# The Effect of Balance Training on Agility in Young Cricketers

**Swati Kubal**[1], **Dhananjay Padwal**[2]

[1]Physiotherapy College, TNMC, B.Y.L. Nair hospital, Mumbai, India

[2]Physiotherapy College, TNMC, B.Y.L. Nair hospital, Mumbai, India

**Abstract:** ***Studies of cricket injuries show an increasing incidence, varying from2.6 to 333/10 000 athlete hours played, 2–4 with 28.4–71.6% of cricketers[2] sustaining between 1.61 and 1.91 injuries per season. The purpose of this study was to determine the effect of 6-week balance training on agility in young cricketers. 66 young cricket players between the age group of 12-16 yrs were selected and randomly assigned to an experimental group and a control group. T agility test, Hexagonal agility test, Single limb stance test, Multi-directional reach test were used as outcome measures. The experimental group underwent 6 week balance training in addition to regular routine exercises. Experimental group showed significant improvement in balance and agility. T agility test performance improved from 13.36± 1.34 sec to 12.5± 1.35 sec. Hexagonal agility test performance improved from 20.25 ±3.08 to 17.52± 2.26. Thus it can be concluded that 6 weeks balance training programme improves agility in young cricketers.***

**Keywords:** Balance training, Agility

## 1. Introduction

Studies of cricket injuries show an increasing incidence, varying from 2.6 to 333/10 000 athlete hours played, 2–4 with 28.4–71.6% of cricketers[2] sustaining between 1.61 and 1.91 injuries per season. Fast bowlers, slow bowlers and batters all had a similar injury prevalence of approximately 5%.[1]

Neuromuscular training programs that include balance training are often implemented for optimizing performance, preventing injury, or providing rehabilitation. Emery CA, Cassidy JD and other authors [3-5] have shown the effectiveness of neuromuscular training programs that include balance training in reducing sport-related injury risk as well as in enhancing functional performance after sport injury[6]. Most authors[7,8] described balance and stabilization exercises, other authors defined neuromuscular training as multi-intervention programs with a combination of balance, strength, plyometric, agility, and sport-specific exercises. Thus, it is unclear whether a single intervention or the combination of various exercises is primarily responsible for the training effects. Because most investigators studied balance training, it is very likely that these exercises have a certain influence on neuromuscular control and functional performance. This view is supported by research proving that poor balance is a predictor of increased lower extremity injury risk in athletes. Any form of balance training assists in increase in proprioception, kinaesthetic awareness, and muscular strength.

Agility is defined as the ability to explosively start, decelerate, change direction, and accelerate again quickly while maintaining body control and minimizing a reduction in speed.[9,10 11,12, 13, 14]. Unfortunately, because of the focus placed on physical attributes, the focus on off-season programs often revolves around strength training and conditioning. It takes athletes weeks and months to see improvements in speed and agility.[15,16] Agility should be trained as an important component of the annual training program.

The relationship between balance ability and sport injury risk has been established in many cases,[17] the relationship between balance ability and athletic performance is less clear. There is evidence from randomized trials that multifaceted prevention programs, including proprioceptive balance training using a wobble board, are effective in reducing injuries to the lower extremities in specific sports.[18-25]

The relationship between balance ability and sport injury risk as well as performance has been studied by many authors, but the relationship between balance ability and agility is less clear. This study focuses on the effect of balance training on agility in young cricketers.

## 2. Methodology

Eighty nine young male cricket players between the age group of 12-16 were screened; sixty six of them were selected on the basis of inclusion criteria. The need of the study and study procedure was explained to them. Once written informed consent was obtained, subjects were randomly assigned to either an Experimental group or Control group using random number table, (n =33) or a control group (n=33). All players were assessed for balance and agility using T agility test, Hexagonal agility test, single limb stance test, multi-directional reach test. The experimental group underwent 6 week balance training programme in addition to regular routine exercises. The training program was conducted on Tuesday, Thursday, and Saturday. Each training session lasted for approximately 45 minutes. Before each training session, an active warm-up that included jogging and upper and lower body stretching was used. Control group followed the regular routine exercises. After 6 weeks training players were reassessed. Improvement in the balance and agility was analysed using the same tests. Details of balance training programme are given below.

**Inclusion criteria**
1) Young male Cricket players within the age group of 12-16 years.
2) Players who have undergone at least 2 years training.
3) Players who have no previous musculoskeletal injury.

**Exclusion criteria**
1) Players who had ankle sprain / ankle injury in last 6 month.
2) Lower limb soft tissues injuries and fractures in last 6-12 months.
3) Lower limb pain.

