Association of quadriceps and hamstring muscle strengths with low back pain due to non-contact injuries among fast bowlers aged between 15 – 19 years in division 1 boys' schools in Colombo

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Abstract. The purpose of this study was to investigate how quadriceps and hamstring muscle strengths associate with low back pain (LBP) due to non-contact injuries among 102 fast bowlers aged between 15-19 years at Colombo division 1 boys' schools in Sri Lanka. Eighty-five fast bowlers were fulfilled the requirements and an interviewer administered questionnaire was used to gather the demographic data regarding general characteristics and the severity of low back pain respectively. Bowlers were prospectively monitored over the competition period of 2019 cricket season and the quadriceps and hamstring muscle strengths were recorded. SPSS software was used to analyse the data. Thirty-seven (43.5%) of the subjects were presented with LBP due to non-contact injuries. Reduction of quadriceps strength of dominant side leg and hamstring strength of non-dominant side leg were found to be significantly associated with LBP ($P<0.05$). Conflicting results were found for the association of quadriceps strength of non-dominant side leg and hamstring strength of dominant side leg with LBP ($P>0.05$). There was a significant difference for the quadriceps strength of dominant side leg and hamstring strength of non-dominant side leg between the fast bowlers with and without lower back pain. The results concluded that reduced quadriceps muscle strength of dominant side leg and reduced hamstring muscle strength of non-dominant side leg have an important role in predisposing a fast bowler to have an increase in low back pain which occurred due to non-contact injuries.

Keywords: quadriceps strength, hamstring strength, low back pain, non-contact injuries, fast bowlers, age 15-19 years

Extended Abstract

Introduction

Cricket is considered as a team sport which is described as the gentlemen's game originated in South East England and has globally developed by today. Fast bowlers have a long run up and generate more speed in bowling/ releasing the ball when compared with the spinners. Run up, pre-delivery stride, delivery stride and follow through are the main components of a fast bowling action (Mathew et al., 2016).

Non-contact injury is defined as the occurrence of an injury without any collision mechanism with an external force; players or objects (Forrest et al., 2017). Right lower limb can be described as ipsilateral leg/ dominant leg/ non-preferred leg while left lower limb as contralateral leg/ non-dominant leg/ preferred leg regarding to a right arm fast bowler. Fast bowlers are more prone to get injuries due to their heavy workload and repetitive stress acts through body alignments which results from ground reaction force (GRF) during front foot impact and back foot impact comparing to other different roles in cricket (Elliott, 2000). The prevalence of injury among fast bowlers were 8% in international cricket (Mount, et al., 2014) and 14% in Australian first class level fast bowlers (Orchard, 2002). According to

Pardiwala, et al., (2017), Australian, South African, English, West Indian and Indian bowlers are the one who experienced more injuries (41.3%). Gamage et al., (2018) observed lower limbs and lower back strains and sprains are at greatest injury incidence in Sri Lankan junior cricket bowlers with 20.3% and match injury incidence rate is 5.7.

Ground reaction force will result a stress force on lumbar spine through foot, ankle, knee and hip kinematic chain. This GRF is absorbed by the knee joint through the lumbar spine. Weakened quadriceps and hamstring muscles result on stiffness of knee joint and this cause reduction of shock absorption on the knee joint and increase the force on the lumbar spine, which increases the vulnerability to low back injuries (Cai and Kong 2015). Limitations in hamstring and quadriceps strengths have a connection with lower back injuries in highly active sportsmen (Murphy, 1997) especially when they are young and playing a high-risk sport such as cricket fast bowling (Millson et al., 2004). Hamstring and quadriceps strains which occurred secondarily to the weakness of those muscles have an association with lumbar stress fractures (Orchard et al., 2010) which is the most severe condition in young fast bowler (Pardiwala et al., 2017).

Thus, the aim of this study was to examine the association of quadriceps and hamstring muscle strengths with low back pain due to non-contact injuries among fast bowlers aged between 15-19 years in division 1 boy's schools in Colombo. School fast bowlers those who are yet having time to mature physically are susceptible for injuries and they are the ones who are going to represent the national team in near future. This research will open up the pathways to evolving of many other research topics related to school level cricketers about what they are going to face in the future.

Methodology

This descriptive cross-sectional study was conducted with 102 subjects in the competition period of 2019 cricket season among all the division 1 boys' schools in Colombo.

