FACTA UNIVERSITATIS
Series: **Physical Education and Sport** Vol. 8, No 2, 2010, pp. 125 - 132

Original empirical article

THE CORRELATION BETWEEN BACK STRENGTH AND LEG STRENGTH AMONG INDIAN INTER-UNIVERSITY MALE CRICKETERS

UDC 796.358:572.087

Shyamal Koley[1], Aseem Khajuria[1], Sheri Melton[2]

[1]Guru Nanak Dev University, Department of Sports Medicine and Physiotherapy, Amritsar, Punjab, India
[2]West Chester University of Pennsylvania, Kinesiology Department, West Chester, PA, USA

Abstract. *The purpose of this cross-sectional study was of two-fold: firstly, to evaluate the back strength of Indian inter-university male cricketers and secondly, to study its relation to leg strength, along with selected anthropometric characteristics. Thirteen anthropometric characteristics were from 98 Indian inter-university male cricketers aged 16–25 (mean age 21.03, ± 1.72), all students at nine Indian universities, and the competition was held in Guru Nanak Dev University, Amritsar, Punjab, India. An adequate number of control participants (n = 99, mean age 21.50, ± 1.13) were also collected from students at the host university for comparison. The findings of the present study indicated statistically significant differences ($p \leq 0.05$) in weight, BMI, thigh length, total leg length, biceps, triceps, sub-scapular and calf skinfolds, percentage of body fat and back strength between the cricketers and control participants. The striking findings of the present study were that back strength showed significant positive correlations only with leg strength but not with any of the other studied anthropometric characteristics.*

Key words: *anthropometric characteristics, back strength, leg strength, Indian inter-university male cricketers.*

Received May 01, 2010 / Accepted October 13, 2010
Corresponding author: Shyamal Koley
Department of Sports Medicine and Physiotherapy, Guru Nanak Dev University, Amritsar-143005, Punjab, India
Tel: +91 0183 2258802-09, Ext. 3338 • Tel: +91 0183 2258820 • E-mail: drkoley@yahoo.co.uk
Acknowledgements. *Authors are thankful to the cricketers and the coaches for their cooperation during collecting the data.*

INTRODUCTION

Cricket is a popular team game in most Commonwealth countries. In the past it was played solely within a specific season (winter in Asian countries and summer in western countries). But the game has gained so much popularity in the last three decades, it is now played throughout the year. Cricketers are therefore exposed to more demanding schedules, with longer periods of training and practicing. The increased workload may be one of the contributing factors to the increased incidence of injuries (Davies et al., 2008).

Several studies revealed that muscle strength is critical to health and well-being (Kraus & Hirschland, 1953; McDonangh & Davies, 1984; Astrand & Rodahl, 1986) and is therefore considered to be a major component of fitness. Various factors, such as altitude (Ruff & Strughold, 1942), diet (Keys et al., 1950), age, sex (Mathiowetz et al., 1985) influence the maximum force that can be exerted by a muscle (Berne & Levy, 1983). In play positions such as bowling, fielding and batting, great strength of the back muscles is required. Mechanical factors play an important role in the etiology of degenerative processes and injuries to the lumbar spine. Especially in fast bowling, where a player must absorb vertical and horizontal components of the ground reaction force that are approximately five and two times body weight at front-foot and rear-foot impact respectively, assessment of back strength is essential (Foster et al., 1989).

The maximum capacity of the back muscles must be known if assessments are to be made of muscle endurance followed by muscle fatigue during playing conditions (Mannion et al., 1999). However, the anatomical and biomechanical structures of the back are extremely complex and consequently, the accurate measuring of back muscle strength is problematic outside of a research setting. If a relationship exists between back strength and easily obtainable anthropometric or strength measurements, coaches and trainers could make reliable estimates using simple methods in the field.

