EFFICACY OF BIOMECHANICAL ANKLE PLATFORM SYSTEM TRAINING TO IMPROVE BALANCE IN ANKLE INJURED PATIENT AT CRP

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Bachelor of Science in Physiotherapy (B.Sc.PT)

Session: 2008-2009

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August, 2014

We the under signed certify that we have carefully read and recommended to the Faculty of Medicine, University of Dhaka, for the acceptance of this dissertation entitled

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Declaration

I declare that the work presented here is my own. All sources used have been cited appropriately. Any mistakes or inaccuracies are my own. I also declare that for any publication, presentation or dissemination of information of the study I would be bound to take written consent of my supervisor and my department too.

Signature: **Date:**

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Contents

Acknowledgment

At first I would like to thanks Almighty Allah for timely completion of my study. I am very much grateful to my family to give me mental and economical support and they always want to see me as successful person in the world. I would like to express my highest gratitude to my honorable supervisor Nasirul Islam for his keen supervision and guidance.

I would also like to express my gratitude to my respected teacher Md. Shofiqul Islam, Assistant Professor, BHPI, Department of Physiotherapy, for his valuable classes and guidance without which I could not able to complete this project.

I am thankful to my respectable teacher Md. Obaidul Haque, Associate Professor, Head of the Physiotherapy Department for his encouraging behave. Mohammad Anwar Hossain, Associate Professor, Dept. of physiotherapy and Muhammad Millat Hossain, Lecturer, Department of Physiotherapy for sharing their precious knowledge in class that helps me in various aspects of concerning this study.

My special thanks for special sitting unite, especially thankful to Mr. Shobol Das for his good advice and kind attitude and for giving me valuable suggestions. Also thanks to Ainur Nishad and Nabagata Das for helping me in different stage of the study that made my work easy, relive from difficulties.

I am thankful to all the staff of musculo-skeletal unit of CRP, Savar for their kind support to collect information about this study specially A.T.M. Thouhidul Islam. Also, thanks to the staff of the Bangladesh Health Professions Institute (BHPI) Library for their friendly attitude to find out related books, journals and access to internet specially HINARI.

Above all I would like to give thanks to the participants of this study. Lastly thanks to all who always are my well-wisher and besides me as friend without any expectation.

Abbreviation

ACL	Anterior Cruciate Ligament
ADL	Activity of Daily Living
BAPS	Biomechanical Ankle Platform System
BHPI	Bangladesh Health Professions Institute
BMI	Body Mass Index
CAI	Chronic Ankle Instability
CRP	Centre for the Rehabilitation of the Paralyzed
FAB	Fullerton Advance Balance
FAI	Functional Ankle Instability
GTO	Golgi Tendon Organ
RCT	Randomized Control trial
SD	Standard Deviation

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Abstract

*Purpose***:** The purpose of the study was to test the hypothesis "BAPS training with conventional physiotherapy is better than only conventional physiotherapy for the treatment of ankle injured patient". *Objectives:* To evaluate the effects of improving balance in Ankle injured patient by BAPS Training during postural instability and low neuromuscular functional balance. Ankle injured patients using pre and post test assessment with BAPS Training, conventional physiotherapy and conventional Physiotherapy alone. Also to explore the commonly affected age and gender group of people vulnerable to Ankle injury. *Methodology:* Single blinded; Randomized controlled trial study was used in this study. 12 patients of Ankle injury with balance problem were listed from musculoskeletal physiotherapy department of CRP (Savar). After those 6 patients were randomly assigned to BAPS Training exercises with conventional physiotherapy group and 6 patients to the only conventional physiotherapy group for this study. Fullerton Advance Balance scale (FAB) was used to measure the Balance level of patients. *Results:* Data was analyzed by using Mann Whitney 'U' test and Microsoft Excel Worksheet 2010 was used to decorate data according to FAB scale. After observing pre-test and post-test score the significant improvement wasn't found. P-value was > 0.05. Improvements were not statistically significant. But it has grater improvement over control group. This study also explore that the male are more affected by ankle injury. About 83% participants were male and 17% were female in this study. And In trial group age 49± 9.375 years and in control group 43 ±13.921 years.

Conclusions: Biomechanical Ankle Platform System training exercises along with conventional therapy are more effective than conventional therapy alone to improve Balance of Ankle injured patients. And P-value is >.05.

Key words: Ankle injury, BAPS Training, Conventional physiotherapy.

CHAPTER-I: INTRODUCTION

1.1 Background

Ankle injury are the most common reported injuries in running and jumping sports, such as basketball, soccer, badminton, and volleyball (Lee & Lin, 2008). As a lower extremity joint close to the body's base of support, the ankle plays an integral role in postural control and balance maintenance (Lee & Lin, 2008). It is estimated that approximately 30% of individuals will develop chronic ankle instability after the first initial lateral ankle sprain. Chronic ankle instabilities often result from ankle sprain and characterized by the subjective complaint of the ankle "giving away" during normal activities. Proper treatment and rehabilitation facilitate the return of an athlete to activity and decrease the incidence of re-injury.

Two most common causes for residual ankle instabilities that can be addressed by rehabilitation are peroneal muscle weakness and proprioceptive defects. (Hoffman, 1993). Startling statistics regarding falls in the elderly has been a growing concern of many health care professionals. Due to loss of balance function and increased incidence of falls in the elderly, improving postural control/balance is a major concern in rehabilitation and geriatric medicine (Wegener, Kisner, & Nichols, 1997).

A previous study found that after an ankle sprain, up to 40% of sufferers continue to report residual disability which might persistent for seven years after the inversion trauma. The term ''Functional ankle instability" (FAI) was firstly purposed and coined by (Lee & Lin, 2008) to describe the subjective sensation of giving way or feeling joint instability after repeated ankle sprain episodes. The factors contributing to FAI are complex but involve sensorimotor, mechanical, and muscular deficiencies.

Proprioception is a specialized variation of the sensory modality and encompasses the sensations of joint movement (kinesthesia) and joint position (joint reposition sense). It contributes to motor programming for neuromuscular control and contributes to muscle reflexes for dynamic joint stability. It is believed that ankle proprioception is critical to the balance of the human body during functional activities such as standing, walking and running. Damage to the proprioception system is thought to be the major causes of functional instability after ankle injuries.

The biomechanical ankle platform system (BAPS) has been commonly used by athletic trainers and physicians in rehabilitation after ankle injuries. It is designed to aid in re-educating the proprioceptive system by improving mechanoreceptor function and restoring normal neuromuscular coordination.

To my knowledge there are no studies documenting the efficacy of BAPS to improve balance for ankle injured patient. It is important to create new treatment options for reducing the burden of ankle injured patient in social and personal life. Therefore this study may provide the rational treatment protocol for improving functional outcome of ankle injured patient.

1.2 Rationale

Serious knee and ankle injuries continue to be a strong concern to athletes of many sports. The frequency of ankle and knee injuries in sport is paramount. The most common type of sprain encountered in athletics is the ankle sprain while the most debilitating of injuries are seen at the knee (Gilchrist, Mandelbaum, Melancon, Ryan, Silvers, et al., 2008). An epidemiological review by Hootman, Dick, & Agel (2007) revealed that ankle sprains make up approximately 15% of all sustained injuries that occur due to athletic participation.

A systematic review of 227 epidemiological studies regarding the frequency and occurrence of ankle sprains in sports was performed as well (Fong, Hong, Chan, Yung, & Chan, 2007). It was found that out of 70 sports, the ankle ranked the most injured in 24 or 34.3% of sports studied. Closely following behind was the frequency of knee injuries with 14 of 70 sports reporting them as the most common injury (Fong et al., 2007). Each injury is associated with not only pain and disability, but medical costs as well, especially in the case of surgical anterior cruciate ligament (ACL) injuries. At a cost per ACL injury of approximately $17,000, surgical and rehabilitative costs near $646,000,000 annually in the United States (Myer, Ford, & Hewett, 2004).

In addition to the traumatic and psychological effects these injuries have on athletes, you must also take into account the potential loss of entire seasons of sport participation and possible scholarship funding, significantly lowered academic performance, long-term disability, and up to 105 times greater risk for radiographically diagnosed osteoarthritis in the future (Myer et al., 2004).

Having said this, it is obvious the importance that should be placed on the prevention of knee and ankle ligamentous injuries. Research is needed regarding the most efficient and effective ways to produce proprioceptive changes in the lower extremity that will lead to decreases in injury frequency and also aid in the effective rehabilitation of previous injury.

Several studies have shown effectiveness of wobble board training in enhancing postural stability. Balogun, Adesinasi, & Marzouk (1992) found a significant improvement in balance ability in subjects who underwent a 6 week course of wobble board training. A study by McGuine et al. in 2000 showed that balance deficits in high school basketball players were predictors of subsequent ankle injuries. Similarly, Caraffa, Cerulli, Projetti, Aisa, & Rizzo (1996) found a significant decrease in the number of ACL injuries in a study of 600 soccer players who performed balance training exercises as part of their training regime. These results have been reproduced in more recent studies as well (Malliou, Gioftsidou, Pafis, Beneka, & Godolias, 2004; Emery, Cassidy, Klassen, Rosychuk, & Rowe, 2005). It is evident that by initiating preventative balance training programs, it is possible to reduce the risk of sustaining lower extremity injuries while also improving balance ability.

The purpose of this study was to determine if significance exists between BAPS training programs on select tests of balance among recreationally ankle injured patients. BAPS training help in improve balance, which is essential for functional activity. So, BAPS training may help to improve the balance, proprioception, stretching, strengthening the lower leg and ankle. BAPS improve postural stability by increasing balance, proprioception and strengthen muscle. So, BAPS training exercise could be included as evidence treatment for those who are suffered by acute and chronic ankle injured patients.

1.3 Hypothesis

BAPS training with conventional physiotherapy is better than only conventional physiotherapy for the treatment of ankle injured patient.

1.4 Null hypothesis

BAPS training with conventional physiotherapy is no more effective than only conventional physiotherapy for the treatment of ankle injured patient.

1.5 Objective

1.5.a General objective

- To identify the efficacy of BAPS training to improve balance in ankle injured patient.

1.5.b Specific objective.

- To evaluate the effect of BAPS training for ankle injured patient during postural instability.
- To determine effect of the BAPS training for ankle injured patient to increase the functional-neuromuscular balance.

1.6 List of variable

- Independent variable: Biomechanical Ankle Platform System (BAPS).
- Dependent variable: Ankle injury.

1.7 Operational definition

Injury

An injury is the damage to a biological organism caused by physical harm. Major trauma is injury that can potentially lead to serious outcomes.

Ankle Injury

Any trauma or physical harm that affects the normal functioning of ankle.

BAPS Training

Some systemic programmed exercises performed by BAPS board for improving postural stability and neuromuscular balance along with ankle injured patient.

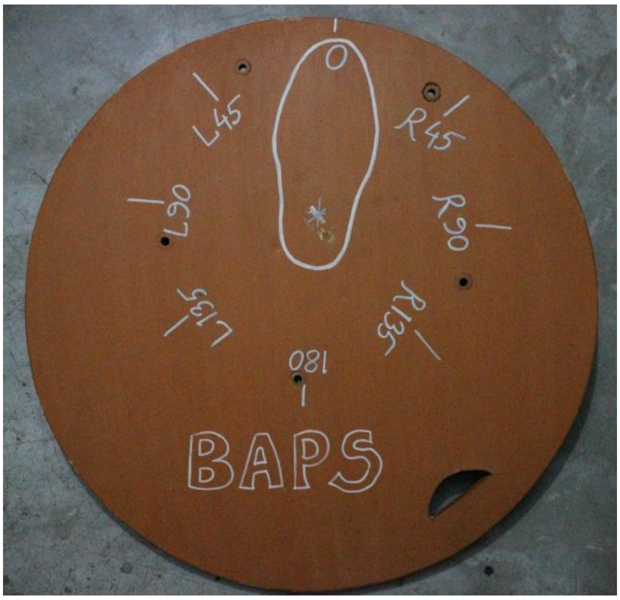

FIG: BAPS

Conventional physiotherapy

Physiotherapeutic interventions that are widely accepted and commonly practiced by medical community.

CHAPTER- I: LITERATURE REVIEW

The acute ankle sprain is the most common injury in both interscholastic and intercollegiate sports (Fernandez et al., 2007). It is estimated that approximately 30% of individuals will develop chronic ankle instability after the first initial lateral ankle sprain (Itay et al., 1982). Simple ankle sprains are not as innocuous as many believe, with high rates of prolonged symptoms, decreased physical activity, recurrent injury, and self-reported disability (Anandacoomarasamy et al., 2005). Routine non-operative treatment is successful in more than 90% of individuals. Surgery is reserved for those who fail bracing, proprioceptive training, and kinetic chain strengthening (Leardini et al., 2000).

