# EFFECTIVENESS OF FIVE PHASE BALANCE TRAINING PROGRAM ON THE RISK OF KNEE INJURIES IN ADOLESCENT ATHLETES

# EFICIENȚA UNUI PROGRAM DE REEDUCARE A ECHILIBRULUI ÎN CINCI FAZE ASUPRA RISCULUI DE ACCIDENTARE A ATLEȚILOR ADOLESCENȚI, LA NIVELUL GENUNCHIULUI

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***Key words:*** knee injuries, rehabilitation, balance training program, injury prevention, fall prevention, high school athletes

**Abstract**

**Back ground & Objectives:** Knee injuries pose serious health burdens to athletes of all ages in nearly every sport. They account for 15.2% of all high school sports injuries, often requiring expensive surgical treatment and prolonged time lost from school and sports participation males accounted for 72% and females for 28%; 65% of the injuries occurred during sports activities**.**

**Objective:** The main objective of the study is to find out the effect of five phase balance training on reducing the risk of knee injuries and association between the injury rate with the baseline characteristics in adolescent athletes.

**Methods:** Subjects fulfilling the inclusion and exclusion criteria were included in the study and base line data is considered and subjects were divided into control and experimental group, the experimental group carried out balance training program 5 days per week, for 5 weeks. Control group will be advised to continue their training with warm up program and home-based balance-training program using a wobble board.

**Results:** Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean SD. sample distribution for lyshlom knee score after intervention which were statistically significant ($p<0.006$) in group-A compared to group-B. For lyshlom knee score after intervention between groups the SD for group-A was 84.02±8.73 and group-B was 79.54±8.62 with p value 0.006.

**Conclusion:** Five phase balance training program is effective on the risk of knee injuries and there is no significant association between injury rates and baseline characteristics in adolescent athletes.

***Cuvinte cheie:*** leziuni de genunchi, reabilitare, program de reeducare a echilibrului, prevenirea accidentărilor, sportivi de liceu

**Rezumat**

**Introducere:** Leziunile de genunchi produc serioase probleme sportivilor de toate vârstele în viața sportivă zilnică. Ele totalizează 15.2% dintre toate leziunile sportive ale liceenilor, adesea necesitând tratament chirurgical costisitor și absențe lungi de la școală și activitățile sportive, accidentările la băieți fiind în proporție de 72% și la fete de 28%; 65% dintre leziuni se produc în timpul activităților sportive.

**Obiective:** Principalul obiectiv al acestui studiu este de a stabili efectul unui program în cinci faze de reeducare a echilibrului, în reducerea riscului de accidentări la genunchi și asocierea dintre rata accidentărilor și caracteristicile de bază ale sportivilor adolescenți.

**Metodă:** Subiecții care au îndeplinit criteriile de includere și excludere au fost introduși în studiu; s-au obținut datele inițiale și subiecții au fost împărțiți în grupul experimental și cel de control. Cel experimental a urmat programul de reeducare a echilibrului 5 zile pe săptămână, timp de 5 săptămâni. Grupul de control a fost sfătuit să își continue antrenamentul cu încălzire și antrenarea echilibrului acasă, pe placa de echilibru.

**Rezultate:** S-a realizat analiza descriptivă și inferențială. Rezultatele la evaluări sunt prezentate sub formă de medie și ab.std. Distribuția eșantioanelor pentru Lyshlom knee score după intervenții a fost smnificativă statistic ($p<0.006$) la gupul-A comparativ cu grupul-B. Pentru Lshlom knee score după intervenții comparat între cele două grupuri, media și ab.std pentru group-A a fost 84.02±8.73 și pentru grupul B a fost 79.54±8.62, valoarea p de 0.006.

**Concluzii:** Antrenarea echilibrului prin programul în cinci faze este eficient pentru reducerea riscului de accidentări la genunchi. Nu există asocieri semnificative între rata accidentărilor și caracteristicile de bază ale sportivilor adolescenți.