Anthropometric dimensions and morphological characteristics play an important role in determining the success of an athlete (Reco-Sanz, 1998; Wilmore & Costill, 1999; Keogh, 1999). It has been well established that specific physical characteristics or anthropometric profiles indicate whether the player would be suitable for competition at the highest level in a specific sport (Claessens et al. 1999; Bourgois et al., 2000; Reilly et al., 2000; Gabbett, 2000; Ackland et al., 2003; Slater et al., 2005). Some literature related to anthropometric research involving cricketers is available (Jones et al., 1965; Foster & Elliott, 1985; Elliott et al., 1986; Stretch, 1987, 1991, Kumar et al., 2007, Koley & Yadav, 2009; Koley et al., 2009; Nande et al., 2009). Literature that focuses on the importance of the relationship between anthropometric characteristics and back and leg strength for optimum performance in cricketers is limited. This is especially true for Indian cricketers. Therefore, the purpose of this study was to determine if the back and leg strength of cricketers would be greater than that of the matched control participants and if the strength would be related to selected anthropometric variables in a statistically significant manner.

METHODS

Participants

The participants in this study were Indian inter-university male cricketers (n = 98) aged 16–25 years (mean 21.03, ± 1.72) who were participating in an inter-university cricket competition organized by Guru Nanak Dev University in Amritsar, Punjab, India. The universities were Punjabi University, Patiala, Punjab University, Chandigarh, Guru Nanak Dev University, Amritsar, Punjab Agricultural University, Ludhiana, Kurukshetra University, Kurukshetra, Guru Jambeswar University, Hisar, Jammu University, Jammu, Himachal Pradesh University, Himachal Pradesh and Delhi University, Delhi. An adequate number of control participants (n = 99, mean age 21.50, ± 1.13) with no particular playing background were also collected from the same place for comparison. The age of the participants was recorded based on the date of birth registered in their respective institutions. The participants were divided in such a way that age 16 refers to the individuals aged 15 years and 6 months through 16 years and 5 months and 29 days. The participants were divided into three age groups, viz. 16 – 18 year-olds, 19 – 21 year-olds and 22 – 25 year-olds for further analyses. Written consent was obtained from the participants. The study was approved by the local ethics committee.

Procedures

Anthropometry

The data were collected under natural environmental conditions in the morning (between 8 AM. and 12 noon). The instruments, viz. stadiometer, weighing machine, Harpenden skinfold caliper and back-leg-chest dynamometer were calibrated prior to use and all of the measurements were taken on the participant's right side. Thirteen anthropometric characteristics, viz. height, weight, BMI, thigh length, lower leg length, total leg length, biceps, triceps, sub scapular and calf skinfold, percent of body fat, as well as back strength, and leg strength were taken for each participant. The anthropometric limb characteristics of the participants were measured using the techniques provided by Lohmann et al. (1988), and were measured in triplicate with the median value used as the criterion.

Height was recorded during inspiration using a stadiometer (Holtain Ltd., Crymych, Dyfed, UK) to the nearest 0.1 cm, and weight was measured by digital standing scales (Model DS-410, Seiko, Tokyo, Japan) to the nearest 0.1 kg. The body mass index (BMI) was then calculated using the formula, BMI = body weight (kg) / height^2 (m)^2 after Meltzer et al. (1988). Percent of body fat was assessed using skinfold measurements taken from four sites, viz. biceps, triceps, sub scapular and calf using Harpenden skinfold caliper (Holtain Ltd, Crosswell, Crymych, UK) to the nearest 0.2 mm, and using the Durnin and Womersley skinfold equation.

Back strength measurement

Back strength of the participants was measured using a Back-leg-chest dynamometer. After 3 minutes of independent warm-up time, the participant was positioned with body erect and knees bent so that the grasping hand rests at proper height. Then, by straightening the knees and lifting the chain of the dynamometer, pulling force was applied on the handle. The body would be inclined forward at an angle of 60 degrees for the meas-

urement of back strength. The strength of the back muscles was recorded on the dial of the dynamometer as the best of three trials in kg. A thirty-second time interval separated each back strength testing.

Leg strength measurement

Leg strength was also measured using a back-leg-chest dynamometer. The participant was asked to stand erect with knees bent so that the grasping hand rests at proper height. The individual then lifted the handle of the dynamometer, bending his legs, and then straightened the legs. The strength of the leg muscles was recorded on the dial of the dynamometer as the best of three trials in kg. Thirty-second time intervals separated each leg strength test.

