

# EXIGENCY OF EXISTENCE

A QUEST



EDITED BY  
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# **EXIGENCY OF EXISTENCE A QUEST**

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# CONTENTS

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<b>CHAPTER NO.</b>	<b>CHAPTER AND AUTHOR(S) NAME</b>	<b>PAGE NO.</b>
1.	<b>EDUCATIONAL INFLUENCES IN HEALTH AND NUTRITION OF ADOLESCENT PUPILS: AN OVERVIEW STUDY</b> Prof (Dr.) Deba Prasad Sahu	1
2.	<b>EFFECT OF EXERCISE ON SERUM CHOLESTEROL</b> Dr. Aloke Sen Borman	14
3.	<b>A SURVEY ON HEALTH STATUS AMONG DIFFERENT PROFESSIONAL GROUPS</b> Subhasish Murmu & Dr. Asish Paul	23
4.	<b>GENDER DIFFERENCE IN LOWER LIMB FRONTAL PLANE KINEMATICS DURING LANDING AFTER TABLE VAULT</b> Dr. Pradipta Kumar Giri & Prof. S. Bhowmick	37
5.	<b>EFFECT OF SELECTED EXERCISES ON EXPLOSIVE LEG STRENGTH, CARDIO-VASCULAR ENDURANCE AND AGILITY AMONG THE SOCCER PLAYERS</b> Dr. Keshab Ch Gope & Ajijul Rahaman Khan	47
6.	<b>ANALYSIS OF PERFORMANCE OF LONG JUMP IN THE HISTORY OF MODERN OLYMPICS</b> Mousumi Hazra & Dr. Asish Paul	58

## CHAPTER 4

# GENDER DIFFERENCE IN LOWER LIMB FRONTAL PLANE KINEMATICS DURING LANDING AFTER TABLE VAULT

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*Dr. Pradipta Kumar Giri & Prof. S. Bhowmick*

### ABSTRACT

Landing is the last phase of a vault. The ultimate goal of every gymnast is to stick the landing –to land without moving their feet. Proper landing technique reduce the risk of injury and enhance the performance. The aim of the present study was to compare the gender difference in lower limb kinematics during landing after vault. Six male national gymnasts and four women national gymnasts were selected as subjects as per availability. The selected mechanical parameters were knee varus/valgus, inter ankle distance, angle at hip joint, angle at knee joint and angle at ankle joint during landing. Videographic technique was used to record the movement. Analysis of technique for the selected parameters was done by freeze frame technique. Results revealed that men had greater knee varus and women had larger inter ankle distance in landing. Hip flexion was greater for men than women. Angle at ankle joint at touch down phase of landing was greater for men than women gymnast.

*Key words: Gender difference, landing, vaulting, kinematics*

## INTRODUCTION

**L**anding is a process of coming down to the Earth surface or rigid surface after remaining in air for sometime. This is a natural consequence of Earth's attraction to an object. For games and sports landing is the important phase in many situations. In volleyball, players land on the court after blocking and spiking. In gymnastics, individuals land on the surface after completing main activity in air born position. In athletics jumpers, hurdlers, runners land after remaining some time in air. Though landing is not directly related with performance in many activities, it has important role to maintain balance and absorb shock to avoid injury.

In gymnastics landing is the final phase in aerial routine (take off phase, flight phase and landing). Landing success depends on the physical fitness and motor control of the gymnast. Physical preparation refers to the gymnast's ability to cope with the load to which they are exposed during the landing. Motor control refers to the control the gymnasts has over the skill they perform. Both of these factors enable successful and safe landing (Marinsek, 2010).

Table vault is one of the artistic gymnastics event for both males and females competitors. The vault features a 25 m approach runway, a spring board and a rectangular table with a surface measuring 1.20m  $\square$  0.95m. The height of the table is different among males (1.35m), females (1.25m) and juniors categories (1.15). Gymnasts are expected to land clearly, with no hops or steps, and within a set landing zone on the landing mat. They must also demonstrate good technique and execution in the actual vault. Falling or stepping on landing incurs deduction, as will lack of height off the table, or distance from the table.