The ankle joint is more than a simple hinge joint. During its arc of motion, rolling and sliding occur and the contours of the joint surfaces, in combination with the geometry of the ligaments, have an intricate balance that is then acted on by multiple muscle groups. Leardini (Leardini et al., 2000) and Bonnel (Brostrom et al., 2010) have both provided excellent reviews of the complex anatomy and biomechanics of the ankle joint. The important lateral ligamentous structures include the anterior talofibular ligament (ATFL), posterior talofibular ligament (PTFL), and calcaneofibular ligament (CFL).

The ATFL runs from the anterior edge of the lateral malleolus to the talar neck, attaching just anterior to the lateral malleolar facet. It is the most important lateral stabilizer of the ankle, being the primary restraint to supination and anterior translation (Johnson et al., 1983); it also limits plantar flexion and internal rotation (Rasmussen, 1985). The PTFL courses from the posterior talus to the back of the lateral malleolus. It is located deep and is the strongest of the lateral ligament complex. The calcaneofibular ligament (CFL) lies deep to the peroneal tendon sheath, originating from the tip of the fibula to the lateral tubercle of the calcaneous.

Balance, or postural stability, is the ability to maintain a position and react to a perpetuating force (Roth et al., 2006). Many physiological components of the human body allow us to perform such reactions. Of most importance regarding maintaining balance is proprioception: the ability to sense the position of a joint or body part in motion (Brown, Miller, & Eason., 2006). Several types of sensory receptors located throughout the skin, muscles, joint capsules, and ligaments give the body its ability to recognize both internal and external environmental changes within each joint and ultimately lead to improvements in balance. This concept is important in a clinical orthopedic setting due to the fact that enhancing balance abilities in athletes helps them to achieve superior athletic performance as effective motor control is defined by accurate sensory information concerning both the external and internal environmental conditions of the body (Riemann & Lephart, 2002).

Proprioception is produced through the simultaneous actions of the vestibular, visual, and sensorimotor systems, each of which plays a significant role in maintaining postural stability. Of most concern in enhancing proprioception are the functions of the sensorimotor system. Encompassing the sensory, motor, and central integration and processing components involved in maintaining joint homeostasis during bodily movements, the sensorimotor system includes the information received through nerve receptors located in ligaments, joint capsules, cartilage, friction, and the bony geometry involved in each joint's structure. Mechanoreceptors are specialized sensory receptors responsible for quantitatively transducing the mechanical events occurring in their host tissues into neural signals (Riemann & Lephart, 2002). Those that are responsible for proprioception are generally located in joint muscles, tendons, ligaments, and capsules while pressure sensitive receptors are located in the fascia and skin (Riemann & Lephart 2002).

The importance of these mechanoreceptors in proprioceptive ability becomes evident in the event of musculoskeletal injuries and how interruptions in the stimulation of them affect the motor control essential to attaining superior athletic performance. There are two basic roles performed through the use of proprioceptive information regarding motor control (Rieman & Lephart, 2002b). on the other hand, consist of specialized afferent nerve endings that are wrapped around modified muscle fibers, called intrafusal fibers, that are sensitive to muscle lengthening (Brown et al., 2006). When these fibers are stimulated by increased length changes, rather than causing a relaxation seen with the GTO, they stimulate a contraction of the muscles in which they reside (Shier et al., 2004).

It is commonly believed that musculoskeletal injury to the lower extremity alters the somatosensory (proprioceptive) input that is essential for neuromuscular coordination. Joint proprioceptors are believed to be damaged during both complete and incomplete rupture of the lateral ligaments of the ankle because the joint receptor fibers possess less tensile strength than the ligament fibers (Guskiewicz et al., 1996). Damage to the joint receptors is believed to cause joint differentiation, which diminishes the supply of messages from the injured joint up the afferent pathway and disrupts proprioceptive function (Guskiewicz et al., 1996). Furthermore, when the anterior cruciate ligament (ACL) in the knee is torn or stretched, kinesthesia of the knee joint is decreased. It is believed that a patient's ability to balance on the ACL-injured leg may be decreased, even following surgical reconstruction of the knee (Guskiewicz et al., 1996).
Current rehabilitation protocols for the lower extremity emphasize the importance of balance and proprioceptive exercises (Guskiewicz et al., 1996) , although there is a lack of consistent findings on balance assessment of the injured athlete.

Much research has been performed regarding the use of balance training for injury prevention purposes, particularly relative to ankle sprains and chronic ankle instability. Only one study exists concerning aquatic balance training and it does not address injury reduction rates (Roth et al., 2006). Due to the lack of research directly related to this study, a review of related literature concerning the relatively reduced rates of injury as a result of balance training on land will be discussed. Many studies on balance training have shown to improve measures of postural control while also reducing the risk of injury or re-injury. In a study by Kidgell, Horvath, Jackson, & Seymour (2007), 6 weeks of dura disc balance training was compared to 6 weeks of the same training protocol on a mini-trampoline. The researchers used postural sway measures of medial-lateral and anterior-posterior sway during a single leg stance to assess for improvements in balance after having completed the training protocols. While no significant differences were found between modes of training, significant improvements in postural sway measures were observed between the intervention groups and the control group who merely performed testing. Another study, by Emery et al. (2005), studied the effectiveness of a home-based balance training protocol using a wobble board in improving static and dynamic balance as well reducing sports related injuries among healthy adolescents. This study randomly selected 2 physical education students from 10 of 15 high schools in a school district to participate in the study. They were randomly assigned to either an intervention group or a control group.

A study by Lee & Lin looked for improvements in postural stability and ankle proprioception among subjects with unilateral functional ankle instability (2008). The researchers used a 12 week training program with a biomechanical ankle platform system (BAPS board) and a progression protocol to reach for improvements in proprioception. Balance testing using single leg stance with eyes open and eyes closed was implemented for measures of postural stability. The researchers found significant improvements in the mean radius of center of pressure on unilateral standing in the functionally unstable ankles after 12 weeks of balance training.

Rasool and George (2007) analyzed the effect of single-leg dynamic balance training on dynamic stability in healthy male athletes. Assessed using the Star Excursion Balance Test, participants performed balance tests at baseline, 2 weeks after initiation of balance training, and again at 4 weeks at the close of training. The exercise group's trained, or dominant, limbs showed significant improvements in balance test parameters in all individual directions at 2 weeks and continued to improve significantly at 4 weeks when compared to the control group. The untrained, or non-dominant, limbs showed significant improvement in four of the eight outcome measures as compared to the control group. These results point out the efficacy of even short duration balance training and the implications it may have in the prevention of injury if used during preseason training are paramount.

MeKeon and Hertel (2008) performed a systematic review of postural control and lateral ankle instability to determine if prophylactic balance training could reduce the risk of sustaining a lateral ankle sprain, if balance training could improve treatment outcomes associated with acute ankle sprains, and whether balance training could improve treatment outcomes associated with chronic ankle instability. The review revealed a 20% to 60% relative reduced risk for sustaining a lateral ankle sprain as a result of balance training. Particularly those athletes with a history of ankle sprains had a consistent and significant reduction in the risk of sustaining recurrent ankle sprains. With regard to the treatment outcomes of acute ankle sprains, the review revealed 3 articles that found a 54% to 74% relative reduced risk of sustaining recurrent ankle sprains after undergoing balance training following an acute ankle sprain. Finally, there were no significant findings regarding the effect of balance training on improving treatment outcomes of individuals who suffer from chronic ankle instability.

Another study looked at the effect that balance training had on the risk of ankle sprains in high school athletes (McGuine & Keene, 2006). In this study 765 high school soccer and basketball players were assigned to either an intervention group that participated in a balance training program or a control group that performed only standard conditioning exercises. Athletic exposures and ankle sprains, as diagnosed by a Certified Athletic Trainer, were recorded and differences in frequency of sprains per exposures were calculated (McGuine & Keene, 2006). Similarly to previously reported results, the study showed that the rate of ankle sprains was significantly lower for subjects in the intervention group. Athletes with a history of an ankle sprain had a 2-fold increased risk of sustaining a sprain while athletes who performed the intervention program decreased their risk of a sprain by one half (McGuine and Keene, 2006). These results were duplicated in a study by Malliou et al. (2004). They studied the effects that balance training had on the occurrence of lower extremity injuries and found that the experimental group, who performed balance training, had 60 lower limb injuries while the control group had 88 injuries. Regarding specific injury types, ankle sprains occurred nearly 1.5 times more in the control group than in the intervention group (22 vs. 38).

While many studies have been performed regarding the decrease in ankle injuries as a result of balance training, it should also be noted that similar theories exist regarding the prevention of knee injuries, more specifically anterior cruciate ligament (ACL) injuries. Many studies have been performed to assess the effect of balance training and other preventative techniques on the reduction of ACL injury rates and treatment outcomes of ACL injuries. Theories supporting balance training in the prevention of ACL injury suggest that proprioceptive training promotes neuromuscular mechanisms responsible for the co-contraction of agonist and antagonist muscles that enhance active joint stability, a component essential for superior athletic performance (Hrysomallis, 2007).

However, balance training has also been shown to have a negative effect on ACL injury rates, especially in females (Hrysomallis, 2007). Therefore, a multi-faceted training protocol is often recommended for ACL injury prevention (Hrysomallis, 2007). In a meta-analysis of balance training and associated injury risks, six studies were examined and it was found that balance training reduced the incidence of ACL ruptures by 7-fold in male soccer players; however, it was also associated with a significant increase in the risk of major knee injuries in female soccer players as well as overuse injuries in male and female volleyball players (Hyrosomallis, 2007). The study that found these results was the only study that used a wobble board in its training protocol and, therefore, the researcher suggests that differing methods of proprioceptive training might influence the rate of ACL injuries in a more positive manner (Hrysomallis, 2007). The researcher also suggested that multi-faceted interventions that incorporated proper jumping and landing techniques as well as rapid-change-of direction exercises could be a more effective means of reducing ACL injuries (Hrysomallis, 2007).

A previously mentioned study by Malliou et al. (2004) found a decrease in knee injuries as a result of proprioceptive training in a sample of young soccer players. Injuries were recorded over one competition period and results showed that twice as many knee ligament injuries occurred in the control group than did in the intervention group (28 vs. 14). Another study by Caraffa et al. in 1996, as reported in a report by Myer et al (2004), evaluated the effect of balance board exercises on noncontact ACL injury rates in elite male soccer players. It showed that athletes who participated in proprioceptive training before their competitive season had a significantly reduced rate of knee injuries. Although no other results were found by the authors that duplicated these results, Myer et al. (2004) were able to find a study that elaborated on the balance training protocol suggested by Caraffa et al. by adding a focus to improve awareness and knee control during standing, cutting, jumping, and landing. They were able to reduce the incidence of ACL injury in women's elite handball players over 2 competitive seasons (Myer et al., 2004).

A study by Soderman, Werner, Pietila, Engstrom, & Alfredson, (2000) as reported in a meta-analysis by Padua & Marshall (2006) investigated overall injury patterns among female soccer players. The players were given their own balance boards and were provided with a printed handout of a balance training program consisting of 5 exercises that would take approximately 10 -15 minutes at home. Contrary to the previously mentioned findings of Caraffa et al., there was no difference between control and intervention groups in the incidence of traumatic injuries. The researchers suggest possible reasons for this difference including gender, playing division, or total amount of balance training (Padua & Marshall, 2006). Of particular interest regarding this study, however, is that four of the five ACL injuries experienced during the study period were to subjects within the balance training group. This idea of a negative effect specific to balance training exercises on a wobble board seen with a previously mentioned study surfaces again; further research is recommended to determine if specific balance training exercises and equipment produce differing results regarding ACL injury prevention (Padua & Marshall, 2006).

Another study reported by Padua & Marshall (2006) investigated the effect of a phased balance training intervention on different handball divisions. The study used an initial season as a control season and the two consecutive seasons following as intervention seasons. Injury data was collected from 60 teams through an injury-surveillance system. During the 5 to 7 week pre-intervention season period, the athletes were instructed to perform balance training exercises three times a week and to decrease training to once a week once the competitive season began. Twenty-nine ACL injuries were reported during the control season while 23 and 17 ACL injuries were reported during the first and second intervention seasons, respectively. There was no significant difference, however, between the incidence of ACL injuries in the control group compared to the intervention group. Of interest is the trend seen between level of skill and ACL injury frequency when the groups were separated by skill. The elite division showed a positive training effect while the second and third divisions showed no significant effects of training on ACL prevention.

