
Original Article

The effect of gender in risk factors and characteristics of injuries in athletes of handball national teams

DIMITRIS HATZIMANOUIL¹, GEORGE GIATSI¹ , AGGELOS KANIOGLOU², IOANNIS KOLKAS³


¹ *Arustotle University of Thessaloniki, School of Physical Education & Sports Science, Greece*

² *Director of Primary School, Greece.*

³ *National Health System, Medicine Physician Consultant, Greece*

ABSTRACT

Hatzimanouil, D., Kanuoglou, A., & Kolkas, I. (2015). The effect of gender in risk factors and characteristics of injuries in athletes of handball national teams. *J. Hum. Sport Exerc.*, 10(4), pp.904-914. The aim of the present study was to present the injuries and to examine the effect of gender in risk factors and characteristics of injuries in players of a high competitive level. The sample of the study consisted of 16 juniors, 16 men, 15 young women and 15 women handball players who were members of Greek national teams. All athletes were given a self-reported questionnaire. The questionnaire related to the injuries the players had suffered during their involvement in the sport during the last 24 months. The incidence was for male and female 40.6% and 37.9% respectively. The percentage of severity for male was 40.9% and for female 40%. Injuries occurred in both genders mainly during the training sessions. The type of injuries in male players was ligament injuries whereas in female it was muscular strains. The localization of injuries for both genders was the lower limbs. The mechanism of injuries was the contact with the opponent player. Players used conservative treatment in their long period of returning to the same sporting activities after injury. A small percentage presented a relapse after injury. Correlation analysis showed the prophylactic equipment, the rate of incidence of at least one injury, the players' opinion about the cause of injuries, the injury mechanism, the severity of injuries, the treatment, the days of players' absence and the players with no modification of training program after injury had a significant difference between male and female players. Conclusively, the gender affects risk factors and characteristics of injuries at a high competitive level. The necessity of studying this matter in another sample is obvious. **Key words:** SEVERITY, TREATMENT, PLAYERS' ABSENCE, MECHANISM

 **Corresponding author.** Arustotle University of Thessaloniki, School of Physical Education & Sports Science, Thessaloniki 541 24, Greece.

E-mail: ggiatsis@phed.auth.gr

Submitted for publication June 2015

Accepted for publication November 2015

JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202

© Faculty of Education. University of Alicante

doi:10.14198/jhse.2015.104.06

INTRODUCTION

Team handball is a spread worldwide Olympic contact sport, with a high risk of injury for both genders (De Loes and Goldie, 1988; Renstrom et al., 2008). From the review of the literature it seems that there is a lot of a research for injuries in team handball. However, few of them refer to injuries for high competitive level handball players (Langevoort et al., 2007). These specific researches didn't correlate the results with these which occurred in the other gender at this competitive level, while this is necessary and very important.

Each sport should have its own model of injuries, which can be more or less, specialized (Hoeberigs et al., 1986). The knowledge of this model can be very important for the prevention and for the medical care that perhaps needs to be given to a woman or a man athlete. Furthermore, it is useful to define the most important causative factors of injuries in handball with a view to make the specialized model for each competitive level of each country (Chatzimanouil et al., 2011).

The frequency of injuries in team handball had been investigated by a lot of researchers and in fact it varies because of injury definition, the athlete's characteristics and the research method (Petersen et al., 2005). Moreover, due to the fact that there is a competitive variety and competitive level the model of injury must be specialized and exclusive and must refer separately to each specific athlete's subgroup (Inklaar, 1994). This is very important because in this way each subgroup will develop its own preventive programs and methods which probably differ from another subgroup of another competitive level of the same sport of the same country. Furthermore, each country has a different competitive level and as much information as someone can collect for injuries for each subgroup, the model of injuries can become more specialized.

Particularly, the recent period team handball in Greece has developed rapidly and has a lot of international success either at national level or at club level. This shows that this sport has a trend to be a professional sport. This also has an impact in the training programs which must apply and must include preventive methods for injuries because in this sport injuries are inevitable (Asembo and Wekesa, 1998). Although many studies have been conducted in European countries, little is known about injuries in Greek handball. Exact information about the gender in high level players needs to be identified before initiating intervention trials. Such a study might provide baseline information for further investigation in Greece.