**Outcome Measures**
1) T agility test[50, 52]
2) Hexagonal agility test[52]
3) Single limb stance test[51,53,54]
4) Multi-directional reach test[55,57]

**Six - Week Balance Training Programme**

Week 1-2 (Eyes open)

| *Exercise* | *Sets* | *Repetitions* |
|---|---|---|
| Standing in tandem and passing the ball | 3 | 20 |
| Walking in tandem | 3 minutes | N.A. |
| Walking on toes | 3 minutes | N.A. |
| Single limb stance and passing the ball | 3 | 20 |
| Heel raises | 3 | 20 |
| Toe raises | 3 | 20 |

Week 3-4 (Eyes open)

| *Exercise* | *Sets* | *Repetitions* |
|---|---|---|
| Standing on in tandem and passing the ball | 3 | 20 |
| Walking in tandem | 3 minutes | N.A. |
| Walking on toes | 3 minutes | N.A. |
| Single limb stance and passing the ball | 3 | 20 |
| Heel raises | 3 | 20 |
| Toe raises | 3 | 20 |
| Front kicks, Back kicks, side kicks | 3 (each) | 20 (each) |
| Single limb squats | 2 | 20 |

Week 5-6 (Eyes closed)

| *Exercise* | *Sets* | *Repetition* |
|---|---|---|
| Standing on in tandem | 3 Minutes | N.A. |
| Single limb stance | 3 Minutes | N.A. |
| Heel raises | 3 | 20 |
| Toe raises | 3 | 20 |
| Front kicks, Back kicks, side kicks | 3 (each) | 20 (each) |
| Single limb squats | 2 | 20 |
| Walking on bricks (Eyes open) | 3 Minutes | N.A. |
| Wobble/ tilt board exercises (Eyes open) | 3 Minutes | N.A. |

**Data Analysis**

In total, 66 players were subjected to the training programme, 6 players dropped out of the study, 3 from the each group, out of 6 players 4 were injured, 1 did not report and 1 player did not participate due to personal reasons. Total 60 players completed the study. Experimental group (n=30) and Control group (n=30).The effect of 6 week balance training on agility was studied. Mean age of Experimental group was 14.40+/- 1.25 yrs and mean age of control group was 13.90 +/- 1.06 yrs. Mean height of experimental group was 150.48 +/- 5.87 and mean height of control group was 148.87 +/- 4.21. The data obtained were entered using MS-Excel-2007 and statistically analysed using SPSS-16 software.

The data of agility tests and balance tests, which passed tests of normality, parametric tests were used to analyse and the data which did not pass the test of normality non parametric tests were used. Within the group comparison was done using Paired T test / Wilcoxon Signed Rank Test. Comparison in between the groups was done by using Unpaired T test / Whitney U Test.

## 3. Results and Tables

**Table 1**

| Study Parameter | Experimental Group | | | | Control Group | | | | MannWhitney Test | P Value |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | S.D | Median | IQR | Mean | S.D. | Median | IQR | | |
| Age | 14.40 | 1.25 | 14 | 1.00 | 13.90 | 1.06 | 14 | 2.00 | 1.655 | 0.098 |
| Height | 150.48 | 5.87 | 149 | 6.50 | 148.87 | 4.21 | 148 | 5.00 | 1.000 | 0.317 |

**Table 2**

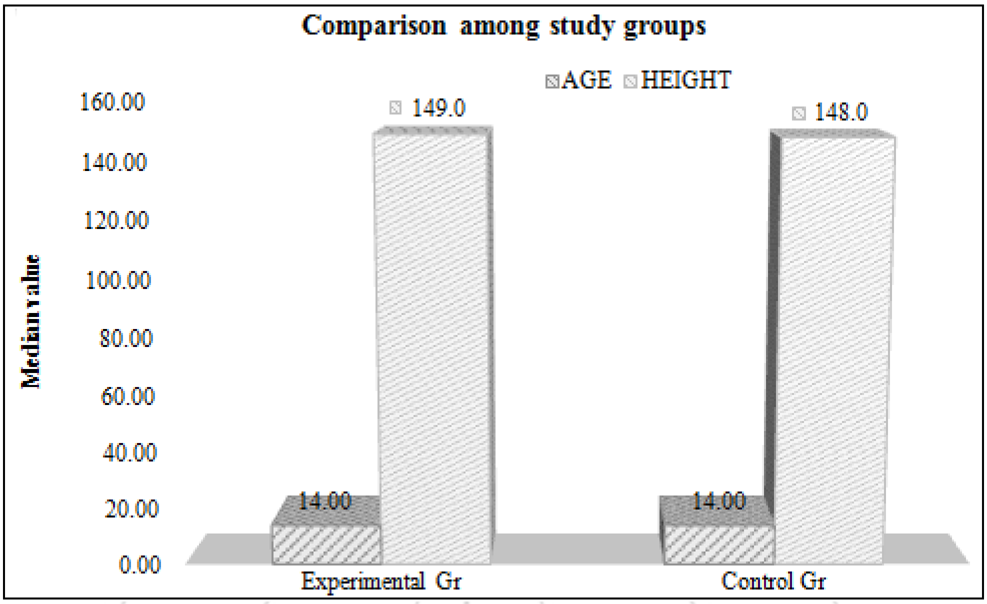
| Agility Tests | Experimental Group | | | | Control Group | | | | Unpaired T test | P Value |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | S.D | median | IQR | Mean | S.D | Median | IQR | | |
| T PRE | 13.36 | 1.34 | 13.18 | 1.83 | 13.90 | 1.11 | 13.64 | 1.50 | 1.694 | 0.096 |
| T POST | 12.50 | 1.35 | 12.27 | 1.48 | 14.88 | 1.06 | 14.78 | 1.20 | 7.626 | 0.000 |
| T (PRE-Post) | 0.86 | 0.43 | 0.86 | 0.60 | -0.99 | 0.43 | -0.90 | 0.52 | 16.625 | 0.000 |

