

The Current Application of the OSTRC Knee Injury Prevention Program among Professional Basketball, Handball, Soccer, and Volleyball Players in the Gulf Cooperation Council Countries

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Abstract Sports are associated with an increased risk of lower limbs injury that may significantly impact the quality of life for the athletes and negatively affected several functions of individuals for many years. For this reason, several injury preventions programs have been developed. These programs involved exercises that focused on core stability, balance, stretching, and strengthening. The Oslo Sports Trauma Research Center (OSTRC) Knee Injury Prevention Program is an evidence-based injury prevention program designed and developed to prevent knee injuries. The implementation of injury prevention programs is a challenge in sports medicine. Therefore, the purpose of this study is to assess the implementation of the OSTRC Knee Injury Prevention Program among professional basketball, handball, soccer, and volleyball players in the Gulf Cooperation Council (GCC) Countries. An online questionnaire to investigate

the implementation of the program was dismissed to 500 professional players. A total of 433 players responded to the survey with a response rate of 86.6%. Basketball was the most practiced sport reported 119 (27.5%), followed by handball 109 (25.2%), then soccer 102 (23.6%), and volleyball 103 (23.8%). The highest percentage of participants were from UAE 79 (18.2%), and Saudi Arabia 78 (18%), followed by Oman 76 (17.6%), whereas an equal percentage of athletes participated from Bahrain and Qatar; 67 (15.5%), the least percentage was recorded from Kuwait 66 (15.2%). The most common exercises performed by the participants were squat+ 229 (52.9%), Nordic hamstring 225 (52%), single-leg sideways hop 223 (51.5%), jumping lungs 218 (50.3%), and flyer 217 (50.1%). This study concluded that implementation of OSTRC knee injury prevention exercise was low among participants, and the implementation was not statistically different between

different sports or GCC countries.

Keywords Basketball, Handball, Volleyball, Soccer, Knee Injuries, Surveys and Questionnaires

1. Introduction

Injuries to the lower limbs, especially the ankle and knee joint injuries, are reported to be the most common cause of loss of participation among athletes in many different sports [1]. In knee injuries, the most noticed injuries are tears in the anterior cruciate ligament (ACL) and medial collateral ligament (MCL), which are considered severe injuries and may result in long term sequelae [2]. These injuries account for about 10-13% of all injuries in different sports [3]. Due to the typical jumping, change of direction, and stop-and-go movements, ACL tears are frequent in ball sports, but knee injuries are also common in other sports such as judo, alpine skiing, and field hockey [4]. Therefore, with a high level of interest in demand for professionalism in such sports, this might lead to an increased incidence of knee injuries with several risks and negative consequences such as an increase in the cost of treatment, loss of playing time, or not return to pre-injury level. Only 50% of athletes return to their pre-injury level of activity, resulting in a premature end of the athlete's career [5]. It is also reported that 7-24% of the ACL reconstruction patients developed ACL injury in the contralateral knee [6]. For these reasons, the prevention of knee injuries is essential and a topic of current interest in sports science.

In the last decades, various strategies for prevention programs of ACL tears have been developed and applied, including education about typical ACL injury mechanisms and possible modifications of risk maneuvers. A review was conducted to evaluate and determine if ACL injury prevention strategies positively impact athletic performance tests and injury rates in female athletes [7]. This review found that two injury prevention programs significantly reduced ACL injury rates among female participants and improved athletic performance tests, these programs are the Prevent Injury and Enhance Performance Program (PEP) and Sportsmetrics [7]. Some other strategies were summarized in special prevention programs such as Knee Ligament Injury Prevention Program and the "11" [8]. Moreover, numerous researches have investigated the effectiveness of the "11+" program. From a physiological perspective, it has been shown optimally, preparing the athlete for a competition and is essential in injury prevention, especially for the knee joint. In 2019 Al Attar et al. [9] conducted a meta-analysis of meta-analyses to investigate the effectiveness of the FIFA injury prevention program among soccer, four meta-analyses were included in this study, and the result

showed a reduction of 29% [RR= 0.71 (0.63 – 0.81)] for injuries to the lower limb. The "11+" was recently applied in two randomized controlled trials (RCTs) among male players.^{10,11} One of these studies was conducted by Owoeye et al. [10], who found a significant reduction of 40% in the incidence of injuries among young Nigerian male players (aged 14-19), and the second RCT was conducted by Silvers-Granelli et al. [11] who reported comparable results but in American male NCAA Division I-II players (aged 18-25) when performing the program regularly (2-3 times a week).