From the review of the literature it seems that there is little knowledge as it concerns injuries in team handball in correlation with the gender in the same competitive level. Most of the researchers examine the correlation between genders with specific injuries. For example Hewett et al. (2007) examines the anterior cruciate ligament injury and the gender-related hormonal differences between men and women. The relation between gender and cruciate ligament injury also showed the research of Shultz et al. (2008), who examined the neuromuscular, the biomechanics, anatomic and hormonal risk factors for injuries. Furthermore Harmon and Ireland (2000), examined the intrinsic and external factors of both genders with the anterior cruciate ligament injury. Lian et al. (2005) examined the correlation between gender and "Jumper's Knee" injury of many sports (included team handball). Furthermore, Bahr and Holme (2003) researched the risk factors while they examined the gender emphasizing the methodological approach concerning hamstring strain injury.

In conclusion, scientific aspects are controversial. Hoeberigs et al. (1986), reported that gender didn't play a role as a risk factor for the injuries in team handball. Furthermore field position is another factor over which there is conflicting evidence and refers to gender. Tsigilis and Hatzimanouil (2005) and Seil et al. (1998), did not find any significant differences among the field positions in relation to the risk injury of male

team handball players. On the other hand, Wedderkopp et al. (1999) reported a higher injury incidence in female backcourt players, whereas Biener & Perka (1980) reported that middle-field females sustained more injuries. The above studies (Biener & Perka, 1980; Seil et al., 1998; Wedderkopp et al., 1999), suggest that the risk injury of a player in relation to their field position might be associated with gender. Moreover Rasuli et al. (2012), reported there were differences between men and women concerning the location of injuries in team handball and they stated that this probably occurred because of the gender, however this research examined only women players and took into account results from other authors who had men population as a sample in their research.

Finally it seems that there is not enough research effort concerning the correlation of the gender and injuries of high level players who are members of national teams. This lead to the aim of the present study which was to compare and to correlate injuries in team handball between men and women of high level players who were members of Greek national teams and to examine the risk factors at this competitive level of this athlete's group.

MATERIAL AND METHODS

Sample

The total sample of the study consisted of 16 juniors, 16 men, 15 young women and 15 women handball players who were in Greek national teams of juniors, men, young women and women. All athletes were regular participants of the teams.

Research tools

All athletes were given a self-reported questionnaire developed specifically for this research. The questionnaire related to the injuries the players had suffered during their involvement with the sport within the period of the last 24 months. An injury was defined as an accident sustained during practice or competition, which led to a medical problem (e.g., pain, disability) and prevented participation in training sessions or games for at least one day beyond the date of occurrence (Gibbs, 1993; Hodgson et al., 1998). More specifically, at the beginning of the questionnaire each player was required to give information and data on personal characteristics such as age, weight, height and his history of athletic activity and participation. In addition, each player gave further information about warm up exercises, prophylactic equipment, stretching exercises and technical training. In the main part of the questionnaire, information was required on injuries which the players had sustained during the last two years. For instance, the incidence, the severity (injuries were graded into four categories of severity): mild (absence from practice less than one week), moderate (1-2 weeks of absence), serious (2-4 weeks of absence), and severe (more than four weeks of absence) (Seil et al., 1998), the percentage of players who had to be hospitalized, the localization, the type and mechanism of injury, the time (that is, during training or at a match), the method of treatment, and the relapse of the injury. Finally, information was asked about environmental factors, such as the place where the injuries occurred.

Procedure

The questionnaires were suitably formed and were completed by each player separately during the visit made by the researchers at both male and female national team training sessions. The completion of the questionnaires was done during the official game tournament. Participation in the study was voluntary. If an injury was listed, more questions had to be answered regarding the severity, the localization, the time (that is, during training or at a match) and relapse. The researchers were present to answer any questions posed by the athletes. There was a 100% response from the questionnaire. In total, 62 questionnaires were

completed (30 by females and 32 by male athletes). All injuries reported concerned sport injuries and not those related to overuse syndromes. Nicholas and Hershman (1990) state that sport injury is an acute musculoskeletal injury, related to an accident which happened in scheduled matches or training sessions and which results in the absence of a player from at least one match or training session. In the present study handball players were asked to complete a self-reported questionnaire. Therefore, an issue can be raised regarding its reliability. It should be underlined that none of the scientific articles that were used as a reference for the research confirmed the reliability of the administered questionnaire. It is possible that the contradictory results which are frequently found in the literature regarding sport injuries, stems from tools of low reliability. Future studies should attempt to clarify this issue. The results of the present study should be viewed while taking into account the above considerations.