**Table 3**

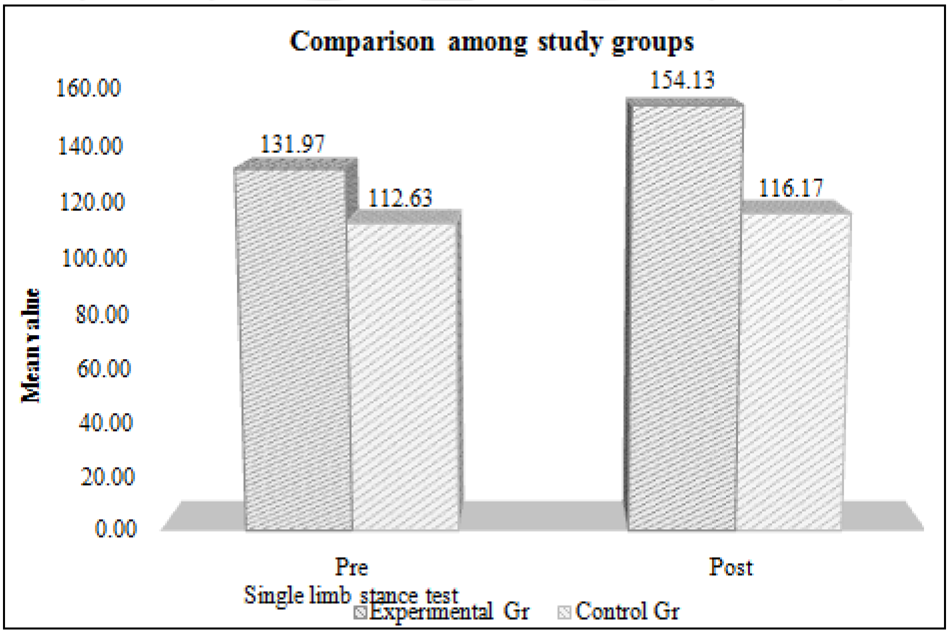
| Agility Tests Hexagonal | Experimental Group | | | | Control Group | | | | Mann Whitney U | P Value |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | S.D | Median | IQR | Mean | S.D | Median | IQR | | |
| PRE | 20.25 | 3.08 | 19.75 | 5.14 | 18.63 | 1.78 | 18.45 | 2.52 | 2.502 | 0.015 |
| POST | 17.52 | 2.26 | 16.91 | 4.29 | 19.71 | 1.81 | 19.51 | 2.69 | 4.144 | 0.000 |
| PRE-POST | 2.74 | 2.40 | 2.11 | 2.18 | -1.08 | 0.66 | -1.09 | 0.66 | 6.653 | 0.000 |

**Table 4**

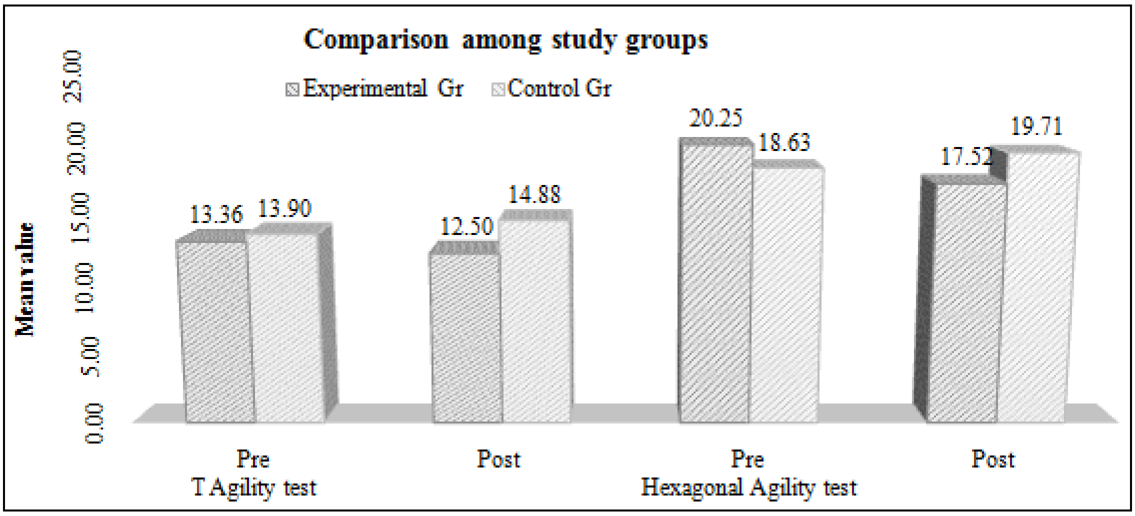
| Single limb stance test | Experimental Group | | | | Control Group | | | | Unpaired T test | P Value |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | S.D | Median | IQR | Mean | S.D | Median | IQR | | |
| PRE (sec) | 131.97 | 57.48 | 134 | 84 | 112.63 | 40.46 | 110 | 54 | 1.506 | 0.137 |
| Post (sec) | 154.13 | 50.74 | 155 | 76 | 116.17 | 39.77 | 103 | 69 | 3.226 | 0.002 |
| (Post-Pre) | 22.17 | 34.25 | 24 | 39 | 3.53 | 19.51 | 2.50 | 23 | 2.589 | 0.012 |