Sports are associated with an increased risk of injury that may have a significant impact on the participants' quality of life and negatively affect several functions of the individual for many years [12]. The Fédération Internationale de Football Association (FIFA) estimates that over 22 million youth soccer players worldwide [13], and the frequency of injury in this group represents a significant public health burden. For this fact, several injury prevention programs have been developed [14]. These programs involved exercises that focused on core stability, balance, stretching, and strength of the muscles [15]. The implementation of injury prevention programs is a challenge in sports medicine [16]. Along these lines, the Oslo Sports Trauma Research Center (OSTRC) was established to provide evidence-based exercises more focused on preventing the most common injuries in popular sports.

In OSTRC programs, an enormous number of researches supported the importance of injury prevention programs. Relying on this, the OSTRC Knee Injury Prevention Program was developed by Olympiatoppen (Norwegian Olympic Committee), the Norwegian High-Performance Center, and the National Sports Federation. The goal was to understand better the injury, common risk factors, the mechanism of these injuries, and how to prevent them from happening. The OSTRC Knee Injury Prevention Program is effective and available on Skadefri resources of the best techniques that should be used to prevent most common injuries for more than 50 different sports by choosing the related prevention program, Figure 1. Although there are numerous studies about injury prevention programs using different protocols, no study has yet investigated the implementation of the OSTRC Knee Injury Prevention Program among athletes. It is expected that implementing this program would have a positive impact on preventing knee injuries among athletes. Therefore, this paper aims to assess the implementation of the OSTRC Knee Injury Prevention Program among professional basketball, handball, soccer, and volleyball players in the Gulf Cooperation Council (GCC) Countries. This will guide and provide scientific knowledge to policymakers, coaches, and athletes about the importance of implementing this program in their professional career path.

OSTRC Knee Injury Prevention Program

The program consists of 3 levels of progression. When you master these exercises, you can move on to the next level.

Level	Ex's	Sets	repetitions
Level 1	Squat	3	8-16
	Backwards lunge	3	8-16
	Side lunges	3	8-16
	Jumping with shoulder contact	3	8-16
	Nordic Hamstring	3	3-5
Level 2	Walking lunges	3	5-10
	Squat +	3	8-16
	Jump & Push	3	8-16
	Jumping lunges	3	8-16
	The diver	3	8-16
	Nordic Hamstrings	3	6-8
Level 3	2-leg forward jump +	3	8-16
	Single-leg squat	3	As many as possible with good control
	Turns	3	8-16
	Single-leg sideways hop	3	8-16
	Flyer	3	6-8
	Nordic Hamstrings	3	8-12

Figure 1. OSTRC Knee Injury Prevention Program

2. Materials and Methods

2.1. Study Design and Questionnaire

A cross-sectional questionnaire study was carried out online to assess the implementation of the OSTRC Knee Injury Prevention Program among professional basketball, handball, soccer, and volleyball players in the GCC countries. A systematic random sampling technique (selecting a random starting point and selecting sample members after a fixed 'sampling interval' where (sampling interval = population size/sample size) was used to select the study participants. A questionnaire consisted of three sections was created by a committee expert in the OSTRC Knee Injury Prevention Program. Content validity of the questionnaire was done, and the questionnaire items were updated according to the results. The first section of the questionnaire included the participants' agreement to participate in the study. The second section included questions regarding the participants' socio-demographic data, such as age, gender, country, sport's type and level. Finally, the third section of the survey included questions focusing on the implementation of OSTRC Knee Injury Prevention Program's exercises, such as; squat, forward lunges, backwards lunges, sideways lunges, jumping with shoulder contact, Nordic Hamstrings, Walking lunges, squat+, Jump and push, jumping lunges, Single-leg deadlift (The diver), Forward jumps, Single-leg squat,

jump turns, Single-leg sideways hop, and Flyer exercises. The survey was available in English and Arabic, supported by videos demonstrating each exercise. This project was reviewed and ethically approved by the Biomedical Ethics Committee at Umm Al Qura University, approval number. HAP002K012202010465. Consent was obtained from each participant in the study before data collection began.

2.2. Survey Software and Administration

Players were invited to complete the online survey where invitation emails were sent to the sport federations of basketball, handball, soccer, and volleyball players in Bahrain, Kuwait, Oman, Qatar, UAE and Saudi Arabia, who sent it through to players (Table 1). The invitation provided a brief background to the survey and encouraged players to participate. The survey was filled anonymously and electronically via online survey software (Google Forms), limited to one response only. Responses were voluntary, and the distribution was from June to October 2020. Consent was obtained from the participant in the study by accepting to proceed before answering the questionnaire. All participants were informed that participation was entirely voluntary. Additionally, no name was recorded in the questionnaires, and all the personal information of participants was confidential, reserved and kept safe.