Statistical Analysis

In the analysis of the data, the mean was taken, as well as the standard deviation, and the frequency of the values of each variable and their percentage. The differences between male and female players were studied with the statistical test χ^2 . The level of significance was determined at 0.05. The statistical package which was used was SPSS 21.

RESULTS

Table 1. Personal characteristics of sample.

Parameter	Male	Men	Juniors	Female	Women	Young Women
Age (years)	23.2(3.9)	26.2(3.5)	20.2(0.5)	22.5(4.2)	25.9(3.3)	19.1(1)
Training age (ys)	11(3.5)	13.6(2.9)	8.4(1.7)	10.4(4)	12.8(3.8)	7.9(2.4)
Height (cm)	188.1(7.2)	187.3(8.1)	188.9(6.3)	165.9(32.2)	173.4(7)	157.8(45.2)
Weight (kg)	84.4(16.9)	89.4(9.6)	79.4(21)	63.9(6.8)	66.3(5.8)	61.4(7.1)
BMI	23.8(0.3)	25.5(0.1)	22.4(0.5)	23.1(0.0)	22.1(0.1)	24.7(0.0)

Note. The values are means. Standard deviation appear in parenthesis.

Descriptive statistics

From the results of descriptive statistics it is shown that incidence rate for male players was 8.3/ (1000h) and for female was 6.79/ (1000h) during games. Incidence rate for male players was 0.69/ (1000h) and for female was 0.47/ (1000h) during training. The severity for male players was serious (40.9%), moderate (36.4%), very serious (13.6%) and small (9.1%). For female players it was serious (40%), very serious (33.3%), moderate (13.3%) and small (13.3%). For the type of injuries female players presented more sprains than male athletes while male players presented more ligament injuries than female athletes. As far as the localization is concerned it seems that beside injuries in lower limbs, female players also presented injuries in upper limbs and differed from male players in the percentage. Female presented 29.4% while male 8.7%. In our study the mechanism of injuries showed male players having injuries from contact with opponent players more often than female players. In our study despite female players presenting a higher percentage and significant difference than male in very serious injuries these players demonstrated a significant difference from the male players in conservative treatment. Furthermore, from our results it

seems male athletes followed surgery treatment more than female athletes. From our results it seems male players needed more duration to come back to the same sporting activity after injury than female. Most of the male players needed more than 30 days while most female athletes needed a period between 20-30 days. Lastly, in our study female players had a significant difference and used more modification training programs after an injury than male athletes while there was a much higher percentage of female players in relation to male athletes that use training programs with no modification.

Table 2. Injuries and their characteristics as a percentage of the sample.

Parameter	Factor	Male	Men	Juniors
Use of prophylactic equipment		43.8	56.3	31.3
Use of technical training		81.3	87.5	75
Incidence of injuries		40.6	37.5	43.8
Incidence of one injury		73.3	75	71.4
Players with past injuries		20	20	20
Place of injury	Training	69.6	58.3	81.8
Type of injury	Ligament injuries	31.8	33.3	30
Localization of injuries	Lower Limbs	78.3	83.3	72.7
Overuse injuries	Player's opinion	69.6	66.7	72.7
Injury mechanism	Contact with opponent player	57.1	63.6	50
Severity of injuries	Serious	40.9	27.3	54.5
Treatment	Conservative	68.2	63.6	72.7
Players with complications		42.1	30	55.6
Players with no modification program		10.5	11.1	10
Players with relapse after injury		13	16.7	9.1

Note. The values and their percentage were taken as the majority by any standard.

Table 3 .Injuries and their characteristics as a percentage of the sample.