Data analysis

Standard descriptive statistics (mean ± standard deviation) were determined for the directly measured and derived variables. The student t-test was used for the comparison of various anthropometric variables between the cricketers and control participants. A one-way analysis of variance was tested for the age-wise comparisons of data among Indian inter-university male cricketers and the control participants, followed by post hoc Bonferroni test (if found significant). Pearson's correlation coefficients were applied to establish the relationships among the measured variables. A multiple regression analysis was also done. The data were analyzed using SPSS (Statistical Package for Social Science) version 17.0. A 5% level of probability was used to indicate statistical significance.

RESULTS

Descriptive statistics of the anthropometric characteristics in the Indian inter-university male cricketers and control participants are shown in Table 1. The cricketers were slightly shorter and lighter, having smaller mean values for all the studied variables, except lower leg length, back strength and leg strength, than their control counterparts. Statistically significant differences ($p \leq 0.05$) were noted in thigh length, total leg length, triceps and calf skinfold, and highly significant differences ($p \leq 0.001$) in weight, BMI, sub scapular skinfold, percent of body fat and back strength between Indian inter-university male cricketers and the control participants.

Bivariate correlations of back and leg strength, and selected anthropometric characteristics were examined in Indian inter-university male cricketers in Table 2. Back strength has significant positive correlations ($p \leq .01$) with only leg strength, but not with any of the studied anthropometric characteristics. On the other hand, among the anthropometric variables, height has significant positive correlations ($p \leq .01$) with weight and three linear measurements, while weight has significantly positive correlations ($p \leq .05$ - .01) with BMI, two linear and skinfold measurements, and with percent of body fat. Thigh, lower leg and total leg length have significantly positive correlations ($p \leq .05$ - .01) among themselves and negative correlations ($p \leq .05$) with some of the skinfold measurements and percent of body fat. All four skinfold measurements have significantly positive correlations ($p \leq .01$) among themselves and with percent of body fat.

Table 1 Descriptive statistics of back and leg strength and selected anthropometric characteristics in Indian inter-university male cricketers and the controls participants

Variable	Cricketers (n=98)		Control (n=99)		
	Mean	S.D	Mean	S.D	P
Height(cm)	171.00	7.10	172.10	5.19	NS
Weight(kg)	61.83	9.60	69.93	11.85	.001
BMI(kg/m^2)	21.09	2.70	23.57	3.61	.001
Thigh length(cm)	51.49	3.30	53.21	4.80	.05
Lower leg length(cm)	44.47	2.90	43.68	3.75	NS
Total leg length(cm)	95.91	5.30	97.51	4.77	.05
Biceps skin fold (mm)	5.27	1.86	6.57	1.64	.001
Triceps skin fold (mm)	8.51	2.70	9.25	2.06	.05
Subscapular skin fold (mm)	10.43	2.89	12.27	2.82	.001
Calf skin fold (mm)	9.95	2.50	11.03	1.97	.001
Percent body fat (%)	15.79	3.63	19.11	4.84	.001
Back strength(kg)	106.00	23.40	85.07	24.91	.001
Leg strength (kg)	52.36	12.90	52.27	16.20	NS

Table 2 Inter-correlation matrix of back and leg strength and selected anthropometric characteristics of Indian inter-university male cricketers

Variables	WT	BMI	TL	LLL	TLL	BSK	TSK	SSSK	CSK	%BF	BST	LST
HT	.57**	.04	.58**	.69**	.77**	-.02	-.15	.03	.01	-.04	-.10	-.07
WT		.84**	.20	.38**	.34**	.20*	.18	.25*	.14	.24*	.02	.07
BMI			-.14	.01	-.08	.27*	.32**	.29*	.16	.33**	.10	.13
TL				.37**	.81**	-.02	-.16	-.11	.00	-.14	-.05	-.04
LLL					.78**	-.09	-.23*	-.17	-.19	-.21*	-.03	.01
TLL						-.10	-.26*	-.21*	-.12	-.25	-.04	-.04
BSK							.62**	.50**	.36**	.59**	.01	-.05
TSK								.73**	.58**	.90**	-.07	-.06
SSSK									.59**	.95**	.02	.02
CSK										.62**	-.04	.04
%BF											-.02	-.01
BST												.59**

* Significant at .05 level; ** Significant at .01 level; HT = Height; WT = Weight; BMI = Body mass index; TL = Thigh length; LLL = Lower leg length; TLL = Total leg length; BSK = Biceps skinfold; TSK = Triceps skinfold; SSSK = Subscapular skinfold; CSK = Calf skinfold, *BF = Percent body fat, BST = back strength; LST = Leg strength