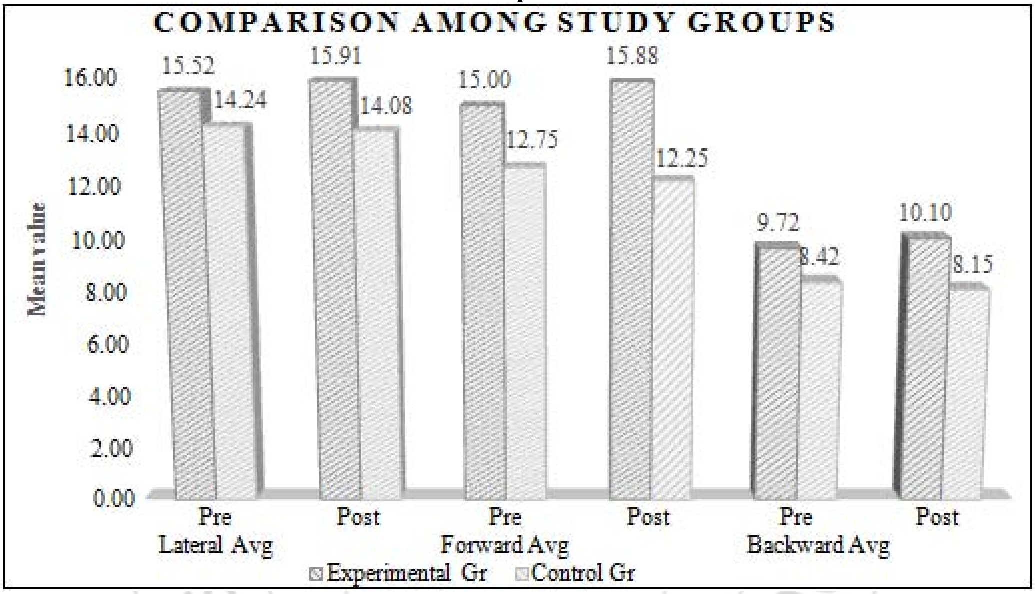

**Graph 1**




**Graph 2**




Graph 3




Graph 4

**Table 5**

| Multi-directional reach test | Experimental Group | | | | Control Group | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | S.D. | Median | IQR | Mean | S.D. | Median | IQR |
| Lateral PRE Avg | 15.52 | 2.41 | 15.40 | 2.85 | 14.24 | 1.93 | 14.40 | 3.85 |
| Lateral Post Avg | 15.91 | 2.40 | 15.95 | 2.75 | 14.08 | 1.82 | 14.45 | 3.45 |
| Backward PRE Avg | 9.72 | 2.07 | 10.25 | 3.35 | 8.42 | 1.01 | 8.33 | 1.05 |
| Backward Post Avg | 10.10 | 1.83 | 9.90 | 2.65 | 8.15 | 1.06 | 8.05 | 1.50 |

**Table 6**

| Multi-directional reach test | Unpaired T test | P Value |
|---|---|---|
| Lateral PRE Avg | 2.275 | 0.027 |
| Lateral Post Avg | 3.326 | 0.002 |
| Backward PRE Avg | 3.102 | 0.003 |
| Backward Post Avg | 5.029 | 0.000 |