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## Introduction

Knee injuries pose serious health burdens to athletes of all ages in nearly every sport. They account for 15.2% of all high school sports injuries, often requiring expensive surgical treatment and prolonged time lost from school and sports participation. One international study reports youth athlete knee injury rates, but these may not represent US high school injury patterns because of country-specific differences in sport availability and participation. Previous studies describing US high school sports-related knee injuries reported high rates of knee injuries, high proportions of knee injuries compared to other injuries, increased risk of re injury, and high numbers of knee injuries requiring surgical treatment, but these were limited in geographic region, described injury patterns in general but not in detail, or did not report injury patterns across a large number of sports. Multiple studies have investigated knee injury patterns by gender, frequently reporting that knee injury rates are higher in female athletes but few studies have directly compared knee injury rates and patterns in both gender-comparable and gender-specific sports. [1]

Although the medial collateral ligament is the most commonly injured ligament, the anterior cruciate ligament (ACL) is the most frequently injured single ligament associated with limited range of motion. [2] More ACL injuries are the requiring surgery, 60.3% were to the knee. [3] The ligaments surrounding the knee joint offer stability by limiting movements and together with several menisci and bursae protect the articular capsule. [1] Biomechanical risk factors summarized by the consensus panel included the effect of the total chain (trunk, hip, knee& ankle) on ACL injuries, awkward or improper dynamic body movements, deceleration and change of direction and neuromuscular control of the joint. [4]

Balance is an ability to maintain the center of gravity of the body with the base of support with minimal postural sway. [5] Balance is a component of all movements, regardless of whether strength, speed, flexibility or endurance dominants the movement. Maintenance of postural equilibrium or balance is a process requiring optimal muscular balance (length tension relationship), joint dynamic (arthrokinematics) and neuromuscular efficiency.

Balance training should constantly stress an individual's limits of stability. Balance training is an effective tool in the prevention of falls. [6] Balance training to stimulate neuromuscular control. Proprioception is mediated by sensory receptors in the skin, musculotendinous unit, ligaments, and joint capsule. [7,8] However, there is the potential that these types of training programs may also be beneficial for decreasing the risk of lower extremity injuries, including knee injuries in the adolescent athletes.

Balance training programs is used in the rehabilitation of sports related injuries and is becoming recognized as an important element in injury prevention of sports. Running, jumping or pivoting on one leg relies on a sense of joint position and muscular control for joint stability.

There is evidence that static balance improves following proprioceptive balance training using a wobble board.

Many balance training programs have been suggested for ACL injuries and there is absence of neuromuscular control of the knee joint may be responsible for the increased rates of knee injury in athletes. [10] Sport participation and injury rates in child and adolescent sport are high[13] and majority of the studies focuses on improving the balance and to improve proprioception. Hence the study is intended to find out the risk of knee injuries in athletes.

## Materials and Methods

A descriptive study is conducted among 100 subjects in and around sports clubs of bangalore inclusion criteria subjects were in the age group between 15 – 2 0 years of age without any injuries and those with fractures around the knee joint and fat pad impingement and previous surgeries in the lower limb were excluded from the study . Informed consent was taken from subjects meeting inclusion and exclusion criteria. Subjects were screened and base line data like gender, age, height, weight, leg dominance, use of knee supports, knee laxity were obtained.

Height was measured with a stadiometer. Weight was measured on digital platform scale. Leg dominance was determined by asking the subject his or her dominance for kicking a ball.

Knee ligament laxity was determined by performing anterior drawer test on the knee with subject in a supine lying with slight knee flexed. Subjects were divided into control and experimental groups using simple random sampling.

**Methodology**

The experimental group was given "Balance Training Programme" 5 days per week, for 5 weeks.

The exercise program includes:

1) Maintaining a single leg stance on a flat surface with eyes open and closed.
2) Performing functional sport activities such as throwing, catching, and dribbling on one leg;
3) Maintaining double-leg stance while rotating the balance board;
4) Maintaining a single-leg stance on the balance board with eyes open and closed; and
5) Performing functional sport activities while in single-leg stance on the board.

The balance Board that was used consisted of a wooden disk 16 inches in diameter with a 4-inch half Sphere attached to the bottom. The sphere allowed approximately 17° of angulations in all Planes. If subjects who are not participating consecutive balance training sessions, he or she will Considered as noncompliant with the balance training protocol.

Control group was advised to continue their training with warm up program and home-based balance-training program using a wobble board, included warm-up, flexibility, jump training, strength training, rehabilitation and sport-specific technical components. 30 onsite athletic trainers were record athlete exposure and sprains after 6months and percentage of injury rate was calculated by the score of lysholm knee scale between experimental and control groups and according to baseline characteristics

**Data analysis**

Descriptive analysis was performed by SPSS (Version13) for windows; Alpha value was set as .05. Descriptive statistics was performed to find out the Mean, SD, Range for demographic variables such as height, Weight and BMI, leg dominance and outcome variable such as Lyshlom knee score. Mann Whitney U test was used to find out significant differences between the groups after intervention for outcome variables such as lyshlom knee score.