Table 1. Survey Questionnaire

Agree to participate:	Yes or No
Country:	Saudi Arabia Bahrain Kuwait Oman Qatar United Arab Emirates
Gender:	Male or Female
Age:	
Pick your sport:	Basketball, Handball, Soccer, and Volleyball
Squat	Yes or No Feet hip-width apart. Elastic band around knees. Knees aligned with toes. Sit down as if on a chair. 3 x 8-16 repetitions.
Forward lunges	Yes or No Lunge forward. Knees aligned with toes. Maintain upper body in an upright position. 3 x 8-16 repetitions
Backwards lunges	Yes or No Lunge backwards. Maintain upper body in an upright position. Knees aligned with toes. 3 x 8-16 repetitions
Sideways lunges	Yes or No Lunge sideways. Knees aligned with toes. Maintain upper body in an upright position. 3 x 8-16 repetitions.
Jumping with shoulder contact	Yes or No Jump sideways. Land on both legs simultaneously. Knees aligned with toes. 3 x 8-16 repetition.
Nordic Hamstrings	Yes or No Kneel on pad or mat. Partner stabilizes legs. Lower your upper body slowly towards the ground. Resist a falling motion using your hamstrings. Push yourself back to the start position. 2 x 3-5 repetitions.
Walking lunges	Yes or No Lunge forward. Knees aligned with toes. Maintain upper body in an upright position. 3 x 8-16 repetitions.
Squat +	Yes or No Feet hip-width apart. Stand on BOSU, elastic band around knees. Sit down as if on a chair. Knees aligned with toes. Slowly back to start position. 3 x 8-16 repetitions.
Jump and push	Yes or No Push partner from different directions. Keep knees aligned with toes. Focus on soft landings. 3 x 8-16 repetitions.
Jumping lunges	Yes or No Alternating jumps. Soft landing in a deep lunge. Knees in alignment with toes in landings. 3 x 8-16 repetitions.
Single-leg deadlift (The diver)	Yes or No Find balance on one leg. Lift the other leg and move the upper body forwards. Keep back extended. 3 x 8-16 repetitions.
Forward jumps	Yes or No Jump forwards onto BOSU. Landing in squat position. Knees aligned with toes. 3 x 8-16 repetitions.
Single-leg squat	Yes or No Squat on one leg. Sit down as if on a chair. Knee in alignment with toes. 10 repetitions.
Jump turns	Yes or No The elastic band as resistance. Jump in different directions. Knee aligned with toes. 3 x 8-16 repetitions.
Single-leg sideways hop	Yes or No Jump sideways. Focus on soft landings. Knee in alignment with toes. 3 x 8-16 repetitions.
Flyer	Yes or No Find balance on one leg. Maintain knee slightly bent. Move upper body forwards. Keep back extended. Rotate upper body to both sides. 3 x 8-16 repetitions.

2.3. Sample Size and Data Analysis

Considering a 3% margin of error at a 95% confidence level, 500 professional players in six GCC countries were invited to participate.

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 24.0 software (SPSS Inc., Chicago, IL, USA). A Frequency test was used to calculate the percentages of all nominal variables. Also, the mean, standard deviation (SD), median and range (minimum-maximum) of the total score were calculated. A chi-square test (χ^2) was used to compare the Countries of the GCC and the different types of sports with respect to different findings. However, a one-way analysis of variance (ANOVA) was used to compare the total score among the GCC countries and the different types of sports. P-value <0.05 was considered significant.

3. Results

Table 2. Demographic characteristics

Variable	Frequency (%)
Sports	
Basketball	119 (27.5 %)
Handball	109 (25.2 %)
Soccer	102 (23.6 %)
Volleyball	103 (23.8 %)
Countries	
Saudi Arabia	78 (18.0 %)
Bahrain	67 (15.5 %)
Kuwait	66 (15.2 %)
Oman	76 (17.6 %)
Qatar	67 (15.5 %)
United Arab Emirates	79 (18.2 %)

A total of 433 male professional players aged 27 \pm 4 years responded to the survey (response rate 86.6%); basketball was the most reported sport practiced 119(27.5%), followed by handball 109(25.2%), then soccer 102(23.6%), and volleyball 103(23.8%). The highest percentage of participants were from UAE 79(18.2%), and Saudi Arabia 78(18%), followed by Oman 76(17.6%), whereas the equal percent of athletes participated from Bahrain and Qatar; 67(15.5%) from

each country, and the least percent was recorded from Kuwait 66(15.2%), Table 2.