**Table 7**

| Multi-directional reach test | Experimental Group | | | | Control Group | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | S.D. | Median | IQR | Mean | S.D. | Median | IQR |
| Lateral (Post-Pre) * | 0.39 | 1.14 | 0.53 | 0.60 | -0.16 | 0.39 | -0.18 | 0.60 |
| Forward PRE Avg * | 15.75 | 2.53 | 15.00 | 3.65 | 12.77 | 1.43 | 12.75 | 2.15 |
| Forward Post Avg * | 16.76 | 2.90 | 15.88 | 3.75 | 12.48 | 1.41 | 12.25 | 1.75 |
| Forward Reach (Post-Pre) * | 1.01 | 1.31 | 0.75 | 0.95 | -0.29 | 0.51 | -0.28 | 0.50 |
| Backward Avg (Post-Pre) * | 0.37 | 1.52 | 0.50 | 1.05 | -0.27 | 0.46 | -0.27 | 0.45 |

**Table 8**

| Multi-directional reach test | MannWhitney Test | P Value |
|---|---|---|
| Lateral (Post-Pre) * | 4.764 | 0.000 |
| Forward PRE Avg * | 4.771 | 0.000 |
| Forward Post Avg * | 5.649 | 0.000 |
| Forward Reach (Post-Pre) * | 5.683 | 0.000 |
| Backward Avg (Post-Pre) * | 4.167 | 0.000 |

## 4. Discussion

The primary objective of this study was to find out the effect of 6 week balance training programme on agility. Experimental group underwent 6 week balance training programme in addition to regular routine exercises.

**Balance tests**

Results of Single limb stance test show mean improvement in stance time in the experimental group was 22.17 secs and the difference in the mean stance time in control group was 3.53 secs, which was statistically significant ($p < 0.05$). This suggests there was a significant improvement in single leg stance duration, post 6 weeks of balance training. In the experimental group significant improvement of reach distances in lateral and backward directions was seen ($P< 0.05$) (unpaired T test 3.326 for lateral and 5.029 for backward).

In the experimental group, difference in mean reach distance for lateral, forward and backward was 0.39, 1.01 and 0.37 respectively, and in control group difference in mean reach distance for lateral, forward and backward was -0.16,-0.29 and -0.27 respectively, which was statistically significant ($p < 0.05$) This suggests that there was a significant improvement in reach distances in experimental group.

This study showed that, there was significant improvement in static and dynamic balance in experimental group as compared to control group. Many studies regarding balance training have discussed the mechanism as task-specific neural adaptations at the spinal and supraspinal levels. It may suppress spinal reflex excitability such as the muscle stretch reflex during postural tasks, which leads to less destabilizing movements[58] and improved balance as required in sports during the activities such as running, jumping changing direction.

The inhibition of muscle stretch reflexes may enhance agonist-antagonist muscle co-contraction, which increases joint stiffness, stabilizing the joints against perturbations and therefore may improve balance.[58]Task specific reduced cortical excitability has also been associated with improved balance from training. It is postulated that balance training promotes a shift in movement control from cortical to subcortical and cerebellar structures[59], making it an automatic response thereby improving feed forward mechanism.

The results of this study are supported by several authors.

**Carolyn A. Emery et al 2005**[51] conducted a randomized controlled trial, to study the effectiveness of a home-based balance-training program in reducing sports-related injuries among healthy adolescents in high school students in 2001. They found an improvement in static and dynamic balance at 6 weeks post training in the intervention group but not in the control group (difference in static balance 20.7 seconds, 95% confidence interval [CI] 10.8 to 30.6 seconds; difference in dynamic balance 2.3 seconds, 95% CI 0.7 to 4.0 seconds). There was evidence of a protective effect of balance training in over 6 months (relative risk of injury 0.2, 95% CI 0.05 to 0.88).

A Systematic Review conducted by **Astrid Zechet al**[60]**, 2010**, Balance training for neuromuscular control and performance enhancement. They concluded that, balance training is an effective intervention to improve static postural sway and dynamic balance in both athletes and non athletes. Although controversial findings have been reported for jumping performance and agility, balance training may have some effect in improving these outcomes.

**Patrick Mckeon**[61] et al, found that 4 weeks of balance training significantly improved self-reported function, static postural control as detected by TTB measures, and dynamic postural control as assessed with the SEBT.

**Agility Tests**

As evident from table 2, the experimental group showed significant improvement in performance on T agility test, difference in the mean time in the experimental group was 0.86 seconds which was statistically significant ($p < 0.05$), (unpaired T test 16.625). The experimental group also showed improvement in performance on Hexagonal agility Test (Table 3), the difference in the mean time in the experimental group was 2.74 seconds, which was statistically significant ($p < 0.05$). This suggests there was a significant improvement in the agility post 6 weeks of balance training. Our results show that there was significant improvement in agility in experimental group. Thus rejecting null hypothesis and accepting the alternative hypothesis.

Agility is a complex ability which depends on coordination, mobility of the joint system, dynamic balance, strength and speed[62]. Since static and dynamic balances are vital for agility, the improvement in agility can be attributed to improvement in balance. The control group showed deterioration in agility which can be attributed to the fact that control group underwent conventional exercise programme which players carried out unsupervised.