Chi-square test was used to analyze gender difference, leg dominance, knee support, knee laxity between groups. Fisher exact test was used to find out significant difference on categorical scale between groups.

Fisher exact test was used to find out significance between No of subjects who scored <=65 on Lyshlom knee score and No of subjects who scored more than 65 on Lyshlom knee score among both groups.

Microsoft word and Excel have been used to generate graphs, tables etc.

**Results**

**Table -1 Base line Data for Demographic variable**

| variable | Group-1 | Group-2 | P value |
|---|---|---|---|
| Age | 15.86±2.44 | 16.02±2.82 | >0.763 |
| Height | 161.26±14.21 | 160.22±18.69 | >0.755 |
| Weight | 51.64±10.57 | 52.92±11.75 | >0.568 |
| BMI | 19.86±3.37 | 20.64±3.42 | >0.251 |

**Age:**

The above table shows the descriptive statistics for demographic variables of age as shown in figure. Mean age of group-1 is 15.86±2.44 and group-2 is 16.02±2.82 P value of >0.763.

**Height:**
The above table-1 shows the descriptive statistics for demographic variables of Height as shown in figure. Mean Height of group-1 is 161.26±14.21 and group-2 is 160.22±18.69. P value of >0.755.

**Weight:**
The above table-1 shows the descriptive statistics for demographic variables of weight as shown in figure. Mean Weight of group-1 is 51.64±10.57 and group-2 is 52.92±11.75. P value of >0.568.

**BMI Kg/m2:**
The above table-1 shows the descriptive statistics for demographic variables of BMI Kg/m2 as shown in figure. Mean Weight of group-1 is 19.86±3.37 and group-2 is 20.64±3.42. P value of >0.251.

**Table 2: Age distribution of patients studied**

| Age in years | Group I | | Group II | |
|---|---|---|---|---|
| | No | % | No | % |
| 10-12 | 5 | 10.0 | 8 | 16.0 |
| 13-16 | 23 | 46.0 | 16 | 32.0 |
| 17-20 | 22 | 44.0 | 26 | 52.0 |
| Total | 50 | 100.0 | 50 | 100.0 |

Table-2 represents the age 10 – 12yrs for group-1 five (10%) participants and group- 2, 8 (16%) participants. The age 13-16yrs for group-1, 23 (46%) participants and group-2, 16 (32%) participants. The age 17-20yrs for group-1, 22(44%) participants and group-2, 26 (52%) participants. But the samples for age distribution are not significant (p>0.763).

**Table 3: Gender distribution of patients studied**

| Gender | Group I | | Group II | |
|---|---|---|---|---|
| | No | % | No | % |
| Male | 40 | 80.0 | 42 | 84.0 |
| Female | 10 | 20.0 | 8 | 16.0 |
| Total | 50 | 100.0 | 50 | 100.0 |

Table-3 represents the gender, males for Group-1, 40 (80%) participants and Group-2, 42 (84%) participants. According to the gender, females for group-1, 10 (20%) participants and group-2, 8(16%) participants. But samples for gender distribution which was not significant (p> 0.795).

Table-4 represents participants with <18.5BMI kg/m2 in group-1 were 16(32%) and in group-2 were 11 (22%) participants. Participants with 18.5 – 25.0BMI kg/m2 in group-1 were 32 (64%) and in group-2 were 36 (72%) participants. Participants with 25.0 – 30.0 BMI kg/m2 in group-1 were 1 (2%) and in group-2 were 1 (2%) participants. Participants with >30.0 BMI kg/m2 in group 1 were 1 (2%) and group-2 were 2 (4%) participants. But the sample distribution for BMI kg/m2 which were statistically not significant (P >0.251).