In present-day gymnastics, stable landings always makes the athletes' skillfull performance even better and therefore have won world-wide emphasis. The aim of landing is to dampen the vibrations of the surface. The surface deforms because of the impulse of the force that is produced by the gymnast's falling body. To dampen the vibrations it is important to harmonize muscle activity with the

surface vibrations i.e. modulate body stiffness in response to changes in surface conditions. Different surface conditions affect landing strategies. If landing on a mat, peak vertical forces are lower, landing phase times are longer, and knee and hip flexions are greater compared to landing without a mat (McNitt Gray, Takashi and Millward, 1994). When comparing landings on stiff or soft mat, knee flexion and peak knee flexion velocities tend to be greater for landings on the stiff mat than on the soft mat. Gymnasts modulate total body stiffness in response to different landing conditions. Mat landings tend to be softer than landings without a mat. However, the presence of a mat may reduce the need for joint flexion and may alter the vertical impulse characteristics experienced during landing (Marinsek, 2010). According to literature landing technique becomes different for children and adults (Carmen E. and others, 2006). It has also been reported that landing technique depends on the height of the jump (Huston L J and others, 2001). Similarly, there has been a good number of research work to study and analyse the gender difference in landing mechanics (Christine D. Pollard and others, 2004; Susan M Sigward and others, 2007; Gerwyn Hughes James Watkins and others, 2008; Thomas W. Kernozek and others, 2008).

Landing is an essential phase in gymnastics for scoring the maximum marks and to avoid the injury. From stand point of mechanics landing requires lowering of centre of gravity by flexing hip, knee and ankle joints. Women and men have structural differences. It is therefore interesting to analyse whether there exists any differences in landing mechanics. So the purpose of the study was to compare the gender difference in selected lower limb kinematic parameters during landing after table vault.

## **METHODOLOGY**

Six men national gymnasts and four women national gymnasts were selected as subjects. They had 10-12 years of training age and were trained by the coaches of SAI, Kolkata. Data had been collected from SAI Complex, Kolkata. In the present study the main task was to find out the comparison of landing difference between

men and women gymnasts in selected lower limb kinematic parameters in vault. During landing two phases was considered – touch down phase and final phase of landing. Knee varus, inter-ankle distance, angle at hip joint, angle at knee joint and angle at ankle joint during landing were considered as measuring criteria for the present study. For measuring and collecting data two HD video graphic Z7 cameras manufacture by Sony Japan was used to record the technique of landing. Necessary materials are like a reference stick used as reference frame, conversion scale made up of wood painted with black and white contrast bands, tripod stand for camera. Marker with adhesive tape was used for marking the hip, knee, ankle and CG position. In this present study data were collected in two phases. At first, two video cameras were used to record the movements of landing technique of the subjects. Subsequently, these recorded movements were analyzed using the freeze frame technique with the help of appropriate software (Final CutPro-7). The time information was obtained from the basic frequency (24fps). The collecting data were analysed using standard statistical technique.

## RESULTS :

The data of the present study and the statistical analysis have been presented parameter wise in the following sections.

1. **Knee varus during landing (distance between two knees)**  
The landing situation was analysed in two successive phases- touch down phase and final phase of landing. The results of the statistical analysis for significance of difference between the mean values of male and female subjects using t-test have been presented in table 1.1.

**Table-1.1**  
**Comparison of mean between men and women in different phases for knee varus during landing**

Phases	Men	Women	't'	Significance	
Touch down phase	17.66±2.05 cm	16.37±2.81 cm	0.845	0.423	NS
Final phase	14.98±2.31 cm	14.88±6.26 cm	0.288	0.780	NS



It is seen from the table that the difference between men and women mean values for knee varus at touchdown phase and final phase of landing was not significant at required level of 0.05 for the game gymnastics. It was understood that in the touch down phase of landing there was no significant difference between men and women subjects in the inter-knee distance.

## 2. Distance between two ankles during landing

The mean difference and statistical significance between male and female group of subjects using t-test for the parameter distance between two ankles during landing have been presented in the table 2.1.

**Table-2.1**

**Comparison of mean between men and women in different phases for distance between two ankles during landing**

Phases	Men	Women	't'	Significance	
Touch down phase	19.05±2.82 cm	20.23±4.12 cm	0.546	0.599	NS
Final phase	15.67±2.05 cm	17.86±3.07 cm	1.361	0.210	NS

It is seen from the table that men women difference in both the phases was not statistically significant for the parameter ankle distance.