The results of this study are supported by, **Sanja simeksalaj**[46] **(2007) et al,** they studied the effect of proprioceptive training on jumping and agility performance. They found changes in performance on some agility tests (20Yard agility test, HOPS agility test) post training, but not in the LAT test. In the 20 Yard shuttle test there were minor numerical changes (0.01 seconds), but the C group had much poorer results compared to the initial status (0.07 seconds).

## 5. Acknowledgement

The authors wish to thank Dr. Hutoxi Writer, The HOD of Physiotherapy college, TNMC, Mumbai, Mr.Sudhir Naik, of National Cricket club, Mumbai for his permission to conduct the study. The authors also acknowledge the support of

Shital Wadekar, Chinmay Pednekar in conducting the Balance training.

## 6. Conclusion

The results of this study showed that, six week balance training was effective in improving balance and agility in young cricketers.

## Reference

[1] Craig Ranson, Roanne Hurley, LorindaRugless, International cricket injury surveillance: A report of five teams competing ICC Cricket world cup 2011. British journal of sports medicine 2013; 47, 637.
[2] Corrigan AB. Cricket injuries. AustFam Physician 1984;13:558–62.
[3] Emery, Carolyn A;Cassidy, J David;Klassen, Terry P;Rosychuk, Rhonda J;Rowe, Brian H, Effectiveness of a home-based balance-training program in reducing sports-related injuries among healthy adolescents: a cluster randomized controlled trialCanadian Medical Association. Journal; Mar 15, 2005; 172, 6; ProQuest Medical Library
[4] Hewett TE, Ford KR, Myer GD. Anterior cruciate ligament injuries in female athletes, part 2: a meta-analysis of neuromuscular interventions aimed at injury prevention. Am J Sports Med. 2006;34(3):490–498.
[5] McGuine TA, Keene JS. The effect of a balance training program on the risk of ankle sprains in high school athletes. Am J Sports Med. 2006;34(7):1103–1111.
[6] McKeon PO, Hertel J. Systematic review of postural control and lateral ankle instability, part II: is balance training clinically effective? J Athl Training 2008;43(3):305–315.
[7] Coughlan G, Caulfield B. A 4-week neuromuscular training program and gait patterns at the ankle joint. J Athl Train. 2007;42(1):51–59.
[8] Pa´ nics G, Ta´ llay A, Pavlik A, Berkes I. Effect of proprioception training on knee joint position sense in female team handball players. Br J Sports Med. 2008;42(6):472–476
[9] Arthur, M. & Bailey, B. Agility Drills (Chapter 7). Complete Conditioning for Football. Pg. 191-237. Human Kinetics: Champaign, IL, 1998
[10] Brittenham, G. Athleticism for Basketball (Chapter 5). Complete Conditioning for Basketball. Pg. 69-87. Human Kinetics: Champaign, IL, 1996
[11] Cissik, J. & Barnes M. Agility (Chapter 5). Sport Speed And Agility. Coaches Choice. Monterey CA, 2004
[12] Costello, F. &Kreis, E.J. Introduction to Agility (Chapter 1). Sports Agility. Pg. 2-3. Taylor Sports Publishing: Nashville, TN, 1993
[13] Plisk, S. Speed, agility, and speed-endurance development. In T.R. Baechle& R.W. Earle (Editors), Essentials of Strength Training and Conditioning, 3rd Edition. Champaign IL: Human Kinetics Publishers, 2008
[14] Tittel, K. Coordination and balance. In: The Olympic Book of Sports Medicine, A. Drix, H.G. Knuttgen, and K. Tittel, eds. Oxford: Blackwell Scientific, 1991. 194-211.
[15] Graham, J. In L.E. Brown & V.A. Ferrigno (Editors), Training for Speed, Agility & Quickness, 2nd Edition. Champaign IL: Human Kinetics Publishers, 2005
[16] Halberg, G.V. Relationships among power, acceleration, maximum speed, programmed agility, and reactive agility: The neural fundamentals of agility. Masters Thesis, Central Michigan University. Mount Pleasant MI, 2001
[17] Balyi,I. Long-term athletic Development: Trainability in childhood and adolescence. Olympic Coach 16(1): 4-9, 2004
[18] Bahr R, Lian O. A two-fold reduction in the incidence of acute ankle sprains in volleyball. Scand J Med Sci Sports 1997;7: 172-7.
[19] Caraffa A, Cerulli G, Projetti M, Aisa G, Rizzo A. Prevention of anterior cruciate ligament injuries in soccer. A prospective controlled study of proprioceptive training. Knee Surg Sports TraumatolArthrosc 1996;4:19-21.
[20] Hewett TE, Lindenfeld TN, Riccobene JV, Noyes FR. The effect of neuromuscular training on the incidence of knee injury in female athletes. Am J Sports Med 1999;27:699-705.
[21] Holme E, Magnusson SP, Becher K, Bieler T,Aagaard P, Kjaer M. The effect of supervised rehabilitation on strength, postural sway, position sense and re-injury risk after acute ankle ligament sprain. Scand J Med Sci Sports 1999;9:104-9.
[22] Myklebust G, Engebretsen L, Braekken IH, et al. Prevention of ACL injuries in female handball players: a prospective intervention study over 3 seasons. Clin J Sports Med 2003;13:71-8.
[23] Tropp H, Askling C, Gillquist J. Prevention of ankle sprains. Am J Sports Med 1985;13:259-62.
[24] Wedderkopp M, Kaltoft M, Lundgaard B, Rosendahl M, Froberg K. Prevention of injuries in young female players in European team handball. A prospective intervention study. Scand J Med Sci Sports 1999;9:41-7.
[25] Wester JU, Jespersen SM, Nielsen KD, Neumann L. Wobble board training after partial sprains of the lateral ligaments of the ankle: A prospective randomized study. J Orthop Sport PhysTher 1996;23:332-6.
[26] 101 Performance evaluation tests Brian Mackenzie.2005, pg no 57, 70
[27] The Effect of a Balance Training Program on the Risk of Ankle Sprains in High School Athletes ,Timothy A. McGuine,* PhD, ATC, and James S. Keene, MD
[28] ROZZI, S.L., S.M. LEPHART, R. STERNER, AND L. KULIGOWSKI. Balance training for persons with functionally unstable ankles. J. Orthop Sports Phys. Ther. 29(8):478–486. 1999.
[29] Drabik J. (1996) Children & Sports Training. Island Pond, Vermont: Stadion Publishing Company, Inc
[30] KURZ, T. (2001) Science of Sports Training. 2nd Edition. Island Pont, Vt: Stadion Publishing Company
[31] Franchignoni, F., Tesio, L., Martino, M., &Ricupero, C. (1998). Reliability of four simple, quantitative tests of balance and mobility in healthy elderly females. Aging (Milan), 10(1), 26-31.
[32] Bohannon, R., Larkin, P., Cook, A., & Singer, J. (1984). Decrease in timed balance test scores with aging.Physical Therapy, 64, 1067-1070.