**Table 4: Comparison of BMI kg/m2 in two groups of patients studied**

| BMI kg/m2 | Group I | | Group II | |
|---|---|---|---|---|
| | No | % | No | % |
| <18.5 | 16 | 32.0 | 11 | 22.0 |
| 18.5-25.0 | 32 | 64.0 | 36 | 72.0 |
| 25.0-30.0 | 1 | 2.0 | 1 | 2.0 |
| >30.0 | 1 | 2.0 | 2 | 4.0 |
| Total | 50 | 100.0 | 50 | 100.0 |

**Table 5: Comparison of Leg dominance in two groups of patients studied**

| Leg dominance | Group I | | Group II | |
|---|---|---|---|---|
| | No | % | No | % |
| Left | 3 | 6.0 | 4 | 8.0 |
| Right | 47 | 94.0 | 46 | 92.0 |
| Total | 50 | 100.0 | 50 | 100.0 |

Table-5 represents left leg dominance in group-1 were 3 (6%) participants and group- 2 were 4 (8%) participants. Right leg dominance were in group-1 were 47 (94%) participants and group-2 were 46 (92%) participants. But the sample distribution for leg dominance which was not significant (p= 1.000).

**Table 6: Comparison of Use of knee supports in two groups of patients studied**

| Use of knee supports | Group I | | Group II | |
|---|---|---|---|---|
| | No | % | No | % |
| Left | 50 | 100.0 | 48 | 96.0 |
| Right | 0 | 0.0 | 2 | 4.0 |
| Total | 50 | 100.0 | 50 | 100.0 |

Table-6 represents participants not using left knee supports in group-1 were 50 (100%) and in group-2 were 48 (96%) participants. Participants not using right knee supports in group-1 were 0 (0%) and in group-2 were 2 (4%) participants. But the samples distribution for not using of knee supports which were statistically not significant (p= 0.495).

**Table 7: Comparison of Knee laxity in two groups of patients studied**

| Knee laxity | Group I | | Group II | |
|---|---|---|---|---|
| | No | % | No | % |
| No | 50 | 100.0 | 50 | 100.0 |
| Yes | 0 | 0.0 | 0 | 0.0 |
| Total | 50 | 100.0 | 50 | 100.0 |

Table-7 represents with no knee laxity group-1 were 50 (100%) and in group-2 were 50 (100%) participants. Participants with no knee laxity group-1 were 0 (0%) and in group-2 were 0 (0%) participants. But sample distribution for no knee laxity which was statistically not significant (p=1.000).

**Table 8: Comparison of Lyshlom knee score in two groups of patients studied (Balance training)**

| Lyshlom knee score | Group I | | Group II | |
|---|---|---|---|---|
| | No | % | No | % |
| 98 – 100 | 1 | 2 | 0 | 0 |
| 93 – 97 | 8 | 16 | 2 | 4 |
| 82 – 92 | 24 | 48 | 26 | 52 |
| 66 – 81 | 16 | 32 | 18 | 36 |
| <= 65 | 1 | 2 | 4 | 8 |

Table-8 represents the lyshlom knee score for group-1 <=65 were 1 (2%) and for group-2 were 4 (8%) participants. The lyshlom knee score for group-1 66 – 81 were 16 (32%) and for group-2 were 18 (36%) participants. The lyshlom knee score for 82 - 92 group-1 were 24 (48%) and for group-2 were 26 (52%) participants. The lyshlom knee score for 93 - 97 group-1 were 8 (16%) and for group-2 were 2 (4%) participants. The lyshlom knee score for 98 - 100 group-1 were 1 (2%) and for group-2 were 0 (0%) participants. But sample distribution for lyshlom knee score which were statistically not significant (p>0.158).

**Table 9: Comparison of Interpretation in two groups of patients studied**

| Results | Group I | | Group II | |
|---|---|---|---|---|
| | No | % | No | % |
| Absent | 49 | 98.0 | 46 | 92.0 |
| Present | 1 | 2.0 | 4 | 8.0 |
| Total | 50 | 100.0 | 50 | 100.0 |

Table-9 represents for group-1 were 49 (98%) participants were absent and for group- 2 were 46 (92%) participants were absent. For group-1 were 1 (2%) participants were have injury and in group-2 were 4 (8%) participants were have injury. But sample distribution for interpretation which were statistically not significant (p>0.362).

**Table 10: Comparison of study variables in two groups of patients studied**

| Variables | Group I | Group II | P value |
|---|---|---|---|
| Lyshlom knee score | 84.02±8.73 | 79.54±8.62 | <0.006 |

Table-9 represents for Lyshlom knee score the SD for group-1 was 84.02±8.73 and group-2 was 79.54±8.62 with p value 0.006.

## Discussion

In this study objective was to find out the association between the injuries rates with the baseline characteristics in adolescent athletes. The results of this study document that a simple, inexpensive, balance training program performed during a sport season will reduce the rate of knee injuries among athletes.