A final study regarding the effects of balance training on ACL injury prevention performed by Petersen, Braun, Bock, Schmidt, & Weimann et al. (2005) showed a decrease in the intervention compared to the control group. The study looked at 134 players following an injury prevention program that included 3 main components: balance board exercises, jump exercises, and balance mat exercises. There were 5 ACL injuries in the control group compared to a single ACL injury in the intervention group. Though this did not reach statistical significance, the ACL injury risk was 80% lower in the intervention group. A meta-analysis by Hewett, Ford, & Myer (2006) went on to make recommendations regarding ACL prevention programs based on analysis of success rates of differing methods of intervention. The researchers suggested 3 common elements of prevention programs: a Plyometric component, a biomechanical analysis and correction component, and a balance and core stability training component (Hewett et al., 2006).

Balance training has not only been shown useful in the prevention of anterior cruciate ligament injury, but also in its rehabilitation. In a study by Vathrakokilis, Malliou, Gioftsidou, Beneka, & Godolias (2008), twenty-four patients who had undergone similar ACL reconstruction surgeries were randomly assigned into either a balance training group or a control group. Using the Biodex Stability System to assess patients' balance in single limb stance, the authors noted significant pre-training differences in proprioceptive ability between healthy and reconstructed legs. After the 8 week balance training program, all balance performance indicators significantly improved in the balance training group while no difference was found among those in the control group. This goes to show that even a long period after rehabilitation of the ACL reconstruction, patients still had significant proprioceptive deficit in comparison to their healthy legs. However, with the 8-week balance training program utilized in this study, that deficit was decreased, thus supporting the role of balance training in the treatment of knee injuries in addition to those of the ankle.

The biomechanical ankle platform system (BAPS) is one way in which participants can train/exercise in older to improve balance (Mandy & Kelly, 2000). The BAPS incorporates an axis of rotation for a insertion of a hemispherical attachment (Mandy & Kelly, 2000). The shape and design of the board is the result of an analysis of the anatomy, kinesiology, and mechanics of motion and function of the ankle. It is essential to maintain proper foot alignment because of the exact calibrated shape and design of the platform (Camp International Limited, 1984).

The BAPS consists of levels 1-5. Each subsequent level increases the percentage of all ranges by an exact proportionate amount. The rotation of the platform around its peripheral edge is a mandatory protocol parameter of the BAPS, except in balance training (Camp International Limited, 1984).

The use of the BAPS board with and without shoes is beneficial. The use of the system without footwear allows for proper exercise without extrinsic compensation and allows for observation of the foot and ankle in various motions. The use of the system with footwear can change the relationships of certain segments of the foot and ankle; therefore rehabilitation, training, and conditioning with footwear is a beneficial part of the program (Camp International Limited, 1984).

The BAPS has been shown to improve lower extremity proprioception, strength and coordination; therefore, with BAPS training, it is possible to increase postural control and balance (Soderberg, Cook, Rider, & Stephenitch, 1991).

CHAPTER-III: METHODOLOGY

3.1 Study design

The study was single blind randomized controlled trial conducted between May 2014 and August 2014. Measurement was obtained before starting the intervention and after the intervention period (6 sessions).

Flowchart of the phases of randomized controlled trial

Assessed for eligibility

↓

Outdoor ankle injured patients

↓

Randomly selected 12 patients with ankle injury

↓

Randomly selected to Experimental or Control Group (n=12)

↓

Experimental Group (n1=6)	Control Group (n2=6)
↓	↓
Received BAPS Training With Conventional Physiotherapy	Received Conventional Physiotherapy only
↓	↓
Follow Up (after 6 sessions)	Follow up (after 6 sessions)
↓	↓
Outcome analyzed	Outcome analyzed

A flowchart for a randomized controlled trial of a treatment program including conventional physiotherapy with BAPS Training for ankle injured patients.

3.2 Study site

Musculoskeletal unit of the Centre for the Rehabilitation of the Paralyzed (CRP), Savar was selected for the study site.

3.3 Study area

The study conducted on musculoskeletal area.

3.4 Study population

The study population was patients with ankle injury.

3.5 Sampling procedure

The researcher used simple random sampling procedure for this research. 12 subjects were randomly selected in to two groups where 6 subjects were in control group and 6 subjects were in trial group.

3.6 Inclusion criteria

- Ankle injury patient :
    i. Chronic ankle sprain
    ii. Chronic ankle instability
    iii. Post fracture complication
- Patients with all age range
- both male and female were included
- The participants were those individuals who continued physiotherapy treatment at least six sessions.
- Voluntary participants.
- Participants with having balance problem.

3.7 Exclusion criteria

- Subjects who are not agree complete at least six session of physiotherapy treatment.
- The participants had any experienced of recent trauma.
- Deltoid ligament injuries

- Multiple injuries
- Dementia
- Mental illness
- Neurological conditions
- Intoxication (alcohol or drugs)
- Bony infection
- Fracture
- Osteoporosis
- Pregnancy
- Osteopenia
- Any pathological lesion on ankle.
- Structural abnormality or any deformity.
- The participant who participated another study.

3.9 Data collection tools

Data collection tools were questionnaire, pen, papers, consent form and FAB scale (Fullerton advance balance scale).

3.10 Data collection

Data collection procedure was conducted through assessing the patient, initial recording, treatment and final recording. After screening the patient at outdoor department, the patients were assessed by qualified physiotherapist in emergency musculoskeletal department of CRP. Those patients were fulfill all the inclusion and exclusion criteria, were chosen for this study. 14 subjects were chosen and randomly allocated in to two groups where one group received only conventional treatment called control group and another group received BAPS training along with conventional treatment called trial group. Data was gathered through a pre-test, intervention and post-test and the data was collected by using a structural mixed type of questionnaire paper. Pre-test was performed before beginning the treatment and functional outcome was noted. The same procedure was performed to take post-test at the end of six session of treatment. The researcher was collected the data both in experimental and control group in front of the qualified physiotherapist in order to reduce the biasness. At the end of the study, specific test was performed for statistical analysis.

3.11 Measurement

Baseline variables included age, sex, occupation, height, weight, dominant leg, living area and balance. Outcome measurements were taken at the baseline and after six session of treatment in two groups. Measurements were made of by FAB scale (Fullerton Advance Balance scale). The FAB scale is simple and standard of objectively assessing balance. FAB scale (Fullerton Advance Balance scale) has 10 different tests and each test has (0-4) point. Long form FAB scale has 40 points and risk of fall is 25 or less. . All the measurements were recorded in double blinding fashion that is both the participants and data collector were not informed about the patient's grouping.

3.12 Intervention

After randomization subjects were assigned into two groups that are control group and trail group. The entire subjects were given intervention according to their groups.

3.12.a Control group

There were 6 subjects in control group. Rest of the six sessions they were received the convention intervention including isometric exercise, isotonic exercise, strengthening exercise, stretching exercise, compression bandage, weight bearing exercise, ice therapy, ultrasound therapy, soft tissue massage, manual mobilization, bicycling, mini-trampoline.

3.12.b Trial group

There were 6 subjects in control group. BAPS training exercises and conventional physiotherapies both were given by clinical physiotherapist .Rest of the six sessions they were received BAPS training exercises in addition with conventional physiotherapy.

Exercises for BAPS training

Category	Components	Setting
Exercise	Anterior–posterior cycles	3 sets/10 rep
	Medial–lateral cycles	3 sets/10 rep
	Clockwise rotation	3 sets/10 rot
	Counterclockwise rotation	3 sets/10 rot
	Single-leg stability	3 times/10 s

FIG: BAPS Training Exercise

3.13 Data analysis

To find out the efficacy of BAPS training for patients with ankle injury data wear collected. In this study there were two different group where one was control that were received only conventional intervention and another group was trail that was received BAPS training exercise with conventional intervention. There were demographic data that was obtained by questioner and ratio data that was scoring for balance test by FAB scale. The clinical outcome variables were analyzed by intention to treat. The results are expressed by means, and standard deviation (SD). Statistical comparison between the groups was made using the U test for balance.

3.13 Statistical test

For the significance of the study, a statistical test was carried out. Statistical analysis refers to the well-defined organization and interpretations of the data by systemic and mathematical procure and rules (Deposy&Gittin, 1998). The U test was done for the analysis of the balance after six session treatment of both control and tail groups.

Mann-Whitney U test is a non-parametric test that is simply compares the result obtained from the each group to see if they differ significantly. This test can only be used with ordinal or interval/ ratio data.

The formula of Mann-Whitney U test:

U = $n_1 n_2 + \frac{n_x(n_x+1)}{2} - T_x$, here, n_1 = the number of the subjects in trail group

n_2 = the number of the subject in control group.T_x = the larger rank total.

n_x = the number of the subjects of the group with larger rank total.

3.14 Ethical consideration

Research proposal was submitted for approval to the administrative bodies of ethical committee of CRP. Again before beginning the data collection, researcher was obtained the permission from the concerned authorities ensuring the safety of the participants. In order to eliminate ethical claims, the participants were set free to receive treatment for other purposes as usual. Each participant was informed about the study before beginning and given written consent.

3.15 Informed Consent

The researcher obtained consent to participate from every subject. A signed informed consent form was received from each participant. The participants were informed that they have the right to meet with outdoor doctor if they think that the treatment is not enough to control the condition or if the condition become worsen. The participants were also informed that they were completely free to decline answering any question during the study and were free to withdraw their consent and terminate participation at any time. Withdrawal of participation from the study would not affect their treatment in the physiotherapy department and they would still get the same facilities.

CHAPTER-V: RESULT

Twelve patients with ankle injury were enrolled in the study. Six in the BAPS training exercise with conventional physiotherapy treatment group (trial group) and Six in the only conventional physiotherapy treatment group (control group).The all subjects of both experimental and control group score their functional outcome level on FAB scale before and after completing treatment.

Mean age of the participants

Trial group		Control group	
Subjects	**Age(Year)**	**Subjects**	**Age(Year)**
T1	49	C1	60
T2	38	C2	52
T3	48	C3	25
T4	40	C4	55
T5	50	C5	25
T6	67	C6	42
Mean Age	**49 year**	**Mean Age**	**43 year**
SD	**9.375**	**SD**	**13.921**

Table-1: Mean age of the participants of experimental and control group.

Sex of the participants

12 patients with ankle injury were included as sample of the study, among them almost 83% (n=10) were male and about 17% (n=2) were female.

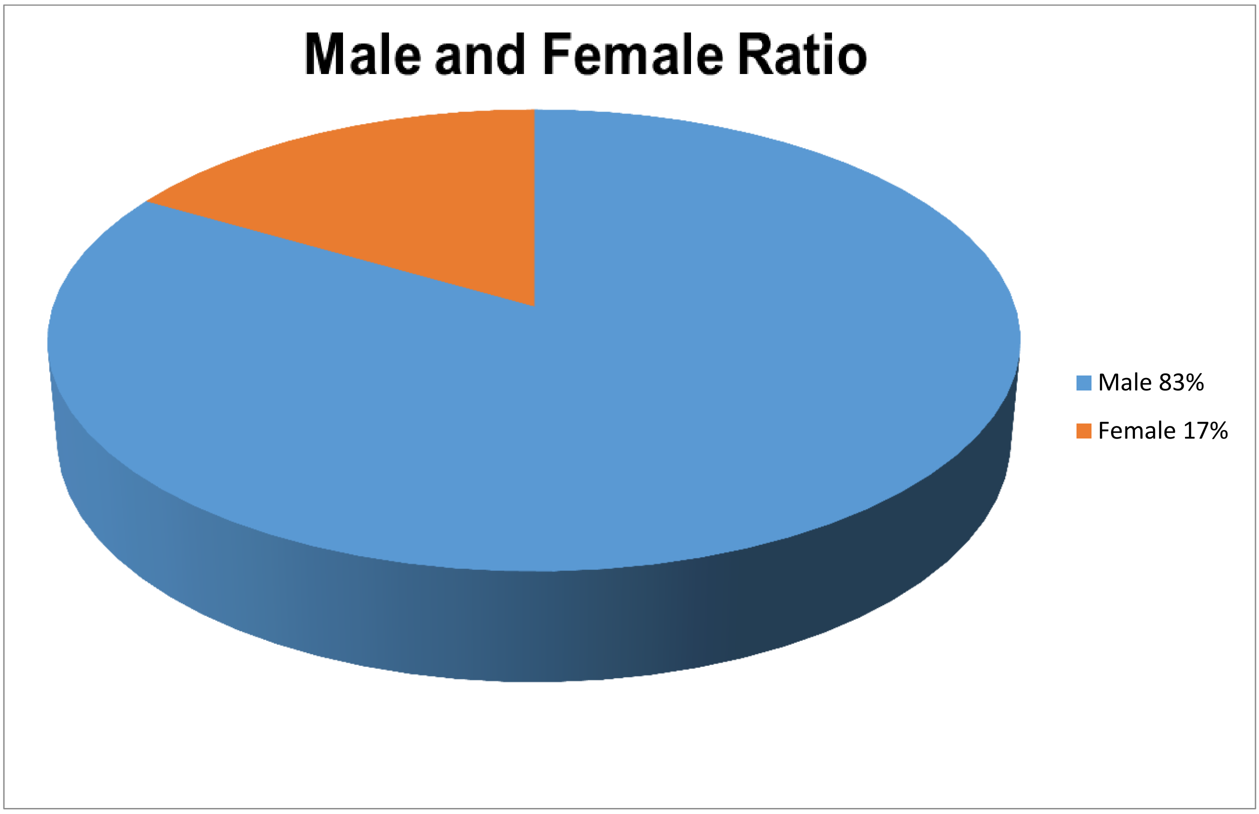

Figure-3: Involvement of the sex

Mean weight of the participants

12 patients with ankle injured were included as sample of the study.

