Although there are many things that affect the success of the golf shot, the shoulder position and its angle with hips, and good weight transfer are basic things a good skilled player must control to play consistently good shots.

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# Bilateral ground reaction forces and joint moments for lateral sidestepping and crossover stepping tasks


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Racquet sports have high levels of joint injuries suggesting the joint loads during play may be excessive. Sports such as badminton employ lateral sidestepping (SS) and crossover stepping (XS) movements which so far have not been described in terms of biomechanics. This study examined bilateral ground reaction forces and three dimensional joint kinetics for both these gaits in order to determine the demands of the movements on the leading and trailing limb and predict the contribution of these movements to the occurrence of overuse injury of the lower limbs. A force platform and Codamotion analysis system were used to record ground reaction forces and track marker trajectories of 9 experienced male badminton players performing lateral SS, XS and forward running tasks at a controlled speed of 3 m·s-1 using their normal technique. Ground reaction force and kinetic data for the hip, knee and ankle were analysed, averaged across the group and the biomechanical variables compared. In all cases the ground reaction forces and joint moments were less than those experienced during moderate running suggesting that in normal play SS and XS gaits do not lead to high forces that could contribute to increased injury risk. Ground reaction forces during SS and XS do not appear to contribute to the development of overuse injury. The distinct roles of the leading and trailing limb, acting as a generator of vertical force and shock absorber respectively, during the SS and XS may however contribute to the development of muscular imbalances which may ultimately contribute to the development of overuse injury. However it is still possible that faulty use of these gaits might lead to high loads and this should be the subject of future work.

**Keywords:** badminton, movement, biomechanics, injury.

**Reference:**

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*Read full paper online at:* www.jssm.org

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# Multidisciplinary high-tech research in Belgium

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MOBILAB is the K.H. Kempen University College high-tech research laboratory for new technologies in health care and rehabilitation. A multidisciplinary team of researchers develops and builds advanced equipment and methods to considerably improve the quality of life. The expertise of the researchers is primarily focused on three research fields: biomedical technology, rehabilitation technology, and orthopaedic technology.

MOBILAB operates in close collaboration with hospitals, rehabilitation and care centers, and international health care related companies. Their questions and experiences are the starting point for applied research to improve diagnostic (diseases, pain, malfunctioning…) and therapeutic tools (treatments, methods, equipment…).

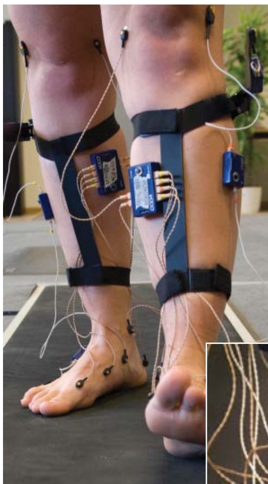
MOBILAB is devoted to improve the quality of life. It strives to be leading in its three fields of research, with acknowledged expertise, in favour of the health care sector (non profit), biomedical enterprises (profit) and the government. Their strategy is as follows:

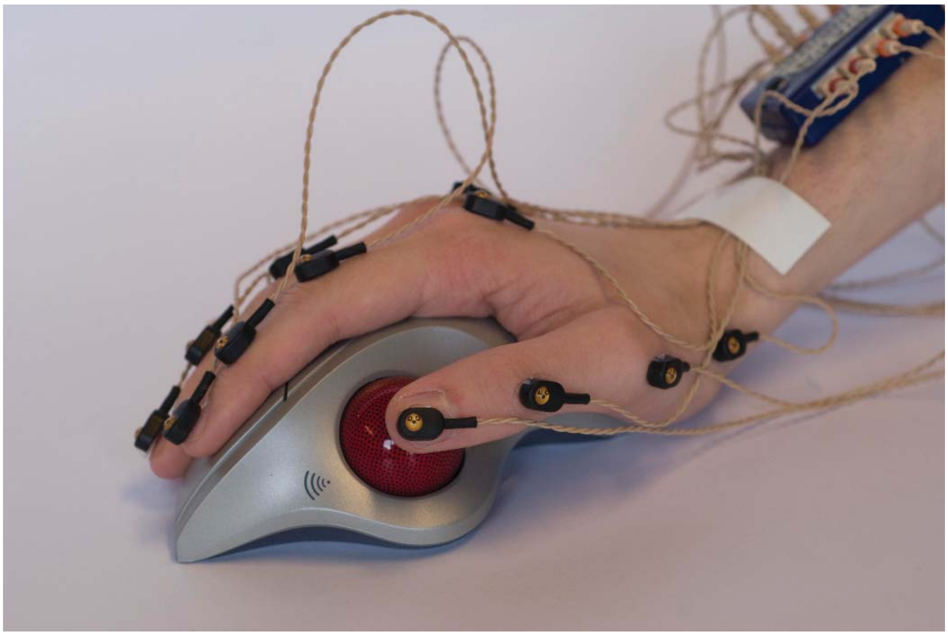
- integrating applied research in a relevant social framework with a clear vision on man and society
- dissemination of knowledge through high quality scientific and working field publications
- developing future oriented technology for efficient health care
- developing technical aids in shoe technology, orthopaedics and rehabilitation technology
- offering technological support to other areas within biomedical technology
- comprehensively integrating research and education efforts in order to stimulate young people to build their careers within the health care technology sector.

The multidisciplinary MOBILAB team totalises more than 20 researchers amongst whom medical doctors, engineers, physical therapists, orthopaedic technicians, nurses. They all work closely together under the inspiring leadership of prof. dr. Louis Peeraer and dr. ir. Bart Vanrumste.

Laboratory equipment comprises:

- 21.5 m walkway
- mobile 3D kinematics measurement system with active markers (CODAMOTION)
- pressure and force plates (AMTI – RSscan)
- high speed camera
- mobile 3D topography system (VIALUX)
- wireless EMG monitoring system (DELSYS)
- body monitoring devices
- high quality image and video acquisition system with stereo near infrared cameras (CYPRESS)





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