[33] Vellas, B., Wayne, S., Romero, L., Baumgartner, R., et al. (1997). One-leg balance is an important predictor of injurious falls in older persons. Journal of the American Geriatric Society, 45, 735-738.
[34] Schlicht, J., Camaione, D., & Owen, S. (2001). Effect of intense strength training on standing balance, walking speed, and sit-to-stand performance in older adults. Journal of Gerontological Medicine and Science, 56A(5), M281-M286.
[35] Frandin, K., Sonn, U., Svantesson, U., &Grimby, G. (1996). Functional balance tests in 76-year-olds in relation to performance, activities of daily living and platform tests. Scandinavian Journal of Rehabilitative Medicine, 27(4), 231-241.
[36] Tinetti, M., Williams, T., &Mayewski, R. (1986). Fall risk index for elderly patients based on number of chronic disabilities. American Journal of Medicine, 80, 429-43 National Safety Council. (2004). Injury Facts. Itasca, IL: Author.
[37] Roberta A. Newton, Validity of the Multi-Directional Reach Test, A Practical Measure for Limits of Stability in Older Adults. Department of Physical Therapy, Temple University, Philadelphia, Pennsylvania 2000.
[38] Kinzey, S.,&Armstrong, C. (1998). The reliability of the Star-Excursion test in assessing dynamic balance.Journal of Orthopedic and Sport Physical Therapy, 27, 356–360.
[39] Earl, J. (2002). Lower-extremity muscle activation during the star excursion balance Tests. *Journal of sport rehabilitation, 10*(2), 93–104.
[40] Olmsted, L. C., Carcia, C. R., Hertel, J., & Shultz, S. J. (2002). Efficacy of the Star Excursion Balance Test in detecting reach deficits in subjects with chronic ankle instability. Journal of Athletic Training, 37(4), 501–506.
[41] Earl, J., &Hertel, J. (2001). Lower-extremity muscle activation during the Star Excursion Balance Tests. Journal of Sport Rehabilitation, 10(2), 93
[42] Miller, J. (2001). Biomechanical analysis of the anterior balance reach test. Unpublished doctoral dissertation, Pennsylvania State University, University Park.–104. 43. Astrid Zech, Markus Hu¨ bscher, Lutz Vogt, Winfried Banzer, Frank Ha¨ nsel, Klaus Pfeifer, Balance Training for Neuromuscular Control and Performance Enhancement: A Systematic Review, Journal of Athletic Training 2010;45(4):392–403
[43] J Parkkari, M Pasanen, Effect of a neuromuscular warm-up programme on muscle power, balance, speed and agility: a randomised controlled study, Br J Sports Med. 2009 Dec;43(13):1073-8. doi: 10.1136/bjsm.2009.061747. Epub 2009 Jul 20.
[44] Patrick o.Mckeon, Balance training improves function And postural control in those with chronic Ankle instability, medicine & science in sports & exercise, American college of sports medicine
[45] SimekSalaj S, Milanovic D, Jukic I. The effects of proprioceptive training on jumping and agility performance. Kinesiol 2007; 39 (2): 131-41
[46] ElkeCumps , Evert Verhagen and RomainMeeusen , Efficacy of a sports specific balance training programme on the incidence of ankle sprains in basketball Journal of Sports Science and Medicine (2007) 6, 212-219, http://www.jssm.org
[47] James A. Yaggie, And Buianm M., Campbell, Effects of four week balance training on selected skills. Journal of Strength and Conditioning Research, 2006, 20(2), 422–428,2006 National Strength & Conditioning Association.
[48] Carolyn A. Emery, J. David Cassidy, Effectiveness of a home-based balance-training program in reducing sports-related injuries among healthy adolescents: a cluster randomized controlled trial, CMAJ • MAR. 15, 2005; 172 (6)