The subjects with a history of any neurological disorders, cardio-vascular diseases, experience a pain in any area that different from lower back region, complaint of pain more than 6 in the NPRS of any joint which will be used in the test procedures and intolerable pain during the measurement gaining procedures were excluded. The data provided by the fast bowlers were collected and recorded following taking the written informed consent and explaining the procedure of the research. Selected subjects performed a 5 minutes warm up session and 5 minutes static stretching exercises specially targeting the quadriceps, hamstring, lower back and upper extremity muscle groups in order to minimize the variability and the standard error of the measurements by reducing the impact of different muscle temperature on muscle flexibility.

Before administrating the questionnaires and the data collection tools to the study participants, it was administered to randomly select 10 male fast bowler between 15-19 years old, who were outside the defined study area.

Height was measured by using the Seca stadiometer 282 (SecaGmBH and Co kg, Hamburg, and Germany) and weight using the Tanita HD 318 digital weighing scale (Tanita Cooperation, Tokyo, Japan). Intensity of pain was measured by using Numerical Pain Rating Scale (NPRS).

Quadriceps and hamstring muscle strength and muscle strength were measured by using a modified sphygmomanometer which was made by making adaptations to a sphygmomanometer. The inflatable part was folded into four equal parts and the remaining velcro part was wrapped around the inflatable part and fixed with adhesive tape. Before the sphygmomanometer was taken to the data collection it was calibrated using 2kg weights to

check whether it provides consistent measurements. When taking the measurement of quadriceps strength, athlete was sitting in 90 degrees flexed hip and 90 degrees flexed knee position. The cuff was placed just above the ankle in line with the knee joint in the anterior side. When assessing the hamstring strength, the athlete was in prone lying position with knees extended fully. During the test, athletes were asked to perform maximum isometric contraction for five seconds. Athletes were given a 10 second rest in between each repetition. Three repetitions were given to an individual athlete to perform.

Data analysis was done using the statistical package for the social science (SPSS) software. As the variable data did not express a normal distribution across the sample, non-parametric tests were used to analyze the data. Mann Whitney U test was used to assess the difference between the fast bowlers with and without LBP. Spearman correlation was used to assess the association between two variables. P < 0.05 was considered for significant level.

Results

Eighty-five (85) fast bowlers were recruited and 17 were excluded from a preliminary sample of 102. No adverse effects were observed during the measurements. The mean age of study population was 16.6 ± 1.0 years. The Prevalence of LBP was 43.5% in the study population. The majority of the population is with right arm bowlers (91%) while the remaining of the population (9%) is with left arm.

Table 1. Distribution of variables in the study population

	Median values (n=85)		**P-value**
	With LBP (n=37)	**Without LBP (n=48)**	
Age (years)	17.0	17.0	0.81
Bowling experience (years)	6.0	6.0	0.83
Training period (hours per week)	2.0	3.0	0.08
Body Mass Index (kg/m^{-2})	20.0	21.1	0.26
Quadriceps strength of non-dominant side (mmHg)	142.0	152.5	0.12
Quadriceps strength of dominant side (mmHg)	147.0	163.0	0.01*
Hamstring strength of non-dominant side (mmHg)	101.0	117.0	0.04*
Hamstring strength of dominant side (mmHg)	108.0	119.0	0.35

P-value → significant level * p < .05 → significant

Table 2. Association of variables with low back pain of the study population

	Low Back Pain	
	r_{sp}	**P-value**
Age (years)	-0.01	0.96
Experience (years)	0.01	0.99
Training period (hours per week)	-0.24	0.13
Body Mass Index (kg/m^{-2})	-0.17	0.11
Quadriceps strength of non-dominant side (mmHg)	-0.18	0.11
Quadriceps strength of dominant side (mmHg)	-0.34*	0.01*
Hamstring strength of non-dominant side (mmHg)	-0.28*	0.01*
Hamstring strength of dominant side (mmHg)	-0.15	0.17

r_{sp} → sperman's correlation P-value → significant level * p < .05 → significant

As the data did not show a normal distribution, non-parametric median values were used to assess the difference between two variables (Table 1). The general characteristics (age, experience, training period and BMI) did not show any significant difference between the fast bowlers with and without LBP (p>0.05). But it showed a highly significant difference for the quadriceps strength of dominant side and hamstring strength of non-dominant side between the fast bowlers with and without LBP (p<0.05).

Association of general characteristics and muscle strengths with the low back pain of the

study population was evaluated in Table 2. There were negative correlations for the age, training period and BMI and positive correlation for the bowling experience with LBP of the study population which were insignificant. The quadriceps strength of dominant side and the hamstring strength of non- dominant side were significantly negatively correlated with the LBP ($p<0.05$) while quadriceps strength of non-dominant side and hamstring strength of dominant side were negatively correlated with the LBP insignificantly.