Experimental group		**Control group**	
Subjects	**Weight(kg)**	**Subjects**	**Weight(kg)**
E1	56	C1	65
E2	48	C2	59
E3	65	C3	60
E4	60	C4	62
E5	67	C5	56
E6	54	C6	61
Mean Weight	**58.33 Kg**	**Mean Weight**	**60.50 Kg**

Table-2: Mean weight of the participants of experimental and control group

Mean height of the participants

Experimental group		Control group	
Subjects	**Height(Inch)**	**Subjects**	**Height(Inch)**
E1	62	C1	63
E2	62	C2	62
E3	69	C3	68
E4	64	C4	69
E5	70	C5	67
E6	66	C6	67
Mean Height	**65.5 inch**	**Mean Height**	**66 inch**

Table-3: Mean Height of the participants of experimental and control group

Occupation

The study was conducted on 12 participants of ankle injured patients. Among them (n=2) were service holder, (n=2) were businessmen, 28.57% (n=1) were house wife, (n=1) were student and (n=1) were farmer, factory worker (n=1), teacher (n=2), unemployed (n=1), other (n=1) persons.

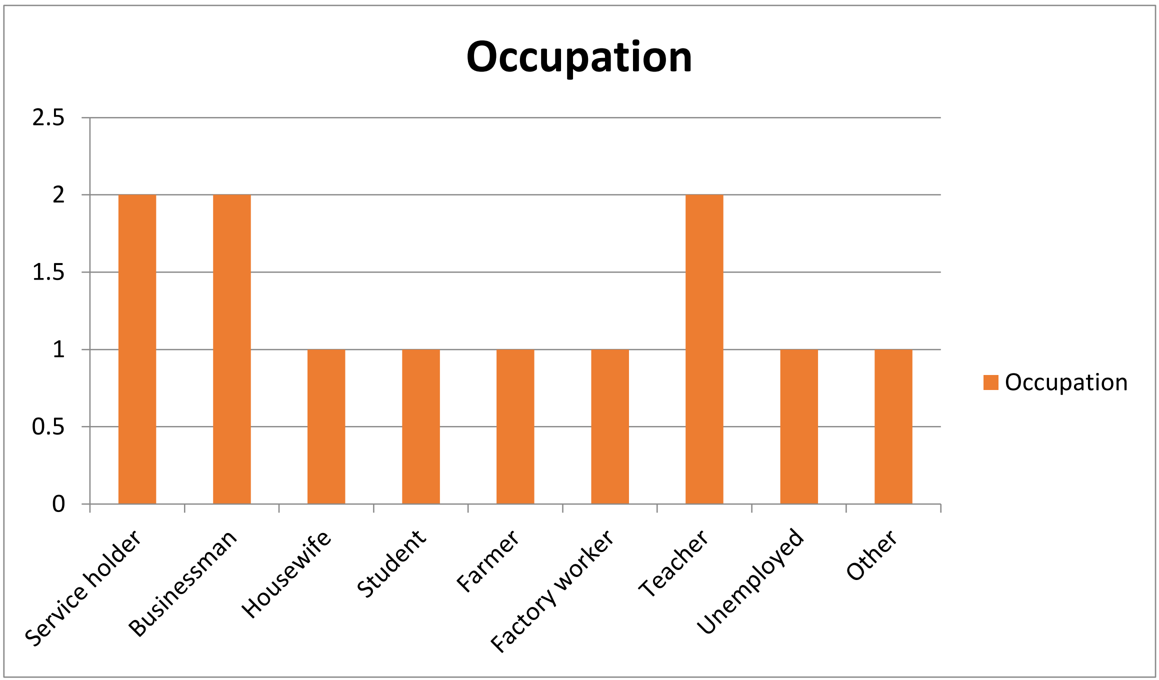

Figure-4: Percentage of occupation of the participants

Injury to the dominant leg of participants

The study was conducted on 12 participants of ankle injured patients. Among them 58% (n=7) has dominant leg involvement and 42 % (n=5) has non-dominant leg involvement.

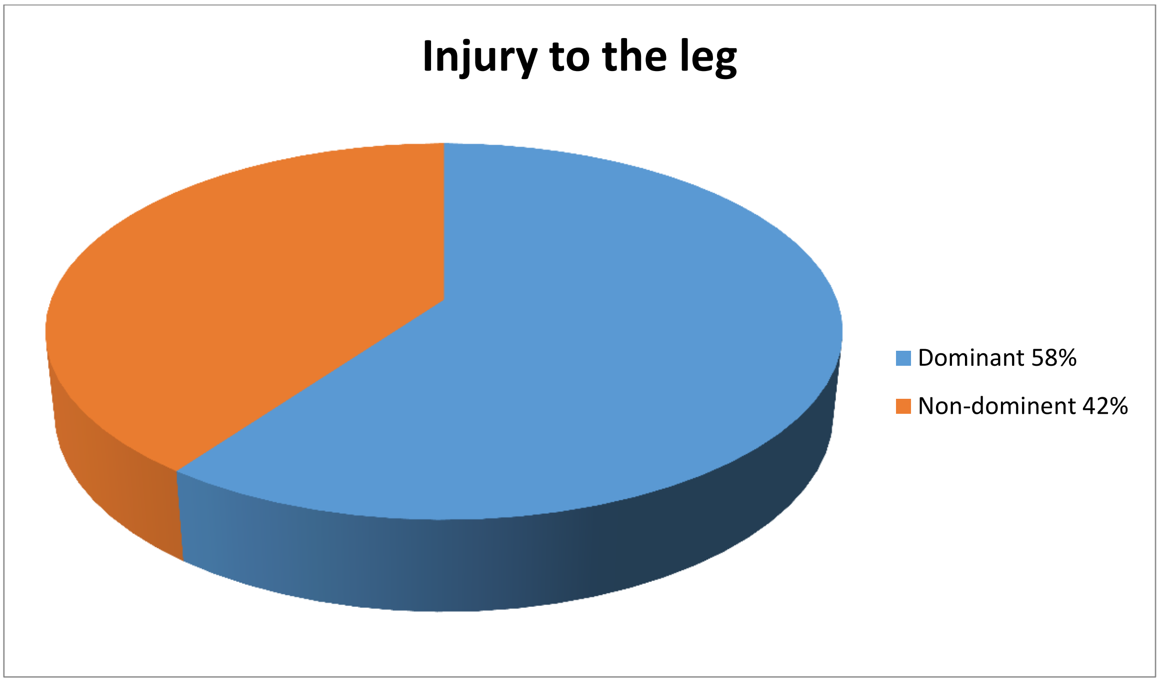

Figure-5: Involvement of the leg

Living area

12 patients with ankle injured were included as sample of the study, among them almost 40% (n=5) lived in rural and 60% (n=7) lived in urban and 0% lived in hill tracks.

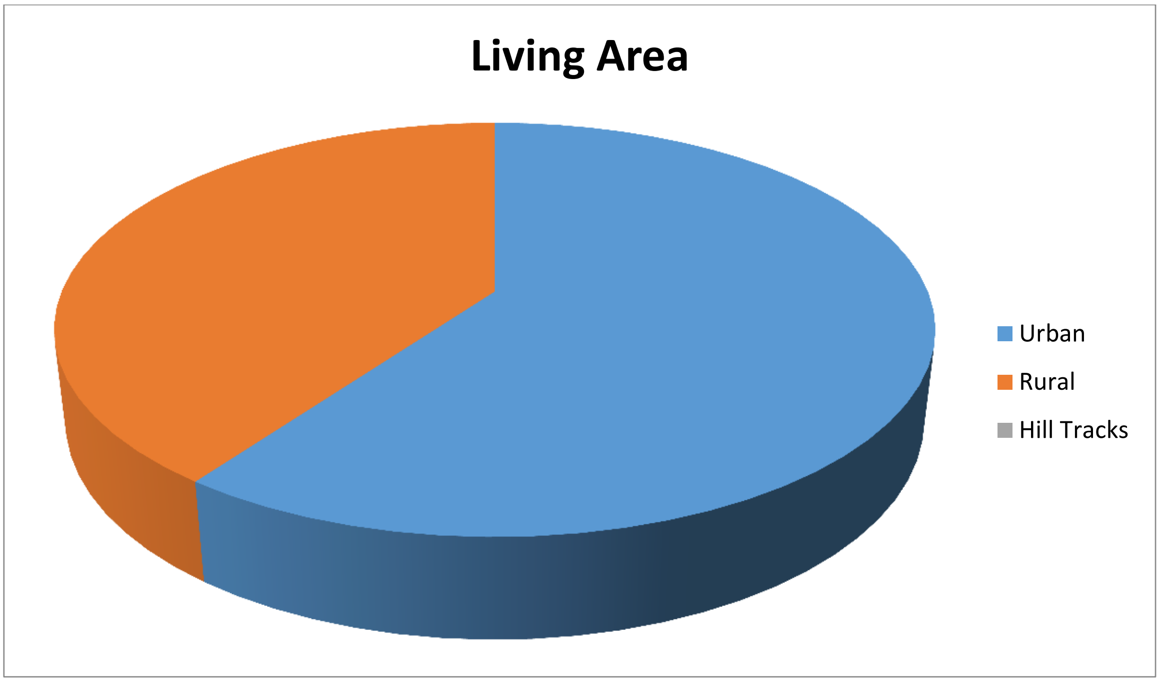

Figure-5: Living area of the participants

Educational level

Among the 12 participants 0% (n=0) participants were illiterate, 16.67% (n=2) participants primary passed, 8.33% (n=1) participants were secondary and S.S.C passed, 33.33% (n=4) participants completed H.S.C level, 25% (n=3) participants were graduate and only 8.33% (n=1) participant was post graduate holder.

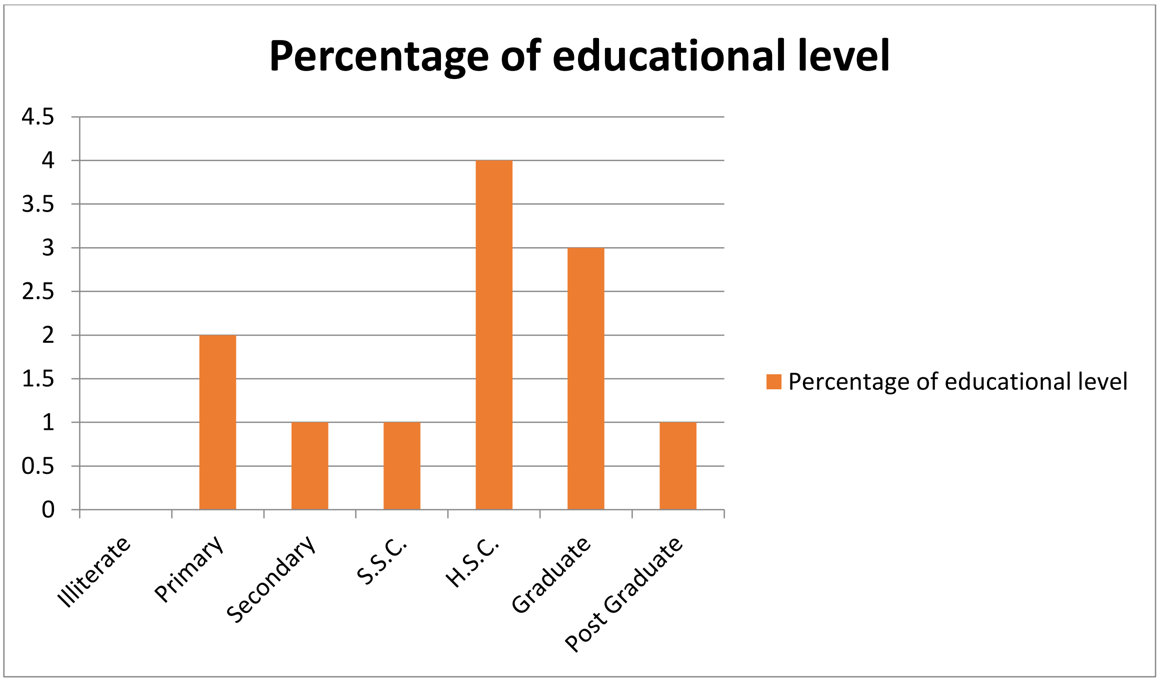

Figure-6: Percentage of educational level of the participants

Monthly family income

The study was conducted on 12 participants of ankle injured patients. The monthly family income is categorized in range.