DISCUSSION

Cricket is a field-based endurance game. Although everyone is required to bat and field during the match, generally, each player possesses specific skills that define their role and contribute to the overall performance of the game (Stuelcken et al., 2007). In the present study, Indian cricketers have significantly higher mean value for back strength than the control participants. These differences are probably due to regular physical exercise and

strenuous training programs of the cricketers. It is common in cricket for a fast bowler to experience a series of collisions with the ground in the run-ups, which are followed by a large impact at rear- and front- foot landing on the pitch during the delivery stride. The major impact with the pitch at the front foot strike generates peak forces of approximately five times body weight vertically and two times body weight horizontally, irrespective of the standard of performance (Elliott & Foster, 1984; Foster et al., 1989; Elliott, 2000). It is well established that anthropometric analysis of different sports have shown that optimum performance appears to have definite physical requirements (Tanner, 1964; Hebbelink et al., 1975; Alexander, 1976; Copley, 1980; Elliot & Smith, 1983; Stretch, 1987, 1991; Claessens et al., 1994; Landers et al., 2000; Slater et al., 2005). Furthermore, when the cricketers were divided into three age groups, viz. 16 – 18 years (younger group), 19 - 21 years (intermediate group) and 22 – 25 years of age (comparatively older group), younger cricketers (age group 16 – 18 years) show significant differences for almost all the characteristics studied than the older players (age groups 19 – 21 and 22 – 25 years) (Table not shown). Physical and physiological maturation factors might be the reason for these differences (if we take their age into consideration as well). In fact, it is well established that strength increases with age, which is the normal phenomena of growth. It reaches its peak after one attains full maturity. In the present study, among the anthropometric measurements, linear measurements have significantly positive correlations among themselves, as do the skinfold measurements, as was already known about the game. In the case of back strength, a statistically significant positive correlation was found only for leg strength, but not with any other anthropometric characteristics. It was the novel finding of the study. Due to the lack of reported references, the present data were not compared. Non-inclusion of female data was one of the limitations of the present study.

CONCLUSION

The findings of the present study carry immense practical application in the selection of talents in cricket as well as the utilization of bowlers (especially pacers) in the field. Back strength and leg strength are both very important in pace bowlers for the prevention of injury to the spine and the increase in performance and bowling pace. Batting also requires back and leg strength as batting requires frequent turning and bending of the back and if the back muscles are not strong enough to counteract these forces, then the batsman risks injury. It also leads to less force production during shot playing. Back and leg strength also play an important role in the game of cricket, especially for bowling and fielding. The data from this study showed that cricketers have stronger back and leg muscles than non-cricketers. Thus, for the holistic development of the game, the findings of the present study illustrate the value of back and leg strength and make a contribution to the current literature. Further study on this topic, however, is needed to validate the findings of this study.

REFERENCES

Ackland, T.R., Ong, K.B., Kerr, D.A. & Ridge, B. (2003). Morphological characteristics of Olympic sprint canoe and kayak paddlers. *Journal of Science and Medicine in Sport*, 6, 285-294.

Alexander, M.J. (1976). The relationship of somatotype and selected anthropometric measures of basketball performance in highly skilled females. *Research Quarterly*, 47 (4), 575-585.

Astrand, PO. & Rodahl, K. (1986). *Text Book of Work Physiology: Physiological Cases of Exercise.* 2nd Ed. McGraw-Hill Inc., New York.

Berne, R.M. & Levy, M.N. (1983). Physiology. St. Louis, MO.: CV Mosby Co.

Bourgois, J., Albrecht, L., Claessens, J. V., Renaat, P., Renterghem, B.V., Thomis, M., Janssens, M., Loos, R. & Lefevre, J. (2000). Anthropometric characteristics of elite male junior rowers. *British Journal of Sports Medicine,* 34, 213-216.

Claessens, A.L., Hlatky, S., Lefevre, J. & Holdhaus, H. (1994). The role of anthropometric characteristics in modern pentathlon performance in female athletes. *Journal of Sports Sciences*, 12, 391-401.