Discussion

This study describes the association of quadriceps and hamstring muscle strengths with low back pain due to non-contact injuries in adolescent male fast bowlers playing for division 1 Colombo boys' schools aged between 15-19 years. Previously some studies had been conducted, but mostly focusing on only one or different intrinsic factor related to LBP in Asian region and non-Asian region. This is the first research study presenting quadriceps and hamstring muscle strengths as associated intrinsic factors to fast bowlers' low back pain due to non-contact injuries in Sri Lankan region.

In the present study, the mean age of the study population was 16.6 ±1.0 years. Similar to present study, Foster et al., (1989) also explained that the age of the fast bowlers (mean age=16.8) might be susceptible for high incidence of back injuries (LBI) due to incomplete ossification of neural arches of lumbar vertebrae. Many of the research studies revealed that younger players (16-20 years) are more prone for lower back injuries among fast bowlers, mainly lumbar stress injuries (Engstrom and Walker, 2007; Foster et al., 1989; Hardcastle et al., 1992). Young cricketers had more trunk and back injuries, on-field injuries and more recurrent injuries than the adult cricketers (Stretch, 2014).

When considering BMI, there was no significant association between the BMI value of the male fast bowlers and their LBP in the current study. Also, there were lack of evidences to support the resulted conclusion with regard to LBP of fast bowlers and BMI. With opposed in a clinic based cross-sectional studies (with back pain patients) stated that LBI are common among the people with higher BMI and obese and overweight subjects presented with severe LBP (Chowdhury et al., 2014). However, the current study differs from a clinical based study as the current study directed from a sample of elite fast bowlers. Therefore, BMI should be compared using a similar sample of elite fast bowlers with a similar geographical and ethnic area and also differentiate in various age groups for further clarification.

In the current study, reduction of the dominant side quadriceps muscle strength showed a highly significant association with the LBP in fast bowlers. Foster et al. (1989) had supported that weakened quadriceps muscle strength lead to low back injuries. Normally during run up phase, the generated GRF was absorbed by the knee joint and the lumbar spine and the reduction of quadriceps and hamstring muscle strength resulted on improving knee joint stiffness and this caused reduction of shock absorption on the knee joint and increased the force on the lumbar spine, which increases the vulnerability to LBI (Cai and Kong 2015). A systemic review was done using a non-sport population who suffered from nonspecific and chronic LBP for more than 03 months and a healthy population as the control group and lower limb muscle power was checked. It was determined that muscle power of knee extensors was greatly reduced in nonspecific chronic LPB group than the control group (De Sousa et al., 2019). In contrast, a study was done by using fast bowlers aged between 18- 22 years interpreted that quadriceps muscle strength of non-dominant side was associated with LBP of fast bowlers (Foster et al., 1989). In fast bowlers, quadriceps and hamstrings

muscles are repeatedly contracted eccentrically and concentrically through the run up phase and a peak vertical GRF and a horizontal GRF exert on the dominant side leg on delivery stride (Feros, 2015). But the relationship between the hamstrings and quadriceps muscle strength of the dominant side and LBI was not identified clearly (Elliott et al.,1989).

Reduced hamstring strength of the non-dominant side was strongly associated with high risk of LBP among the current study population. Recently it was evident in some articles (Burton, 2012; de Sousa et al., 2019) that reduced hamstring muscle strength cause LBP. Hamstring and quadriceps muscles were possessed with equal flexibility, length and strength in order to stabilize the movements of knee and pelvis as a pulley system. When hamstrings weakened than quadriceps muscle, it resulted a downward pull of pelvis by tightened quadriceps, since hamstring muscles was unable counter balance the pull. That downward pull of pelvis caused hyperextended lumbar spine. Due to the changed vertebral angle of the spine, the pressure placed on intervertebral discs was increased which would lead to lower back injuries (Burton, 2012). To support the current study, Madic et al., (2019) conducted a study with professional soccer players to investigate the correlation of strength and imbalances of knee muscles with LBP. The study showed a satisfactory difference in peak torque of left and right knee flexors between players with and without LBP. Although there were limited literatures done related to association of hamstring strength in prevalence of LBP in cricket fast bowlers, a recent study has interpreted a contrast result to our current study concluded that there was no significant variant between hamstring strength of persons with LBP and without LBP, but using a non-sport related population. (de Sousa et al., 2019).

Conclusions

In summary, the findings of this study revealed that none of the general characteristics which are age, BMI, training hours per week and experience did not contribute to develop low back pain symptoms among the adolescent fast bowlers aged between 15-19 years. The higher muscular strength of dominant side quadriceps muscle and non-dominant side hamstring muscle having less probability to develop LBP.

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