Parameter	Factor	Female	Women	Senior Girls
Use of prophylactic equipment		66.7	60	73.3
Use of technical training		93.3	86.7	100
Incidence of injuries		37.9	50	26.7
Incidence of one injury		54.5	42.9	75
Players with past injuries		15	12.5	16.7
Place of injury	Training	68.8	85.7	55.6
Type of injury	Sprain	53.3	50	57.1
Localization of injuries	Lower Limbs	58.8	42.9	70
Overuse injuries	Players' opinion	43.8	42.9	44.4
Injury mechanism	Contact with opponent player	35.7	42.9	28.6
Severity of injuries	Serious	40	42.9	37.5
Treatment	Conservative	93.8	85.7	100
Player with complications		66.7	57.1	75
Players with no modification program		25	42.9	11.1
Players with relapse after injury		18.8	14.3	22.2

Note. The values and their percentage were taken as the majority by any standard.

Correlation Analysis

Use of prophylactic equipment

There was a significant difference between the gender and the use of prophylactic equipment ($\chi^2(1) = 6.398, P=.01$). More specifically it is shown that, female players used the prophylactic equipment more often than male players.

Type of injury

There was a significant difference between the gender and the type of injury ($\chi^2(6) = 108.869, P=.000$). Female players presented more sprain injuries than male players. Furthermore male players presented more ligament injuries than female athletes.

Localization of injuries

There was a significant difference between the gender and the localization of injuries ($\chi^2(2) = 9.226, P=.01$). Female players presented injuries mainly in the lower extremities while they had a higher percentage in upper extremities than male players. In male players the localization of injuries was mainly in lower extremities while they had a higher percentage than female players.

Overuse

There was a significant difference between the gender and the player's opinion of what the reason of their injuries was ($\chi^2(2) = 10.968, P = .004$). Male players believed more than female players that their injuries originated from overused while 1/3 of female athletes can't understand the reason which caused their injuries.

Injury mechanism

There was a significant difference between the gender and the injury mechanism ($\chi^2(3) = 17.9, P = .000$). More specifically it is shown that the mechanism of injuries for male players was caused more often by contact with opponent players than female players. Moreover, 4.8% of male players presented injuries from contact with teammates while female players didn't. Lastly, male players presented more self-inflicted injuries than female players.

Severity of injuries

There was a bias in a significant difference between the gender and the severity of injuries ($\chi^2(3) = 6.786, P = .079$). More specifically it is shown that female players differ from men players in the severity of injuries. The differences are mainly in variables of very serious injuries, moderate injuries and small injuries. The percentages of male and female players are 13.6% and 33.3%, 36.4% and 13.3%, 9.1% and 13.3% respectively.

Treatment

There was a significant difference between the gender and the treatment of injuries ($\chi^2(1) = 4.816, P = .028$). More specifically it was shown that female players differ from men players in treatment of injuries. Female players followed conservative treatment more often than men players. Furthermore, injured male players followed operative treatment more often than females.

Days of absence

There was a significant difference between the gender and the days of returning to the same sporting activity after injury ($\chi^2(4) = 26.261, P = .000$). More specifically 50% of female players returned to the same sporting activity after 20-30 days while the percentage of male athletes for the same days was 17.4%. For the duration of returning to the same sporting activity in more than 30 days, male players presented a percentage of 47.8% while female presented 14.2%.

Players with no modification program

There was a significant difference between the gender and the players with no modification of training program after injury ($\chi^2(4) = 19.034, P = .001$). Female players who used modification training programs after injury were more than male players. More specifically the percentage of female players was 37.5% and of the male was 15.8%. Furthermore female players were more than male players in using training programs with no modification. The percentage was 25% and 10.5 respectively.

DISCUSSION

The injury incidence was calculated as the number of injuries sustained multiplied by 1.000 and divided by the total hours of exposure to injury. The total number of hours of exposure was calculated as the number of handball players multiplied by the length of play multiplied by the number of games played. The number of male and female injuries was 17 and 11 while the number of male and female players was 32 and 30. Lastly the number of games played was 64 for male and 54 for female. For the training for male and female

players the number of trainings was 509.6 and 512 for the last two years while the duration of training for both genders lasted 1.5 hours.

The results of our study for male players are comparable with the results of Olsen et al. (2006) as Zantop and Petersen, (2003) who reported an injury incidence for male players 8.3/ (1000h) and 12.1/ (1000h) during games. The results of female players are similar to the study of Olsen et al., (2006) who reported an injury incidence for female players 10.4/ (1000h) during games. For the training the results are similar to those of Olsen et al. (2004), (2006) who reported an injury incidence for male players 0.6/ (1000h) during training. For female players the results in our study are far from other researchers who found much higher incidence rate. For example Wedderkopp et al. (1997), (1999) reported an injury incidence rate for female players 3.4/ (1000h) during training while the sample of these studies differentiated a lot from our study and presented injuries only for female athletes aged 16-18 years and stems from intermediate and recreational level.