## 3. Angle at hip joint during landing

The manipulating of cg is accompanied by flexion of hip, knee and ankle joints. It was felt necessary to analyse the men women difference in angle at hip joint. Table-3.1 shows the mean values and the comparison for statistical significance between male and female subjects using 't'-test.

**Table-3.1**

**Comparison of mean between men and women in different phases for angle at hip joint during landing in table vault**

Phases	Men	Women	't'	Significance	
Touch down phase	164.83±11.41 degree	155.35±10.81 degree	1.326	0.221	NS
Final phase	86.50±19.58 degree	90.00±09.76 degree	0.326	0.752	NS

It is seen from the table that men women difference in both the phases was not statistically significant at required 0.05 level for the parameter angle at hip joint.

#### 4. Angle at knee joint during landing

Table-4.1 shows the mean values and the statistical significance of difference between men and women subjects using 't'-test for the parameter of angle at knee joint during both the phases of landing.

**Table-4.1**  
*Comparison of mean between men and women in different phases for angle at knee joint during landing*

Phases	Men	Women	't'	Significance	
Touch down phase	176.33±3.20 degree	171.75±2.75 degree	2.333	0.047	S
Final phase	100.17±11.34 degree	98.50±8.43 degree	0.249	0.809	NS

It is seen from the table that the gender difference was significant at 0.04 level in angle at knee joint at touch down phase of landing for table vault. Angle at knee joint during touch down phase of landing was more for men than women. It is seen from the table that the difference between men and women mean values for angle at knee at final phase of landing was not significant at required level of 0.05 for the vault in gymnastics.

#### 5. Angle at ankle joint during landing

The mean difference and statistical significance between men and women group of subjects using t-test for the parameter ankle angle during landing have been presented in the table 5.1.

**Table-5.1**

**Comparison of mean between men and women in different phases for angle at ankle joint during landing**

Phases	Men	Women	't'	Significance	
Touch down phase	136.00±13.11 degree	129.50±12.82 degree	0.774	0.461	NS
Final phase	81.83±14.96 degree	82.50±7.42 degree	0.172	0.867	NS

It is seen that the difference between men and women mean values for angle at ankle joint at both phases touch down phase and final phase of landing was not significant at required level of 0.05 for the table vault in artistic gymnastics.

#### **DISCUSSION:**

The parameter knee varus during landing was greater (though statistically insignificant) for men than women for both touch down phase and final phase of landing [reported by Ford, Myer and Hewett (2003), Kernozek and others (2005), Russell et al. (2006) and Michael and others (2008)]. This may be due to the fact that the women has wider hip width than the men.

Distance between two ankles during landing was more (statistically not significant) for women than men for both the phases of landing. This may be due to the fact of height of cg and anatomical difference of the women.

Angle at hip joint during landing at final phase was larger (statistically insignificant) for female than male subjects. This has been supported by the results reported by Decker et al. (2003), Pollard and others (2004). This might be due to the more flexion of upper body helps male subject bring the line of gravity nearer to the point of support for maintaining stability more effectively. Hip flexion for men was  $78.33^{\circ}$  and for women was  $65.35^{\circ}$ .

Results of the present study indicated that the angle at knee joint was statistically greater for men than women at touch down phase of landing. And for final phase of landing male subjects also showed tendency to have more knee angle than that of female

although the result was statistically insignificant [Lephart *et al.* (2002), Ford, Myer and Hewett (2003), Kernozek and others (2005), Chappel and others (2007), Watkins, Owen and Lewis (2008), Beutler *et al.* (2009), Pfeiffer *et al.* (2010)]. There may be a reason that the women do not use their thigh muscles as effective as men in landing.

Angle at ankle joint at final phase of landing was higher (although statistically not significant) in favour of male subjects. This has been resulted due to greater flexion at hip joint and greater knee angle as explained by Salci and Others (2004).

### CONCLUSION:

On the basis of results obtained out of analysis of data and within the limitations of the study the following conclusions were drawn.

1. Angle at knee joint at touch down phase of landing is greater for men than women table vaulter.
2. Knee varus during landing in table vault is greater for men than women.
3. Women table vaulter have greater hip angle indicating their landing with more erect poster than men vaulter.
4. Knee angle during landing becomes more for men indicating their use of thigh muscles more for absorbing shock during landing.

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