Claessens, A.L., Lefevre, J., Beunen, G. & Malina, R.M. (1999). The contribution of anthropometric characteristics to performance scores in elite female gymnasts. *Journal of Sports Medicine and Physical Fitness,* 39, 355-360.

Copley, B.B. (1980). *An anthropometric, somatotypological and physiological study on tennis players with special reference to the effects of training.* Ph.D. Thesis, University of Witwatersrand, Johannesburg, South Africa.

Davies, R., du-Randt, R., Venter, D. & Stretch, R. (2008). Cricket: Nature and incidence of fast-bowling injuries at an elite, junior level and associated risk factors. *South African Journal of Sports Medicine,* 20 (4), 115-119.

Elliott, B.C. (2000). Back injuries and the fast bowler in cricket. *Journal of Sports Sciences*, 18, 983-991.

Elliott, B. & Smith, J. (1983). The relationship of selected biomechanical and anthropometric measures to accuracy in netball shooting. *Journal of Human Movement Studies*, 9, 171-187.

Elliott, B. & Foster, D. (1984). A biomechanical analysis of the front-on and side-on fast bowling techniques. *Journal of Human Movement Studies*, 10, 83-94.

Elliot, B.C., Foster, D.H. & Gray, S. (1986). Biomechanical and physical factors influencing fast bowling. *Australian Journal of Science and Medicine in Sport*, 18, 16-21.

Foster, D. & Elliot, B. (1985). Fast bowling- An impact sport: A profile of D.K. Lillee. *Sports Coach,* 9 (3), 3-8.

Foster, D., John, D., Elliott, B., Ackland, T. & Fitch, K. (1989). Back injuries to fast bowlers in cricket: A prospective study. *British Journal of Sports Medicine*, 23, 150-154.

Gabbet, T.J. (2000). Physiological and anthropometric characteristics amateur rugby players. *British Journal of Sports Medicine,* 34, 303-307.

Hebblink, M., Carter, L. & De Gray, A. (1975). *Body build and somatotype of Olympic swimmers, divers and water polo players*. In Liwillie, L. & Clarys, J.P. (eds.), Swimming II, Baltimore: University Park Press.

Jones, P.R.M., Worth, W.J.C., Stones, P.G., Ellis, M.J. & Jeffrey, J.A. (1965). *The influence of somatotype and anthropometric measures on hear-rate during work in students and specialist sporting groups*. Loughborough, College of technology.

Keogh, J. (1999). The use of physical fitness scores and anthropometric data to predict selection in an elite under-18 Australian rules football team. *Journal of Sport Science and Medicine,* 2, 125–133.

Keys, A., Brozek, J., Henschel, A., Mickelsen, O. & Taylor, HN. (1950). *Biology of Human Starvation*. University of Minnesota Press, Minneapolis.

Koley, S. & Yadav, M.K. (2009). An association of hand grip strength with some anthropometric variables in Indian cricket players. *Facta Universitatis, Series: Physical Education and Sports*, 7 (2), 113-123.

Koley, S., Yadav, M.K. & Sandhu, J.S. (2009). Estimation of hand grip strength and its association with some anthropometric traits in Cricketers of Amritsar, Punjab, India. *Internet Journal of Biological Anthropology*. 3 (1).

Kraus, H. & Hirschland, RP. (1953). Minimum muscular fitness tests in schools children. *Research Quarterly*, 25, 177-188.

Kumar, A., Koley, S. & Sandhu, J.S. (2007). Anthropometric and physiological relationship of cricketers. *Research Bi-Annual for Movement*, 23 (2), 34-45

Landers, G.J., Blanksby, B.A., Ackland, T.R. & Smith, D. (2000). Morphology and performance of world championship triathletes. *Annals of Human Biology*, 27, 387-400.

Lohmann, T.G., Roche, A.F. & Martorell, R. (1988). *Anthropometric Standardization Reference Manual.* Champaign, IL: Human Kinetics Books.

Mannion, A.F., Adams, M.A., Cooper, R.G. & Dolan, P. (1999). Prediction of maximal back muscle strength from indices of body mass and fat-free body mass. *Rheumatology*, 38, 652-655.

Mathiowetz, V., Rennells, C. & Donahoe, L. (1985). Grip and pinch strength: Normative data for adults. *Archives for Physical Medicine and Rehabilitation*, 66, 69-74.