The difference in severity in our results between the gender is probably because females have a significant higher risk to ACL injury than men (Henke et al., 2014). Furthermore, for knee injuries there are more cases of serious ligament injuries which are usually treated by means of surgery. Cumps et al. (2008), figured out that ACL injuries cause the highest direct costs.

From correlation analysis our results showed that there was a significant difference between the gender and the use of prophylactic equipment. Aaltonen et al. (2007) and Kreische (2007) reported there is an evidence of preventive effect which can be done by the external joint support. Thus, male players must use protective equipment more often.

As far as the type of injuries is concerned, the most common acute injuries were sprains, with knee, ankle and fingers being the most frequently affected locations followed by contusions and strains (Froböse et al., 1996; Olsen et al., 2006; Seil et al., 1998; Wedderkopp et al., 1997).

Regarding the localization of injuries and the difference between the genders is concerned it is because younger athletes seem to be more prone to injuries of the upper body regions, especially finger injuries (Luig and Henke, 2010). In our sample of female players there were senior girls.

Concerning the overuse injuries and players' opinion of what the reason for their injuries was, it seems that both female and male players don't know what the reason and the cause of their injuries was. In our study injuries seem to be acute injuries. The most common acute injuries are sprains with knee ankle and fingers being the most frequently affected locations followed by contusions and strains (Froböse et al., 1996; Olsen et al., 2006; Seil et al., 1998; Wedderkopp et al., 1997). On the other hand chronic and overuse injuries usually result from repetitive stress on biological tissues leading to instability of affected joints. The most common overuse injuries are lower back pain, periostitis, shoulder and elbow pain (Olsen et al., 2006; Pieper, 2002; Pieper and Muschol, 2007; Wedderkopp et al., 1997).

One possible explanation for the difference between the genders as far as the mechanism of an injury is concerned is that generally in team handball most players get injured in contact situations while these injuries are most commonly less severe (i.e. minor contusions) compared to non-contact injuries (i.e. ACL injury) (Henke et al., 2014). As we mentioned before females have a significantly higher risk of ACL injury than men players, while 90% of ACL ruptures were reported to happen without the opponents' or teammates' contribution (Myklebust et al., 1997; Myklebust et al., 1998; Myklebust et al., 2003). This

reason possibly also explains why male players presented more injuries from contact with opponents than female players.

When it comes to the treatment, ligament injuries and specifically ACL injuries are usually treated by means of surgery (Luig & Henke, 2010). The results of our study are controversial and must be studied thoroughly. Besides it is clear there is a necessity of studying this matter in another study in depth. Luig and Henke (2010) supported the knowledge of medical and no medical treatment which appears in the literature as a part of multifaceted approaches of handball injuries.

As far as the days of absence are concerned, our results are similar to those of Salman (2014) who found statistical difference between the genders and the absence after an injury in team handball. However, his sample consisted of moderate and recreational handball players.

As regards to the modification of the training program, it seems female athletes had a dispersion in modification of training programs after an injury and sometimes they followed modification programs and other times they followed training with no modification. We believe this depends on how serious or not the severity of their injury is.

CONCLUSIONS

Conclusively, it seems from the review of the bibliography to date, that the role of the gender in risk factors and characteristics of injuries in handball players is a controversial issue and needs more research. In our study we examined this and we found that gender plays an important role and is a crucial factor for the definition of handball injuries and for their prevention. Thereby, gender affects risk factors and the characteristics of handball injuries. Consequently, the use of prophylactic equipment, the type of injury, the localization of injury, the player's opinion of what the reason for their injuries was, the mechanism of injury, the severity of injury, the treatment of injury, the number of days before returning to the same sporting activity after injury (absence) and the modification of the training program after an injury, a significant difference exists between male and female athletes of national handball teams.