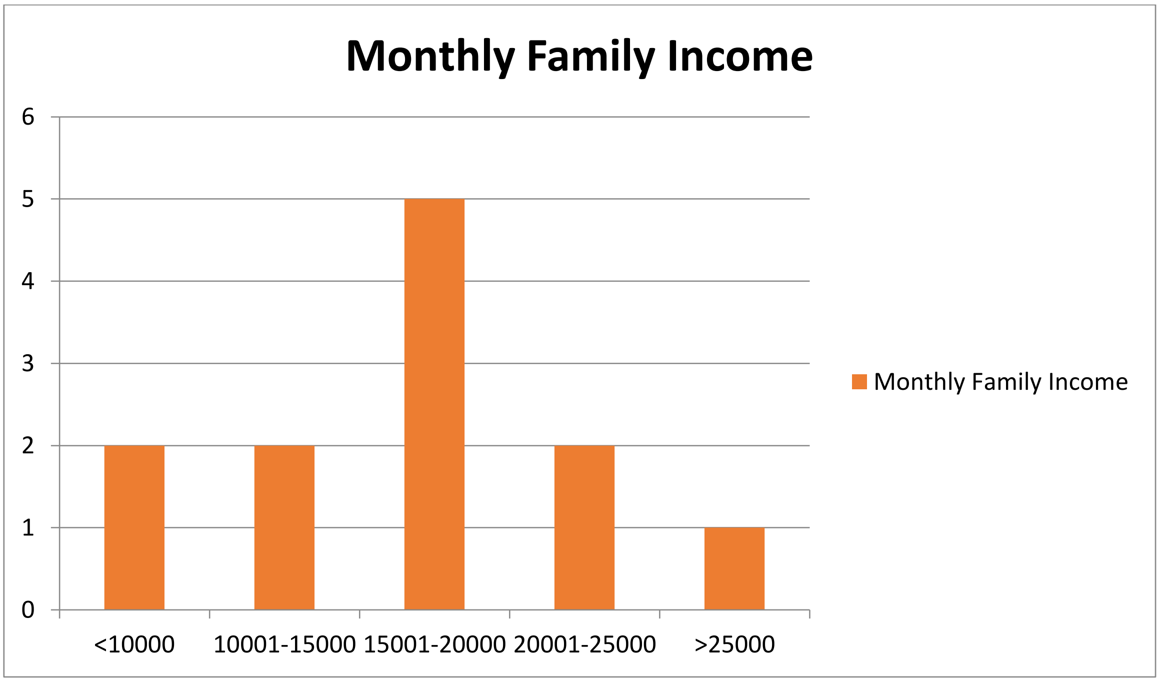

Figure-7: Monthly income of participant's family

FAB Scale total Score of the participants (Pre Test)

12 patients with Ankle injured were included as sample of the study.

Experimental group		Control group	
Subjects	**Scale Ranking**	**Subjects**	**Scale Ranking**
E1	22	C1	22
E2	26	C2	20
E3	23	C3	30
E4	21	C4	25
E5	20	C5	25
E6	22	C6	24
Mean Score	**22.33**	**Mean Score**	**24.33**

Table-4: Mean FAB Scale Score of the participants of experimental and control group (Pre Test)

FAB Scale total Score of the participants (Post Test)

12 patients with Ankle injured were included as sample of the study.

Experimental group		Control group	
Subjects	**Scale Ranking**	**Subjects**	**Scale Ranking**
E1	25	C1	26
E2	33	C2	28
E3	24	C3	30
E4	25	C4	29
E5	25	C5	34
E6	25	C6	24
Mean Score	**26.17**	**Mean Score**	**28.5**

Table-5: Mean FAB Scale Score of the participants of experimental and control group (Post Test)

Balance during stand with feet together and eye close

Assess ability to use somatosensory (i.e., ground and body position) cues to maintain upright balance while standing in a reduced base of support and vision unavailable. The functional outcome is different between pre-test and post-test scores.

To evaluate the balance during stand with feet together and eye close and difference of balance among experimental and control group.

NO	Control Group		Experimental Group	
	Pre Test	Post Test	Pre Test	Post Test
1	3	3	2	3
2	3	3	3	2
3	3	3	2	2
4	2	2	2	3
5	2	3	2	3
6	2	3	2	2
Total	15	17	13	15
Mean	2.5	2.8	2.2	2.5

Table-6: Balance score during stand with feet together and eye close

Balance during reach forward to retrieve an object (pencil) held at shoulder height with outstretched arm

Assess ability to lean forward to retrieve an object without altering the base of support; measure of stability limits in a forward direction. The functional outcome is different between pre-test and post-test scores.

To evaluate the Balance during reach forward to retrieve an object (pencil) held at shoulder height with outstretched arm and difference of balance among experimental and control group.

NO	Control Group		Experimental Group	
	Pre Test	Post Test	Pre Test	Post Test
1	2	2	2	2
2	2	3	3	3
3	4	4	2	3
4	3	3	2	3
5	3	3	2	2
6	2	2	2	2
Total	16	17	13	15
Mean	2.7	2.8	2.2	2.5

Table-7: Balance score during reach forward to retrieve an object (pencil) held at shoulder height with outstretched arm

Balance during turn 360 degree in right and left directions

Assess ability to turn in a full circle in both directions in the fewest number of steps without loss of balance. The functional outcome is different between pre-test and post-test scores.

To evaluate the Balance during turn 360 degree in right and left directions and difference of balance among experimental and control group.

NO	Control Group		Experimental Group	
	Pre Test	Post Test	Pre Test	Post Test
1	2	3	2	2
2	2	2	4	4
3	3	4	2	2
4	3	3	3	3
5	2	3	3	3
6	2	3	2	3
Total	14	18	16	14
Mean	2.3	3	2.7	2.3

Table-8: Balance score during turn 360 degree in right and left directions

Balance during step up onto and over a 6-inch bench

Assess ability to control body in dynamic task situations; also a measure of lower body strength and bilateral motor coordination. The functional outcome is different between pre-test and post-test scores.

To evaluate the Balance during step up onto and over a 6-inch bench and difference of balance among experimental and control group.

NO	Control Group		Experimental Group	
	Pre Test	Post Test	Pre Test	Post Test
1	2	4	4	4
2	3	3	4	4
3	4	4	3	3
4	3	3	3	3
5	3	3	4	4
6	4	4	3	3
Total	19	21	21	21
Mean	3.2	3.5	3.5	3.5

Table-9: Balance score during step up onto and over a 6-inch bench

Balance during tandem walk

Assess ability to dynamically control center of mass with an altered base of support. The functional outcome is different between pre-test and post-test scores.

To evaluate the Balance during tandem walk and difference of balance among experimental and control group.

NO	Control Group		Experimental Group	
	Pre Test	Post Test	Pre Test	Post Test
1	3	3	3	3
2	2	3	2	3
3	3	3	2	2
4	3	3	2	2
5	3	3	2	2
6	3	3	3	3
Total	17	18	14	15
Mean	2.8	3	2.3	2.5

Table-10: Balance score during tandem walk

Balance during stand on one leg

Assess ability to maintain upright balance with a reduced base of support. The functional outcome is different between pre-test and post-test scores.

To evaluate the Balance during stand on one leg and difference of balance among experimental and control group.

NO	Control Group		Experimental Group	
	Pre Test	Post Test	Pre Test	Post Test
1	1	2	2	3
2	1	2	2	3
3	3	3	1	2
4	3	3	2	2
5	3	3	1	2
6	2	3	2	2
Total	13	16	10	14
Mean	2.2	2.7	1.7	2.3

Table-11: Balance score during stand on one leg

Balance during stand on foam with eyes close

Assess ability to maintain upright balance while standing on a compliant surface with eyes closed. The functional outcome is different between pre-test and post-test scores.

To evaluate the Balance during stand on foam with eyes close and difference of balance among experimental and control group.

NO	Control Group		Experimental Group	
	Pre Test	Post Test	Pre Test	Post Test
1	2	2	2	3
2	1	2	2	3
3	2	3	2	3
4	2	3	2	2
5	3	3	2	3
6	2	2	2	2
Total	12	15	12	16
Mean	2	2.5	2	2.7

Table-12: Balance score during stand on foam with eyes close

Balance during two-footed jump

Assess upper and lower body coordination and lower body power. The functional outcome is different between pre-test and post-test scores.

To evaluate the Balance during two-footed jump and difference of balance among experimental and control group.

NO	Control Group		Experimental Group	
	Pre Test	Post Test	Pre Test	Post Test
1	2	3	2	2
2	1	1	2	3
3	3	4	1	2
4	3	3	2	2
5	2	3	2	2
6	3	3	1	2
Total	14	17	10	13
Mean	2.3	2.8	1.7	2.2

Table-13: Balance score during two-footed jump

Balance during walk with head turns

Assess ability to maintain dynamic balance while walking and turning the head from side-to-side. The functional outcome is different between pre-test and post-test scores.

To evaluate the Balance during walk with head turns and difference of balance among experimental and control group.

NO	Control Group		Experimental Group	
	Pre Test	Post Test	Pre Test	Post Test
1	2	2	1	2
2	3	3	3	4
3	3	3	3	3
4	2	3	2	3
5	2	4	1	2
6	2	3	2	3
Total	14	18	12	17
Mean	2.3	3	2	2.8

Table-14: Balance score during walk with head turns

Balance during reactive postural control

Assess ability to efficiently restore balance following an unexpected perturbation. The functional outcome is different between pre-test and post-test scores.

To evaluate the Balance during reactive postural control and difference of balance among experimental and control group.

NO	Control Group		Experimental Group	
	Pre Test	Post Test	Pre Test	Post Test
1	2	2	1	2
2	2	2	1	3
3	2	3	1	2
4	2	3	1	2
5	1	2	1	2
6	1	2	2	2
Total	10	14	7	13
Mean	1.7	2.3	1.2	2.2

Table-15: Balance score during reactive postural control

Variables in the study statistically significance at the following level of significance:

No.	Variables	Observed 'U' value	The critical value of U at p≤ 0.05 is	Significance (Value ≤ 8)
1.	Balance during stand with feet together and eye close	12	5	Not significant
2.	Balance during reach forward to retrieve an object (pencil) held at shoulder height with outstretched arm	13.5	5	Not significant
3.	Balance during turn 360 degree in right and left directions	15.5	5	Not significant
4.	Balance during step up onto and over a 6-inch bench	18	5	Not significant
5.	Balance during tandem walk	9	5	Not significant
6.	Balance during stand on one leg	12	5	Not significant
7.	Balance during stand on foam with eyes close	15	5	Not significant
8.	Balance during two-footed jump	8	5	Not significant
9.	Balance during walk with head turns	15.5	5	Not significant
10.	Balance during reactive postural control	15	5	Not significant

Table-16: Level of significance in different variables

Mean difference between different variables

NO	Variables	Control Group			Experimental Group			Improvement between experimental and control group
		Pre Test	Post Test	Differences	Per Test	Post Test	Differences	
01	Balance during stand with feet together and eye close	2.5	2.8	0.3	2.2	2.5	0.3	Equal
02	Balance during reach forward to retrieve an object (pencil) held at shoulder height with outstretched arm	2.7	2.8	0.1	2.2	2.5	0.3	Experimental more than control group
03	Balance during turn 360 degree in right and left directions	2.3	3	0.7	2.7	2.8	0.1	Experimental less than control group
04	Balance during step up onto and over a 6-inch bench	3.2	3.5	0.3	3.5	3.5	0	Experimental less than control group
05	Balance during tandem walk	2.8	3	0.2	2.3	2.5	0.2	Equal

06	Balance during stand on one leg	2.2	2.7	0.5	1.7	2.3	0.6	Experimental more than control group
07	Balance during stand on foam with eyes close	2	2.5	0.5	2	2.7	0.7	Experimental more than control group
08	Balance during two-footed jump	2.3	2.8	0.5	1.7	2.2	0.5	Equal
09	Balance during walk with head turns	2.3	3	0.7	2	2.8	0.8	Experimental more than control group
10	Balance during reactive postural control	1.7	2.3	0.6	1.2	2.2	1	Experimental more than control group

Table-16: Mean difference between different variables.