McDonangh, M.J.N. & Davies, C.T.M. (1984). Adaptive response of mammalian skeletal muscle to exercise with high loads. *European Journal of Applied Physiology*, 52, 139-155.

Meltzer, A., Mueller, W., Annegers, J., Grimes, B. & Albright, D. (1988). Weight history and hypertension. *Journal of Clinical Epidemiology*, 41, 867-874.

Nande, P.J., Mudafale, V. & Vali, S.A. (2009). Anthropometric profile of female and male players engaged in different sports disciplines. *The International Journal of Nutrition and Wellness*, 8 (1). Retrieved 30.03.2010, from

http://www.ispub.com/journal/the_internet_journal_of_nutrition_and_wellness/volume_8_number_1_15/article/anthropometric-profile-of-female-and-male-players-engaged-in-different-sports-disciplines.html
Reilly, T., Bangsbo, J. & Franks, A. (2000). Anthropometric and physiological predispositions for elite soccer. *Journal of Sports Sciences,* 18 (9), 669-683.
Rico-Sanz, J. (1998). Body composition and nutritional assessments in soccer. *International Journal of Sport Nutrition*, 8, 113–123.
Ruff, S. & Strughhold, H. (1942). *Compendium of Aviation Medicine*. WADA Technical Report 14. OH.Wright Air Development Centre, Air Research and Development Command. United States Air Force pp. 32-34.
Slater, G.J., Rice, A.J., Mujika, I., Hahn, A.G., Sharp, K. & Jenkins, D.G. (2005). Physique traits of lightweight rowers and their relationship to competitive success. *British Journal of Sports Medicine,* 39, 736-741.
Stretch, R.A. (1987). Anthropometric profile of first-class cricketers. *South African Journal for Research in Sport, Physical Education and Recreation,* 10 (1), 65-75.
Stretch, R.A. (1991). Anthropometric profile and body composition changes in first-class cricketers. *South African Journal for Research in Sport, Physical Education and Recreation,* 14 (2), 57-64.
Stuelcken, M., Pyne, D. & Sicclair, P. (2007). Anthropometric characteristics of elite cricket fast bowlers. *Journal of Sports Sciences*, 25 (14), 1587-1597.
Tanner, J.M. (1964). *The Physique of the Olympic Athlete*. London: George Allen and Unwin.
Wilmore, J.H. & Costill, D.L. (1999). *Physiology of Sports and Exercise*. 2nd ed. Human Kinetics, Champaign, pp. 490–507.

KORELACIJA IZMEĐU SNAGE LEĐA I SNAGE NOGU KOD INDIJSKIH IGRAČA KRIKETA SA RAZLIČITIH UNIVERZITETA

Shyamal Koley, Aseem Khajuria, Sheri Melton

Cilj ovog istraživanja bio je dvostruk: pre svega da se uradi evaluacija snage leđa indijskih igrača kriketa sa različitih univerziteta, a kao drugo da se prouči odnos između snage leđa i snage nogu, uz procenu antropometrijskih karaktersitika. Trinaest antropometrijskih karakteristika od ukupno 98 igrača kriketa sa različitih univerziteta, starosti 16-25 godina (srednja vrednost 21,03 ± 1,72), od kojih su svi studenti sa devet univerziteta u Indiji, je procenjivano. Takmičenja u kriketu održala su se na Guru Nanak Dev univerzitetu, Amritsar, Punjab, Indija. Obezbeđen je adekvatan broj pripadnika kontrolne grupe za potrebe poređenja (n = 99, srednja vrednost godina starosti 21,50 ± 1,13), studenata sa univerziteta koji je takmičenjima bio domaćin. Rezultati istraživanja pokazali su statistički značajne razlike ($p \leq 0,05$) u pogledu težine, BMI, dužine butina, ukupne dužine nogu, bicepsa, tricepsa, nabora kože na leđima i listovima, procenta masnih naslaga u telu i snage leđa između igrača kriketa i članova kontrolne grupe. Rezultati istraživanja ukazuju da snaga leđa ima pozitivne korelacije sa snagom nogu ali ne i sa ostalim antropometrijskim karakteristikama.

Ključne reči: *antropometrijske karakteristike, snaga leđa, snaga nogu, igrači kriketa muškog pola sa različitih univerziteta u Indiji.*