The baseline data of the demographic and outcome variables did not show any statistically significant difference between the patient populations in both groups. All patients in the both groups were able to complete the study. Baseline data studies are age, gender, BMI, leg dominance, use of knee support, and knee laxity. This insignificance accordance with studies showed overall, girls and boys sustained ankle/foot (35.9% and 43.2%, respectively), knee (18.2% and 10.6%, respectively), head/face/neck (14.2% and 12.8%, respectively), lower arm/hand (9.5% and 9.4%, respectively), and hip/thigh/upper leg (8.7% and 8.2%, respectively) injuries most often. Girls were more likely to injure a knee (IPR, 1.71; 95% CI, 1.27- 2.30; *P*

<.01), although the most comprehensive study to date found no gender differences in high school basketball injury rates. [3, 12, 15, 17] Knee laxity did not show any statistical difference.[13, 14]

It was hypothesized that, as a direct result of muscular fatigue or secondary to increased joint laxity, subjects would demonstrate aberrations in joint proprioception and alterations in joint-stabilizing muscle activity. Increases in joint laxity subsequent to exercise are suggested to be primarily due to the fact that joint structures, particularly the ligaments, exhibit viscoelastic characteristics. Ligaments are composed of collagen and other structural proteins, and, therefore, when stressed, respond in a time-dependent and stress-dependent manner. [30]

In experimental group balance training program were given this is followed with the methodology given by Timothy A et al. [8, 9]In the Group A Lyshlom knee scale score shows better result, out of 50 subject 1 subject fall under <=65, and 16 subjects fall under score between 66-81and 24 subjects fall under score between 82-92 and 8 subjects fall under score between 93-97 finally 1 subject fall under 98-100 but this is when compared to group B Lyshlom score out of 50 subjects 4 fall under score <=65 and 18 subjects fall under score between 66-81and 26 subjects fall under score between 82-92 and 2 subjects fall under score between 93-97 and finally only 1 subject fall under the score of 98-100 which was statistically not significant ($p > 0.158$). [28]

Group A got greater score lead to less injury rate when compared to group B result this is accordance with, two studies reported significant reductions in ankle sprains used balance training programs that had both preseason and in-season components and were performed in a team setting as part of the regular training or practice session, thus were supervised by a coach or athletic trainer. These two studies also reported better subject compliance (≥ 90%). The home-based program, which included a short group training component, was dependent upon subjects performing the majority of the balance training exercises on their own. The findings of this study demonstrated lower subject compliance (60.3%) with subjects participating, on average, in 9 training sessions (range 0–43). Emery et al also demonstrated a significant protective effect of this home-based wobble board training program, while controlling for cluster randomized design, in healthy adolescents where individual training was provided biweekly by a physiotherapist and reported compliance was greater (median 3 times per week; range 1–7). [13]

Result did not show any statistical significance in comparison of interpretation of Lyshlom knee rating score for injury rate in both the groups.

In group A out of 50 subject one subject undergone injury but in group B out of 50 subjects 4 undergone injuries. This statistical insignificance can be due to awareness to prevent injury, and both the groups would have got proper training period for the performance. Result shows a significant difference in comparison of Lyshlom knee score in both the groups group A mean of 84.02 and in group B mean of 79.54 which was statistically significant ($p<0.006$) this is accordance with the studies showed that prior studies has been able to document that a proprioceptive training program will significantly reduce the incidence of ankle sprains in athletes without a prior sprain. Verhagen et al, who found that the average time lost from volleyball after an ankle sprain was not affected by taking part in a balance training program. [19, 20, 21, 24]

This same reason would have influenced for knee by increasing the lyshlom knee score.

Hence there is a significant effect of five phase balance training program on risk of knee injuries. But there is no significant association between injury rates and base line characteristics in adolescent athletes.

**Limitations**

- Training could have influence the study.
- Gender could have influence the study.

**Future Implications**

 Study can be conducted by taking dominance of leg.
 Study can be conduct to determine whether this exercise program can significantly improve the balance.
 Study can be conducted on level of training program.

**Conclusion**

The five phase balance training program on knee injuries and outcome of lyshlom knee score in athletes effective. There was a significant difference between the groups for lyshlom knee score after intervention. But there was no significant difference between the groups for all other baseline characteristics. The study concluded that there is a significant effect of five phase balance training program on risk of knee injuries. But there is no significant association between injury rates and base line characteristics in adolescent athletes.

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