CHAPTER-V: DISCUSSION

The purpose of this study was to evaluate the efficacy of BAPS Training with conventional physiotherapy compare to only conventional physiotherapy for Ankle injured patients. In this experimental study 12 patients with Ankle injured were randomly assigned to the experimental group and to the control group. Among these 12 patients, 6 patients were included in the experimental group who received BAPS Training with conventional physiotherapy and the rest of the 6 patients were included in the control group, who received conventional physiotherapy only.

Each group attended for 5 sessions of treatment in the physiotherapy outdoor department of CRP Savar in order to demonstrate the improvement. The functional outcome was measured by using structural mixed type of questionnaire and with FAB scale (Fullerton advance balance scale) in different functional activity.

In this study it was found that among participants who were suffering from Ankle injury the age distribution of them were 20- 30 aged were 17%, 31-40 aged were 8%, 41-50 aged were 33 %, 51- 60 aged were 25% and 60-70 aged were 17%. The mean age for experimental group was 49 years and control group was 43 years. Age is a factor that provokes the test result.

In this study it was found that the persons who were suffering from ankle injured there almost 83 % were male from total male and about 17 % were female from total female participants. Female often demonstrate leg dominance, which is imbalance between muscular strength and joint kinematics between contralateral lower extremity measures during dynamic tasks.

In this study it was found that the 58% patients have dominant leg involvement and 42 % patients have non-dominant leg involvement. In this study it was found that the mean weight of the experimental group was 58.33 kilograms and the mean weight of the control group was 60.50 kilograms. In this study it was found that the mean height of the experimental group was 65.5 inch and the mean height of the control group was 66 inch. Balance is obviously influenced by a host factor. The study was conducted on 12 participants of ankle injured patients. Among them 58% has dominant leg involvement and 42 % has non-dominant leg involvement.

The U value is 9.5. The critical value of U at $p \leq 0.05$ is 5. Therefore the result is not significant at $p \leq 0.05$ at two tailed hypothesis. So, the difference is not statistically significant.

5.1 Limitations

The main limitation of this study was its short duration. The study was conducted with 12 patients of ankle injured with balance problem, which was a very small number of samples in both groups and was not sufficient enough for the study to generalize the wider population of this condition. It was limited by the fact daily activities of the subject were not monitored which could have influenced. Researcher only explored the effect of BAPS training after 6 sessions, so the long term effect of treatment was not explored in this study. The research was carried out in CRP, Savar such a small environment, so it was difficult to keep confidential the aims of the study for blinding procedure. Therefore, single blinding method was used in this study. There was no available research done in this area in Bangladesh. So, relevant information about Ankle injury with BAPS Training for Bangladesh was very limited in this study.

6.1 Conclusion

The result of this experimental study have identified the effectiveness of conventional physiotherapy with BAPS training are better treatment than the conventional physiotherapy alone for improving balance among ankle injured patient. Participants in the conventional physiotherapy with BAPS training group showed no statistically significant value but a small separate compares improvement than those in the only conventional physiotherapy group, which indicate that the conventional physiotherapy with BAPS training can be an effective therapeutic approach for ankle injured patient with balance problem.

BAPS training exercise is used along with conventional physiotherapy that aims to improve balance, proprioception for ankle injured patients. It also may cost effective treatment. So it may become helpful for patients with ankle injury those have balance problem to improve balance. From this research the researcher wishes to explore the effectiveness of BAPS training among the ankle injured patient.

6.2 Recommendations

The aim of the study was to find out the effectiveness of BAPS Training among the patient with ankle injured those have balance problem. However, the study had some limitations. Some steps were identified that might be taken for the better accomplishment for further study. The main recommendations would be as follow:

- The duration of the study was short, so in future wider time would be taken for conducting the study.
- Investigator use only 12 participants as the sample of this study, in future the sample size would be more.
- Double blinding procedure.
- A specific protocol should be included that in which stage patient will be able to start this exercises in the home.

REFERENCES

- Anandacoomarasamy A, Barnsley L. Long term outcomes of inversion ankle injuries. Br J Sports Med 2005;39(3):e14.
- Balogun, J.A., Adesinasi, C.O., & Marzouk, D.K. (1992). The effects of a wobble board exercise training program on static balance performance and strength of lower extremity muscles. Physiotherapy Canada, 44(4): 23-30.
- Bonnel F, Toullec E, Mabit C, Tourne Y, Sofcot. (2010). Chronic ankle instability: biomechanics and pathomechanics of ligaments injury ans associated lesions. Orthop Tramatol Surg Res. 96(4):424-32.
- Brown, S.P., Miller, W.C., & Eason, J.M. (2006). Neuroanatomy and Neuromuscular Control of Movement. Exercise physiology: Basis of human movement in health and disease. Philadephia: Lippincott Williams & Wilkins. 217-246.
- Camp International Limited (1984). Biomechanical Ankle Platform System manual.
- Caraffa, A., Cerulli, G., Projetti, M., Aisa, G. & Rizzo, A. (1996). Prevention of anterior cruciate ligament injuries in soccer: a prospective controlled study of proprioceptive training. Knee Surgery, Sports Traumatology, & Arthroscopy, 4: 19-21.

- Caraffa, A., Cerulli, G., Projetti, M., Aisa, G. & Rizzo, A. (1996). Prevention of anterior cruciate ligament injuries in soccer: a prospective controlled study of proprioceptive training. Knee Surgery, Sports Traumatology, & Arthroscopy, 4: 19-21.

- Emery,C.A., Cassidy, J.D., Klassen, T.P, Rosychuk, R.J. & Rowe, B.H. (2005). Effectiveness of a home-based balance-training program in reducing sports-related injuries among healthy adolescents: a cluster randomized controlled trial. Canadian Medical Association Journal, 172(6): 749-754.

- Emery,C.A., Cassidy, J.D., Klassen, T.P, Rosychuk, R.J. & Rowe, B.H. (2005). Effectiveness of a home-based balance-training program in reducing sports-related injuries among healthy adolescents: a cluster randomized controlled trial. Canadian Medical Association Journal, 172(6): 749-754.

- Fernandez WG, Yard EE, Comstock RD. Epidemiology of lower extremity injuries among U.S. high school athletes. Acad Emerg Med 2007;14(7):641--5.
- Fong, D.T.., Hong, Y., Chan, L., Yung, P. & Chan, K. (2007). A systematic review on ankle injury and ankle sprain in sports. Sports Medicine, 37(1): 73-94.
- Freeman, M., M. Dean, and I. Hanham. (1965). The etiology and prevention of functional instability of the foot. J. Bone Joint Surg. 47B:669-677.
- GIOFTSIDOU, A. et al., 2012. Balance training programs for soccer injuries prevention. Journal of Human Sport and Exercise, 7(3): 639-47.
- Guskiewicz, K.M. & Perrin, D.H., 1996. Research and clinical application of assessing balance. Journal of Sports Rehabilitation, 5: 45-63.
- Guskiewicz, K.M., & Perrin, D.H. (1996). Research and clinical applications of assessing balance. Journal of Sport Rehabilitation, 5:45-63.
- Hewett, T.E., Ford, K.R., & Myer, G.D (2006). Anterior cruciate ligament injuries in female athletes: Part 2, A meta-analysis of neuromuscular interventions aimed at injury prevention. American Journal of Sports Medicine, 34(3): 490-498.
- Hiller, C.E. et al., 2011. Characteristics of people with recurrent ankle sprains: a systematic review with meta-analysis. British journal of sports medicine, 45(8): 660-72.
- Hoffman, M., 1993. The Effect of proprioceptive training on postural sway using system on healthy subjects.
- Hrysomallis, C. (2007). Relationship between balance ability, training, and sports injury risk. Sports Medicine, 37(6); 547-556.
- Itay SA, Ganel H, Horoszowski, Farine I. (1982). Clinical and functional status following lateral ankle sprains.Orthopaedic Review 11(5), 73-76.
- Johnson E and K.L. Markolf. (1983). The contribution of the anterior talofibular ligament to ankle laxity. J Bone Jt Surg (Am) 65-A(1):81-88.
- Kidgell, D.J., Horvath, D.M., Jackson, B.M., & Seymour, P.J. (2007). Effect of six weeks of dura disc and mini-trampoline balance on postural sway in

athletes with functional ankle instability. Journal of Strength and Conditioning Research, 21(2): 466-469.

- Leardini A, O'Connor JJ, Catani F, Giannini S. (2000). The role of passive structures in the mobility and stability of the human ankle joint: a literature review. Foot Ankle Int. 21(7):602-15.
- Lee, A.J.Y. & Lin, W.-H., 2008. Twelve-week biomechanical ankle platform system training on. clinical biomechanics, 23(8): 1-4.
- Malliou, P., Gioftsidou, A., Pafis, G., Beneka, A., & Godolias, G. (2004). Proprioceptive training (balance exercises) reduces lower extremity injuries in young soccer players. Journal of Back and Musculoskeletal Rehabilitation, 17; 101-104.
- Malliou, P., Gioftsidou, A., Pafis, G., Beneka, A., & Godolias, G. (2004). Proprioceptive training (balance exercises) reduces lower extremity injuries in young soccer players. Journal of Back and Musculoskeletal Rehabilitation, 17; 101-104.
- Malliou, P., Gioftsidou, A., Pafis, G., Beneka, A., & Godolias, G. (2004). Proprioceptive training (balance exercises) reduces lower extremity injuries in young soccer players. Journal of Back and Musculoskeletal Rehabilitation, 17: 101-104.
- Mandy L. Krause & Kelly A. Ogden., (2000). The effect of a 4-week BAPS Training Program on Measures of Static and Dynamic Balance in The Older Adult Population: A Case Study.
- McGuine, T.A. & Keene, J.S. (2006). The effect of a balance training program on the risk of ankle sprains in high school athletes. The American Journal of Sports Medicine, 34(7): 1103-1111.
- McGuine, T.A., Grene, J.J., Best, T., & Leverson, G. (2000). Balance as a predictor of ankle injuries in high school basketball players. Clinical Journal of Sports Medicine, 10: 239-244.
- McKeon, P.O. & Hertel, J. (2008). Systematic review of postural control and lateral ankle instability, part II: Is balance training clinically effective? Journal of Athletic Trainers, 43(3): 305-315.

- Mohammadi, F. (2007). Comparison of 3 preventative methods to reduce the recurrence of ankle inversion sprains in male soccer players. The American Journal of Sports Medicine, 35(6); 922-926.
- Myer, G.D., Ford, K. R., Hewett, T.E. (2004). Rationale and clinical techniques for anterior cruciate ligament injury prevention among female athletes. Journal of Athletic Training; 39(4): 352-364.

- Myer, G.D., Ford, K. R., Hewett, T.E. (2004). Rationale and clinical techniques for anterior cruciate ligament injury prevention among female athletes. Journal of Athletic Training; 39(4): 352-364.