REFERENCES

1. Aaltonen, S., Karjalainen, H., Heinonen, A., Parkkari, J., & Kujala, U. M. (2007). Prevention of Sports Injuries – A systematic Review of Randomized Controlled Trials. *Archive of Internal Medicine*, 15(167), pp.1585-1592.
2. Asembo, J. M., & Wekesa, M. (1998). Injury pattern during team handball in East Africa. *East African Medical Journal*, 75(2), pp.113-116.
3. Bahr, R., & Holme, I. (2003). Risk factors for sports injuries—a methodological approach. *British Journal of Sports Medicine*, 37(5), pp.384-392.
4. Biener, K., & Perka, D. (1980). Portrait of the female handball player in sport. *Deutsche Zeitschrift fuer Sportsmedizin*, 31, pp.316-XII.
5. Chatzimanouil, D., Kanioglou, A., & Lazaridis, S. (2011). Injuries in female athletes of Greek national handball teams. *Minerva Ortopedica e Traumatologica*, 62(5), pp.353-359.
6. Cumps, E., Verhagen, E., Annemans, L., & Meeusen, R. (2008). Injury rate and socioeconomic costs resulting from sports injuries in Flanders: data derived from sports insurance statistics 2003. *British Journal of Sports Medicine*, 42(9), pp.767-772.

7. De Loës, M. & Goldie, I. (1988). Incidence rate of injuries during sport activity and physical exercise in a rural Swedish municipality: incidence rates in 17 sports. *International Journal of Sports Medicine*, 9(6), pp.461-467.
8. Froböse, I., Knaak, A.K., & Menkle, W. (1996). Häufigkeit und Lokalisation von Verletzungen im Frauenhandball. *Deutsche Zeitschrift für Sportmedizin*, 47, pp.472-477.
9. Gibbs, N. (1993). Injuries in professional rugby league: A three-year prospective study of the South Sydney professional rugby league football club. *American Journal of Sports Medicine*, 21, pp.696-700.
10. Harmon, K.G., & Ireland M.L. (2000). Gender differences in noncontact anterior cruciate ligament injuries. *Clinics in Sports Medicine*, 19(2), pp.287-302.
11. Henke, T., Luig, P., & Schulz, D. (2014). Sports injuries in German club sports, Aspects of epidemiology and prevention. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz*, 57(6), pp.628-637.
12. Hewett, T.E., Zazulak, B.T., & Myer, G.D. (2007). Effects of the Menstrual Cycle on Anterior Cruciate Ligament Injury Risk. A Systematic Review. *American Journal of Sports Medicine*, 35(4), pp.659-668.
13. Hodgson, P.L., Standen, P.J., & Batt, M.E. (1998). Effects of seasonal change in rugby league on the incidence of injury. *British Journal Sports Medicine*, 32, pp.144-148.
14. Hoeberigs, J., van Galen, W. & Philipsen, H. (1986). Pattern of injury in handball and comparison of injured versus non injured handball players. *International Journal Sports Medicine*, 7, pp.333-337.
15. Inklaar, H. (1994). Soccer injuries. I: Incidence and severity. *Sports Medicine*, 18(1), pp.55-73.
16. Kreische, G. (2007). *Stabilisierung zur Verletzungsprävention am Sprunggelenk-eine Metaanalyse*. (Doctoral Dissertation, Medizinische Fakultät, Universität Würzburg). Retrieved from <http://opus.bibliothek.uni-wuerzburg.de>
17. Langevoort, G., Myklebust, G., Dvorak, J., & Junge, A. (2007). Handball injuries during major international tournaments. *Scandinavian Journal of Medicine and Science in Sports*, 17, pp.400-407.
18. Lian, O.B., Engebretsen, L., & Bahr, R. (2005). Prevalence of jumper's knee among elite athletes from different sports: A cross-sectional study. *The American Journal of Sports Medicine*, 33(4), pp.561-567.
19. Luig, P. & Henke, T. (2010). *Safety in Sports: Inventory on the burden of handball injuries, existing prevention measures and safety promotion strategies*. Ruhr-Universität Bochum: Bochum. *Medicine. Deutsche Zeitschrift fuer Sportmedizin*, 31, pp.316-XII.
20. Myklebust, G., Maehlum, S., Engebretsen, L., Strand, T., & Solheim, E. (1997). Registration of cruciate ligament injuries in Norwegian top level team handball. A prospective study covering two seasons. *Scandinavian Journal of Medicine and Science in Sports*, 7(5), pp.289-292.
21. Myklebust, G., Maehlum, S., Holm, I., & Bahr, R. (1998). A prospective cohort study of anterior cruciate ligament injuries in elite Norwegian team handball. *Scandinavian Journal of Medicine and Science in Sports*, 8(3), pp.149-153.
22. Myklebust, G., Engebretsen, L., Braekken, I.H., Skjøberg, A., Olsen, O.E., & Bahr, R. (2003). Prevention of anterior cruciate ligament injuries in female team handball players: a prospective intervention study over three seasons. *Clinical Journal of Sport Medicine*, 13(2), pp.71-78.
23. Nicholas, J., & Hershman, E. (1990). *The lower extremity and spine*. The CV Mosby Company, St Louis.