[49] Souhail Hermassi1, MouradFadhloun, Mohamed SouhailChelly, AbdelkrimBensbaa, Relationship between agility T-test and physical fitness measures as indicators of performance in elite adolescent handball players, Tunisian Research Laboratory « Sport Performance Optimization », Tunis, Tunisia Institute of Sport and Physical Education, KsarSaïd, Tunisia 2011.
[50] Carolyn A Emery, J David Cassidy, Development of a Clinical Static and Dynamic Standing Balance Measurement Tool Appropriate for Use in Adolescents, Physical Therapy . Volume 85 . Number 6 . June 2005, http://ptjournal.apta.org.
[51] Kainoapauole, Kent madole, Reliability and Validity of the T-Test as a Measure of Agility, Leg Power, and Leg Speed in College-Aged Men and Women journal of strength and conditioning research - j strength cond res , vol. 14, no. 4, 2000
[52] Clark MS (2007): The Unilateral Forefoot Balance Test: Reliability and validity for measuring balance in late midlife women. New Zealand, Journal of Physiotherapy 35(3): 110-118.
[53] Eva Ageberg, David Roberts, Eva Holmström and Thomas Fridén, Balance in single-limb stance in healthy subjects – reliability of testing procedure and the effect of short-duration sub-maximal cycling- Department of Rehabilitation, University Hospital, Lund, Sweden, 2Department of Orthopedics, University Hospital, Lund, Sweden and Department of Physical Therapy, Lund University, Lund, Sweden
[54] Roberta A. Newton, validity of the multi-directional reach test a practical measure for limits of stability in older adults, Journal of Gerontology: medical sciences, 2001, vol. 56a, no. 4, m248–m252
[55] Phillip A. Gribble and Jay Hertel, Considerations for Normalizing Measures of the Star Excursion Balance Test, Department of Kinesiology Athletic Training Research Lab Pennsylvania State University Journal of Strength and Conditioning Research, 2006. 20(21, 422-428
[56] K Volkman, N stergioui,WStuberg, D Blanke and J Stoner,Effects of measurement method and subject characteristics on the functional reach test in typically developing children. University of Nebraska 2002.
[57] Taube W, Gruber M, Gollhofer A. Spinal and supraspinal adaptations associated with balance training and their functional relevance. ActaPhysiol 2008; 193 (2): 101-16
[58] Lloyd D. Rationale for training programs to reduce anterior cruciate ligament injuries in Australian football. J Orthop Sports PhysTher 2001; 31 (11): 645-54
[59] Astrid zech, phd*; markushu¨ bscher, balance training for neuromuscular control and Performance

enhancement: a systematic review Journal of Athletic Training 2010;45(4):392–403.
[60] Patrick o. Mckeon1, christopher d. Balance training improves function And postural control in those with chronic Ankle instability, medicine & science in sports & exercise, American college of sports medicine
[61] Verstegen, M., & Marcello, B. (2001). Agility and coordination. In B. Foran (Ed.), High performance sports conditioning. Champaign, IL: Human Kinetics. (pp. 139-165).

## Author Profile

**Swati Kubal**, received her Bsc and Msc in physiotherapy from The Mumbai University in 1990 and 1995 respectively. She joined Department of Physiotherapy, of Topiwala National Medical College, BYL Nair Hospital, Mumbai in 1992 as Junior Physiotherapist. She became a lecturer in 2003, since then she is working as an Assistant Professor. Currently she is pursuing Phd from Mharashtra University of Health Sciences, Nashik.

**Dhananjay Padwal,** received his BPTh from the Maharashtra University of Health sciences Nashik in 2009, MPTh degree from Topiwala National Medical college, Mumbai in 2014. He joined Qi Spine Clinic Mumbai as Physiotherapist in 2014. His current research interests include Sports physiotherapy and Muskuloskeletal injuries.