- Padua, D.A. & Marshall, S.W. (2006). Evidence supporting ACL-Injury-Prevention exercise programs: A review of the literature. Athletic Therapy Today; 11(2): 11-23.
- Petersen, W., Braun, C., Bock, W., Schmidt, K., Weimann, A., Drescher, W., Eiling, E., Stange, R., Fuchs, T., Hedderich, J., & Zantop, T. (2005). A controlled prospective case control study of a prevention training program in female team handball players: the German experience. Archives of Orthopedic and Trauma Surgery, 125(9):614-621.
- Rasmussen O. (1985). Stability of the ankle joint: Analysls of the functlon and traumatology of the ankle ligaments. Acta Orthop Scand, 211:1-75.
- Rasool, J. & George, K. (2007). The impact of single-leg dynamic balance training on dynamic stability. Physical Therapy in Sport, 8: 177-184.
- Riemann, B.L. & Lephart, S.M. (2002a). The sensorimotor system, part I: the physiologic basis of functional joint stability. Journal of Athletic Training, 37(1): 71-79.
- Riemann, B.L. & Lephart, S.M. (2002b). The sensorimotor system, part II: the role of proprioception in motor control and functional joint stability. Journal of Athletic Training, 37(1): 80-84.
- Roth, A.E., Miller, M.G., Ricard, M., Ritenour, D., & Chapman, B.L. (2006). Comparisons of static and dynamic balance following training in aquatic and land environments. Journal of Sport Rehabilitation, 15: 299-311.
- Shellie N. Spiers., (2010). Comparison of the effect of Aquatic and Land – Based Balance Training Programs on the Proprioception of College-Aged Recreational Athletes.

- Shier, D., Butler, J., & Lewis, R. (2004). Somatic and Special Senses. Hole's Human Anatomy and physiology. 10th ed. New York: The McGraw-Hill Companies, Inc. 421-466.
- Soderburg, G. L., Cook, T. M., Rider, S. C., & Stephenitcch, B. L. (1991). Electomyographic activity of selected leg musculature in participants with normal and chronically sprained ankles performing on a BAPS Board. Physical Therapy, 71 (7), 514-522.
- Soderman, K., Werner, S., Pietila, T., Engstrom, B., & Alfredson, H. (2000). Balance board training: prevention of traumatic injuries of the lower extremities in female soccer players? A prospective randomized intervention study. Knee Surg Sports Traumatol Arthrosc., 8:356-363.
- Vathrakokilis, K., Malliou, P., Gioftsidou, A., Beneka, A., & Godolias, G. (2008). Effects of a balance training protocol on knee joint proprioception after anterior cruciate ligament reconstruction. Journal of Back and Musculoskeletal Rehabilitatio*n*, 21: 233-237.
- Wegener, L., Kisner, C., & Nichols, D. (1997). Static and dynamic balance responses in persons with bilateral knee osteoarthritis. Journal of Sports Physical Therapy, 25 (1), 13-18.
- Wilcock, I.A., Cronin, J.B., Hing, W.A. (2006). Physiological response to water immersion: a method for sport recovery? Sports Medicine, 36(9); 747-765.

APPENDIX-1

CONSENT FORM

Assalamu-alaikum /Namaskar,

I am Md. Abu Hasan student of B.Sc. in physiotherapy at Bangladesh Health Professions Institute (BHPI), CRP.I shall have to conduct a research and it is a part of my academic activity. The participants are requested to participate in the study after reading the following.

My research title is "Efficacy of BAPS training to improve balance in ankle injured patient along with conventional physiotherapy." Through this experimental research I will test the hypothesis "BAPS training with conventional physiotherapy is better than only conventional physiotherapy for the treatment of ankle injured patient." The objective of my study is to identify the efficacy of BAPS training to improve balance in ankle injured patient. If I can complete this study successfully, patient may get the benefits who have been suffering from balance problem and it will be an evidence based treatment.

To fulfill my research project, I need to collect data. Considering the area of my research, which criteria is necessary for my research is present of you. So, you can be a respected participant of my research and I would like to request you as a subject of my study. I want to meet you a few couple of session, during your regular therapy. The exercises that will be given are pain free and safe for you.

I would like to inform you that this is a purely academic study and will not be used for any other purpose. I assure that all data will be kept confidential. Your participation will be voluntary. You may have the right to withdraw consent and discontinue participation at any time of the experiment. You also have the right to answer a particular question that you don't like.

If you have any query about the study or right as a participant, you may contact with me.

Do you have any questions before I start?

So may I have your consent to proceed with the interview?

Yes ……… No………

Signature of the Interviewer…………………

I………………………………………….. have read and understand the contents of the form. I agree to participate in the research without any force.

Signature of the participant ……………………

Signature of the witness…………………………

<u>মৌখিক সম্মতিপত্র</u>

আসসালামু-আলাইকুম/ নমস্কার, আমি মোঃ আবু হাসান, বাংলাদেশ হেল্থ প্রফেসনস ইনস্টিটিউট (বি.এইচ.পি.আই), সি.আর.পি এর বি.এস.সি ইন ফিজিওথেরাপি ৪র্থ বর্ষের শিক্ষার্থী। আমার প্রাতিষ্ঠানিক কাজকর্মের অংশ হিসেবে আমাকে একটি গবেষণা করতে হবে।নিম্নোক্ত তথ্যাদি পাঠ করার পর অংশগ্রহণকারীদের অধ্যয়নে অংশগ্রহণের জন্য অনুরোধ করা হল।

আমার গবেষণার বিষয় হল ''পায়ের গোড়ালির আঘাত জনিত রোগের কারণে রুগীর ভারসাম্য বৃদ্ধীতে বি.এ.পি.এস. ট্রেনিং এর কার্যকরীতা'' । এ পরীক্ষামূলক গবেষণার মাধ্যমে আমি একটি অনুমান পরীক্ষা করবো যে "পায়ের গোড়ালির আঘাতগ্রস্থ রোগীদের ক্ষেত্রে শুধুমাত্র প্রচলিত থেরাপি অপেক্ষা প্রচলিত থেরাপি সাথে বি.এ.পি.এস. ট্রেনিং বেশী কার্যকরি হবে'' ।আমার গবেষণার উদ্দেশ্য হল,এই থেরাপির আগে ও পরে ভারসাম্যের হ্রাস ও বৃদ্ধী পরিমাপ করা।আমি যদি এই গবেষণাটি সফলভাবে সম্পূর্ণ করতে পারি তাহলে যেসব রুগীরা পায়ের গোড়ালির আঘাতের কারণে ভারসাম্য জনিত সমস্যায় ভুগছেন তারা উপকৃত হবেন এবং এটি হবে একটি পরীক্ষামূলক প্রমান।

গবেষণাটি সম্পাদনের জন্য,আমার তথ্য সংগ্রহ করা প্রয়োজন হবে।গবেষণার ক্ষেএ বিবেচনা করে আপনার মধ্যে আমার গবেষণায় অংশগ্রহণ করার জন্য প্রয়োজনীয় বৈশিষ্ট্য লক্ষ্য করা গেছে।এজন্য,আপনি আমার গবেষনার একজন সম্মানিত অংশগ্রহণকারী হতে পারেন এবং আমি আপনাকে আমার গবেষণায় অংশগ্রহণের জন্য অনুরোধ জানাচ্ছি ।আপনার নিয়মিত থেরাপির সময় আমি আপনার সাথে কয়েকবার দেখা করব।যে চিকিৎসা পদ্ধতি প্রয়োগ করা হবে তা আপনার জন্য ব্যথামুক্ত এবং নিরাপদ।

আমি আপনাকে অবগত করছি যে, এটি একটি সম্পূর্ণ প্রাতিষ্ঠানিক গবেষণা এবং এটি অন্য কোন উদ্দেশ্যে ব্যবহার হবে না। আমি আপনাকে আরও নিশ্চিত করছি যে আপনার সব তথ্য গোপন রাখা হবে।আপনার অংশগ্রহণ হবে ইচ্ছাকৃত। এই গবেষণা থেকে আপনি যে কোন মুহূর্তে সম্মতি প্রত্যাহার করতে পারবেন কিংবা অংশগ্রহন থেকে বিরত থাকতে পারেন।আপনার যদি এই গবেষণা সম্পর্কে এবং অংশগ্রহণকারী হিসেবে আপনার অধিকার সম্পর্কে কোন জিজ্ঞাসা থাকে তবে আপনি আমার সাথে যোগাযোগ করতে পারবেন।

শুরু করার পূর্বে আপনার কি কোন প্রশ্ন আছে ? আমি কি আপনার সাক্ষাৎকার গ্রহণের সম্মতি পেয়েছি?

হ্যাঁ ....   না............

প্রশ্নকর্তার স্বাক্ষর:

আমি ....এই সম্মতিপত্রটি পড়েছি এবং বুঝেছি । আমি সেচ্ছায় এই গবেষণায় অন্তর্ভুক্ত হচ্ছি।

অংশগ্রহণকারীর স্বাক্ষর :..

সাক্ষীর স্বাক্ষর :................................. ....

APPENDIX-2

Questionnaire

Date of test: Code no:

1. Socio demographic information:

1.1. Age……………………..years

1.2. Sex: 1= male 2= female

1.3.Weight: ……….. Kg

1.4.Height: ………...Inch

1.5. Occupation :

1= Farmer 2= Day labourer 3= Service holder 4=Garments/ Factory worker 5= Driver 6= Rickshaw puller 7= Businessman 8= Unemployed 9= Housewife 10= Teacher 11= Student 12= Other…………………...

1.6. Monthly family income:…………………..taka

1.7. Dominant leg: 1=Rt 2=Lt

1.8.Marital status:

1= Married 2= Unmarried 3 = Widow 4 = Discard 5= Separate

1.9. Family type:

1= Nuclear family 2= Extended family

1.10. Living area:

1= Rural 2= Urban 3= Hill tracks

1.11. Educational level:

1= Illiterate 2=literate 3= Primary 4=Secondary 5 = S.S.C

6=H.S.C. 7= Graduate 8= Post Graduate

2. Participant related information:

2.1. Stand with feet together and eyes closed

( ) 0 Unable to obtain the correct standing position independently

( ) 1 Able to obtain the correct standing position independently but unable to maintain

the position or keep the eyes closed for more than 10 seconds

( ) 2 Able to maintain the correct standing position with eyes closed for more than 10

seconds but less than 30 seconds

( ) 3 Able to maintain the correct standing position with eyes closed for 30 seconds

but requires close supervision

( ) 4 Able to maintain the correct standing position safely with eyes closed for 30

seconds

2.2. Reach forward to retrieve an object (pencil) held at shoulder height with outstretched arm

( ) 0 Unable to reach the pencil without taking more than two steps

( ) 1 Able to reach the pencil but needs to take two steps

( ) 2 Able to reach the pencil but needs to take one step

( ) 3 Can reach the pencil without moving the feet but requires supervision

( ) 4 Can reach the pencil safely and independently without moving the feet

2.3. Turn 360 degrees in right and left directions

( ) 0 Needs manual assistance while turning

( ) 1 Needs close supervision or verbal cueing while turning

( ) 2 Able to turn 360 degrees but takes more than four steps in both directions

( ) 3 Able to turn 360 degrees but unable to complete in four steps or fewer in one

direction

( ) 4 Able to turn 360 degrees safely taking four steps or fewer in both directions

2.4*. Step up onto and over a 6-inch bench

( ) 0 Unable to step up onto the bench without loss of balance or manual assistance

( ) 1 Able to step up onto the bench with leading leg, but trailing leg contacts the bench or leg swings around the bench during the swing-through phase in both directions

( ) 2 Able to step up onto the bench with leading leg, but trailing leg contacts the bench or swings around the bench during the swing-through phase in one direction

( ) 3 Able to correctly complete the step up and over in both directions but requires
close supervision in one or both directions

( ) 4 Able to correctly complete the step up and over in both directions safely and independently

2.5*.Tandem walk

( ) 0 Unable to complete 10 steps independently

( ) 1 Able to complete the 10 steps with more than five interruptions

( ) 2 Able to complete the 10 steps with three to five interruptions

( ) 3 Able to complete the 10 steps with one to two interruptions

( ) 4 Able to complete the 10 steps independently and with no interruptions

2.6*.Stand on one leg

( ) 0 Unable to try or needs assistance to prevent falling

( ) 1 Able to lift leg independently but unable to maintain position for more than 5 seconds

( ) 2 Able to lift leg independently and maintain position for more than 5 but less than 12 seconds

( ) 3 Able to lift leg independently and maintain position for 12 or more seconds but less than 20 seconds

( ) 4 Able to lift leg independently and maintain position for the full 20 seconds

2.7*.Stand on foam with eyes closed

( ) 0 Unable to step onto foam or maintain standing position independently with eyes open

( ) 1 Able to step onto foam independently and maintain standing position but unable or unwilling to close eyes

( ) 2 Able to step onto foam independently and maintain standing position with eyes closed for 10 seconds or less

( ) 3 Able to step onto foam independently and maintain standing position with eyes closed for more than 10 seconds but less than 20 seconds

( ) 4 Able to step onto foam independently and maintain standing position with eyes closed for 20 seconds