24. Olsen, O.E., Myklebust, G., Engebretsen, L., & Bahr, R. (2006). Injury pattern in youth team handball: a comparison of two prospective registration methods. *Scandinavian Journal of Medicine and Science in Sports*, 16(6), pp.426-432.
25. Olsen, O.E., Myklebust, G., Engebretsen, L., & Bahr, R. (2004). Injury mechanisms for anterior cruciate ligament injuries in team handball: a systematic video analysis. *American Journal of Sports Medicine*, 32(4), pp.1002-1012.
26. Petersen, W., Braun, C., Bock, W., Schmidt, K., Weimann, A., Drescher, W., Zantop, T. (2005). A controlled prospective case control study of a prevention training program in female team handball players: the German experience. *Archives of Orthopaedic and Trauma Surgery*, 125(9), pp.614-621.
27. Pieper, H.G. (2002). Überlastungen des Schultergelenks und Fehlbelastungsfolgen am Ellenbogen. *Sportorthopädie- Sporttraumatologie*, 18(4), pp.241-244.
28. Pieper, H.G. & Muschol, M. (2007). Sportverletzungen und Überlastungsschäden im Handballsport. *Sportorthopädie – Sporttraumatologie*, 23(1), pp.4-10.
29. Rasuli, S., Jafari, A., Moghaddam, J.B., & Shotorbani, F. N. (2012). The prevalence of sports injuries in female Handball players. *Advances in Environmental Biology*, 6(5), pp.1801-1808.
30. Renstrom, P., Ljungqvist, A., Arendt, E., Beynon, B., Fukubayashi, T., Garrett, W., Engebretsen, L. (2008). Non-contact ACL injuries in female athletes: an International Olympic Committee current concepts statement. *British Journal of Sports Medicine*, 42(6), pp.394-412.
31. Salman A. F. (2014). Comparison of injuries between male and female handball players in junior and senior teams. *The Swedish Journal of Scientific Research*, 1(4), pp.1-15.
32. Seil, R., Rupp, S., Tempelhof, S., & Kohn, D. (1998). Sports injuries in team handball: a one year prospective study in sixteen men's senior teams of superior nonprofessional level. *American Journal of Sports Medicine*, 26(5), pp.81-687.
33. Shultz, S. J., Schmitz, R. J., & Nguyen, A.D. (2008). Research Retreat IV: ACL Injuries—The Gender Bias: April 3–5, 2008 Greensboro, NC. *Journal of Athletic Training*, 43(5), pp.530–531.
34. Tsigilis, N., & Hatzimanouil, D. (2005). Injuries in handball: Examination of the risk factors. *European Journal of Sport Science*, 5(3), pp.137-142.
35. Wedderkopp, N., Kalltoft, M., Lundgaard, B., Rosendahl, M., & Froberg, K. (1997). Injuries in young female players in European team handball. *Scandinavian Journal of Medicine and Science in Sports*, 7(6), pp.342-347.
36. Wedderkopp, N., Kalltoft, M., Lundgaard, B., Rosendahl, M., & Froberg, K. (1999). Prevention of injuries in young female players in European team handball. Aprospective intervention study. *Scandinavian Journal of Medicine and Science in Sports*, 9(1), pp.41-47.
37. Zantop, T., & Petersen, W. (2003). Prevention of ankle joint injuries in handball. *Z Orthop Ihre Grenzgeb*, 141(5), pp.499-501.