2.8. Two-footed jump

( ) 0 Unwilling or unable to attempt or attempts to initiate two-footed jump, but one

or both feet do not leave the floor

( ) 1 Able to initiate two-footed jump, but one foot either leaves the floor or lands before the other

( ) 2 Able to perform two-footed jump, but unable to jump farther than the length of their own feet

( ) 3 Able to perform two-footed jump and achieve a distance greater than the length of their own feet

( ) 4 Able to perform two-footed jump and achieve a distance greater than twice the length of their own feet

2.9. Walk with head turns

( ) 0 Unable to walk 10 steps independently while maintaining 30^{o} head turns at an

established pace

( ) 1 Able to walk 10 steps independently but unable to complete required number of

30^{o} head turns at an established pace

( ) 2 Able to walk 10 steps but veers from a straight line while performing 30^{o} head

turns at an established pace

( ) 3 Able to walk 10 steps in a straight line while performing 30^{o} head turns at an established pace but head turns less than 30^{o} in one or both directions

( ) 4 Able to walk 10 steps in a straight line while performing required number of 30^{o}

head turns at established pace

2.10. Reactive postural control

( ) 0 Unable to maintain upright balance; no observable attempt to step; requires manual assistance to restore balance

( ) 1 Unable to maintain upright balance; takes two or more steps and requires manual assistance to restore balance

( ) 2 Unable to maintain upright balance; takes more than two steps but is able to restore balance independently

( ) 3 Unable to maintain upright balance; takes two steps but is able to restore

balance independently

( ) 4 Unable to maintain upright balance but able to restore balance independently with only one step

Total Score:

APPENDIX-III: Calculating the U test

Balance during stand with feet together and eye close

Subject control	Condition FAB		Rank	Subject Trial	Condition FAB		Rank
C1	3	2	2.5	T1	3	2	2.5
C2	3	3	8.5	T2	2	2	2.5
C3	3	3	8.5	T3	2	2	2.5
C4	2	3	8.5	T4	3	3	8.5
C5	3	3	8.5	T5	3	3	8.5
C6	3	3	8.5	T6	2	3	8.5
TOTAL			45				33
MEAN			7.5				5.5

Table-1: Balance during stand with feet together and eye close

Where, $n_1 = 6$

$n_2 = 6$

$T_x = 45$

$n_x = 6$

Now u formula

$U = n_1 n_2 + \frac{n_x(n_x+1)}{2} - T_x$

$U = 6\times6 + \frac{6(6+1)}{2} - 45$

$U = 36 + 21 - 45$

$U = 12$

The U-value is 12. The critical value of U at $p \leq 0.05$ is 5. Therefore, the result is not significant at $p \leq 0.05$.

Balance during reach forward to retrieve an object (pencil) held at shoulder height with outstretched arm

Subject control	Condition FAB		Rank	Subject Trial	Condition FAB		Rank
C1	2	2	3	T1	2	2	3
C2	3	2	3	T2	3	2	3
C3	4	3	8.5	T3	3	2	3
C4	3	3	8.5	T4	3	3	8.5
C5	3	3	8.5	T5	2	3	8.5
C6	2	4	12	T6	2	3	8.5
TOTAL			43.5				34.5
MEAN			7.25				5.75

Table-2: Balance during reach forward to retrieve an object (pencil) held at shoulder height with outstretched arm

Where, n_1 = 6

n_2 = 6

T_x = 43.5

n_x = 6

Now u formula

U = $n_1 n_2 + \frac{n_x(n_x+1)}{2} - T_x$

U = $6\times7 + \frac{6(6+1)}{2} - 43.5$

U = 36 + 21− 43.5

U = 13.5

The U-value is 13.5. The critical value of U at $p \leq 0.05$ is 5. Therefore, the result is not significant at $p \leq 0.05$.

Balance during turn 360 degree in right and left directions

Subject control	Condition FAB		Rank	Subject Trial	Condition FAB		Rank
C1	3	2	2	T1	2	2	2
C2	2	3	7	T2	4	2	2
C3	4	3	7	T3	2	3	7
C4	3	3	7	T4	3	3	7
C5	3	3	7	T5	3	3	7
C6	3	4	11.5	T6	3	4	11.5
TOTAL			41.5				36.5
MEAN			6.92				6.08

Table-3: Balance during turn 360 degree in right and left directions

Where, n_1 = 6

n_2 = 6

T_x = 41.5

n_x = 6

Now u formula

$U = n_1 n_2 + \frac{n_x(n_x+1)}{2} - T_x$

$U = 6\times6 + \frac{6(6+1)}{2} - 41.5$

U = 36 + 21− 41.5

U = 15.5

The U-value is 15.5. The critical value of U at $p \leq 0.05$ is 5. Therefore, the result is not significant at $p \leq 0.05$.

Balance during step up onto and over a 6-inch bench

Subject control	Condition FAB		Rank	Subject Trial	Condition FAB		Rank
C1	4	3	3.5	T1	4	3	3.5
C2	3	3	3.5	T2	4	3	3.5
C3	4	3	3.5	T3	3	3	3.5
C4	3	4	9.5	T4	3	4	9.5
C5	3	4	9.5	T5	4	4	9.5
C6	4	4	9.5	T6	3	4	9.5
TOTAL			39				39
MEAN			6.5				6.5

Table-4: Balance during step up onto and over a 6-inch bench

Where, n_1 = 6

n_2 = 6

T_x = 39

n_x = 6

Now u formula

U = $n_1 n_2 + \frac{n_x(n_x+1)}{2} - T_x$

U = 6×6 + $\frac{6(6+1)}{2} - 39$

U = 36 + 21 − 39

U = 18

The U-value is 18. The critical value of U at $p \leq 0.05$ is 5. Therefore, the result is not significant at $p \leq 0.05$.

Balance during tandem walk

Subject control	Condition FAB		Rank	Subject Trial	Condition FAB		Rank
C1	3	3	8	T1	3	2	2
C2	3	3	8	T2	3	2	2
C3	3	3	8	T3	2	2	2
C4	3	3	8	T4	2	3	8
C5	3	3	8	T5	2	3	8
C6	3	3	8	T6	3	3	8
TOTAL			48				30
MEAN			8				5

Table-5: Balance during tandem walk

Where, n_1 = 6

n_2 = 6

T_x = 48

n_x = 6

Now u formula

U = $n_1 n_2 + \frac{n_x(n_x+1)}{2} - T_x$

U = 6×6 + $\frac{6(6+1)}{2} - 48$

U = 36 + 21$-$ 48

U = 9

The U-value is 9. The critical value of U at p≤ 0.05 is 5. Therefore, the result is not significant at p≤ 0.05.

Balance during stand on one leg

Subject control	Condition FAB		Rank	Subject Trial	Condition FAB		Rank
C1	2	2	3.5	T1	3	2	3.5
C2	2	2	3.5	T2	3	2	3.5
C3	3	3	9.5	T3	2	2	3.5
C4	3	3	9.5	T4	2	2	3.5
C5	3	3	9.5	T5	2	3	9.5
C6	3	3	9.5	T6	2	3	9.5
TOTAL			45				33
MEAN			7.5				5.5

Table-6: Balance during stand on one leg

Where, n_1 = 6

n_2 = 6

T_x = 45

n_x = 6

Now u formula

U = $n_1 n_2 + \frac{n_x(n_x+1)}{2} - T_x$

U = 6×6 + $\frac{6(6+1)}{2} - 45$

U = 36 + 21− 45

U = 12

The U-value is 12. The critical value of U at p≤ 0.05 is 5. Therefore, the result is not significant at p≤ 0.05.

Balance during stand on foam with eyes close

Subject control	Condition FAB		Rank	Subject Trial	Condition FAB		Rank
C1	2	2	3	T1	3	2	3
C2	2	2	3	T2	3	2	3
C3	3	2	3	T3	3	3	9
C4	3	3	9	T4	2	3	9
C5	3	3	9	T5	3	3	9
C6	2	3	9	T6	2	3	9
TOTAL			36				42
MEAN			6				7

Table-7: Balance during stand on foam with eyes close

Where, n_1 = 6

n_2 = 6

T_x = 42

n_x = 6

Now u formula

U = $n_1 n_2 + \frac{n_x(n_x+1)}{2} - T_x$

U = 6×6 + $\frac{6(6+1)}{2} - 42$

U = 36 + 21− 42

U = 15

The U-value is 15. The critical value of U at $p \leq 0.05$ is 5. Therefore, the result is not significant at $p \leq 0.05$.

Balance during two-footed jump

Subject control	Condition FAB		Rank	Subject Trial	Condition FAB		Rank
C1	3	1	1	T1	2	2	4
C2	1	3	9	T2	3	2	4
C3	4	3	9	T3	2	2	4
C4	3	3	9	T4	2	2	4
C5	3	3	9	T5	2	2	4
C6	3	4	12	T6	2	3	9
TOTAL			49				29
MEAN			8.17				4.83

Table-8: Balance during two-footed jump

Where, $n_1 = 6$

$n_2 = 6$

$T_x = 49$

$n_x = 6$

Now u formula

$U = n_1 n_2 + \frac{n_x(n_x+1)}{2} - T_x$

$U = 6\times6 + \frac{6(6+1)}{2} - 49$

$U = 36 + 21 - 49$

$U = 8$

The U-value is 8. The critical value of U at p≤ 0.05 is 5. Therefore, the result is not significant at p≤ 0.05.

Balance during walk with head turns

Subject control	Condition FAB		Rank	Subject Trial	Condition FAB		Rank
C1	2	2	2	T1	2	2	2
C2	3	3	7	T2	4	2	2
C3	3	3	7	T3	3	3	7
C4	3	3	7	T4	3	3	7
C5	4	3	7	T5	2	3	7
C6	3	4	11.5	T6	3	4	11.5
TOTAL			41.5				36.5
MEAN			6.92				6.08

Table-9: Balance during walk with head turns

Where, n_1 = 6

n_2 = 6

T_x = 41.5

n_x = 6

Now u formula

U = $n_1 n_2 + \frac{n_x(n_x+1)}{2} - T_x$

U = 6×6 + $\frac{6(6+1)}{2} - 41.5$

U = 36 + 21$-$ 41.5

U = 15.5

The U-value is 15.5. The critical value of U at $p \leq 0.05$ is 5. Therefore, the result is not significant at $p \leq 0.05$.

Balance during reactive postural control

Subject control	Condition FAB		Rank	Subject Trial	Condition FAB		Rank
C1	2	2	5	T1	2	2	5
C2	2	2	5	T2	3	2	5
C3	3	2	5	T3	2	2	5
C4	3	2	5	T4	2	2	5
C5	2	3	11	T5	2	2	5
C6	2	3	11	T6	2	3	11
TOTAL			42				36
MEAN			7				6

Table-10: Balance during reactive postural control

Where, n_1 = 6

n_2 = 6

T_x = 42

n_x = 6

Now u formula

U = $n_1 n_2 + \frac{n_x(n_x+1)}{2} - T_x$

U = 6×6 + $\frac{6(6+1)}{2} - 42$

U = 36 + 21− 42

U = 15

The U-value is 15. The critical value of U at p≤ 0.05 is 5. Therefore, the result is not significant at p≤ 0.05.

12thJuly, 2014

To,

Head of the Physiotherapy department

Centre for the rehabilitation of the paralyzed (CRP)

Savar, Dhaka-1343

Subject: Prayer for seeking permission to collect data to conduct a research study.

Sir,

With due respect & humble submission to state that I am a student of 4th professional B.Sc in physiotherapy at Bangladesh health professions institute (BHPI). In 4th year we have to do a research project for the partial fulfillment of the requirement for the degree of B.Sc in physiotherapy. My dissertation title is, "Efficacy of BAPS training to improve balance in knee disorder patient along with conventional physiotherapy at CRP savar". It is randomized controlled trial. I have chosen physiotherapy musculoskeletal outdoor department to collect required data. Now I am looking for your kind approval to start my research project & data collection. I would like to assure that anything of my research project will not harmful for the participant & department as well.

So, I therefore pray & hope that you would be kind enough to grant me the permission to data collection successfully in musculoskeletal outdoor unit.

Your faithfully

MD. Abu Hasan

Department of Physiotherapy

4th year student

Roll No. : 21

Session: 2008 - 2009

Forward to the head of PT for kind approval
12/07/14

Given Permission for data collection, so please contact with Mr. Zahid Hossain, CPT as a counterpart of this research. Thanks

12/07/14

Mohammad Anwar Hossain
Associate Professor &
Head of Physiotherapy Dept.
CRP, Chapain, Savar, Dhaka- 1343