The most common exercises performed by participants included squat+ 229(52.9%), Nordic hamstring 225(52%), single-leg sideways hop 223(51.5%), jumping lunges 218(50.3%), and flyer 217(50.1%), the percentages of exercises performed and reported by participants are shown on Table 3.

Table 3. Percentages and frequencies on different points

Exercise	Frequency (%)
Squat	207 (47.8 %)
Forward lunges	205 (47.3 %)
Backward lunges	214 (49.4 %)
Sideways lunges	215 (49.7 %)
Jumping with shoulder contact	201 (46.4 %)
Nordic Hamstrings	225 (52.0 %)
Walking lunges	206 (47.6 %)
Squat +	229 (52.9 %)
Jump and push	214 (49.4 %)
Jumping lunges	218 (50.3 %)
Single-leg deadlift (The diver)	212 (49.0 %)
Forward jumps	211 (48.7 %)
Single-leg squat	201 (46.4 %)
Jump turns	208 (48.0 %)
Single leg sideways hops	223 (51.5 %)
Flyer	217 (50.1 %)

The comparison of diverse types of sports reported by participants with respect to the reported prevention exercises is shown in Table 4. The comparison showed no significant differences between the exercises performed by athletes who practiced different sports, except for the single-leg squat, which showed a significant difference between different sports (P=0.047). More than half of basketball and volleyball players tended to perform single-leg squats compared to other sports players. The comparison was also made for exercises regarding countries included in the study in Table 5. There was no significant difference between the exercises performed in different countries.

Table 4. Comparison of the diverse types of sports with respect to different points (chi-square test)

Exercise	Basketball	Handball	Soccer	Volleyball	P-value
Squat	56 47.1%	55 50.5%	44 43.1%	52 50.5%	0.677
Forward lunges	63 52.9%	42 38.5%	50 49.0%	50 48.5%	0.167
Backward lunges	60 50.4%	50 45.9%	50 49.0%	54 52.4%	0.807
Sideways lunges	54 45.4%	52 47.7%	55 53.9%	54 52.4%	0.553
Jumping with shoulder contact	53 44.5%	45 41.3%	54 52.9%	49 47.6%	0.373
Nordic Hamstrings	64 53.8%	59 54.1%	51 50.0%	51 49.5%	0.857
Walking lunges	48 40.3%	58 53.2%	55 53.9%	45 43.7%	0.104
Squat +	68 57.1%	60 55.0%	57 55.9%	44 42.7%	0.127
Jump and push	66 55.5%	50 45.9%	54 52.9%	44 42.7%	0.200
Jumping lunges	54 45.4%	50 45.9%	55 53.9%	59 57.3%	0.208
Single-leg deadlift (The diver)	56 47.1%	52 47.7%	52 51.0%	52 50.5%	0.918
Forward jumps	59 49.6%	56 51.4%	53 52.0%	43 41.7%	0.427
Single-leg squat	60 50.4%	45 41.3%	39 38.2%	57 55.3%	0.047
Jump turns	54 45.4%	51 46.8%	55 53.9%	48 46.6%	0.592
Single leg sideways hops	70 58.8%	55 50.5%	44 43.1%	54 52.4%	0.139
Flyer	66 55.5%	52 47.7%	52 51.0%	47 45.6%	0.480

Table 5. Comparison among the Countries of the Gulf Cooperation Council (GCC) with respect to different points (chi-square test)

Exercise	Saudi Arabia	Bahrain	Kuwait	Oman	Qatar	U.A. E	P-value
Squat	36 46.2%	35 52.2%	38 57.6%	33 43.4%	27 40.3%	38 48.1%	0.387
Forward lunges	38 48.7%	29 43.3%	26 39.4%	39 51.3%	35 52.2%	38 48.1%	0.651
Backwards lunges	37 47.4%	36 53.7%	40 60.6%	33 43.4%	28 41.8%	40 50.6%	0.250
Sideways lunges	34 43.6%	35 52.2%	33 50.0%	34 44.7%	38 56.7%	41 51.9%	0.614
Jumping with shoulder contact	40 51.3%	31 46.3%	29 43.9%	31 40.8%	31 46.3%	39 49.4%	0.828
Nordic Hamstrings	40 51.3%	39 58.2%	31 47.0%	38 50.0%	35 52.2%	42 53.2%	0.865
Walking lunges	37 47.4%	28 41.8%	31 47.0%	39 51.3%	32 47.8%	39 49.4%	0.920
Squat +	42 53.8%	31 46.3%	31 47.0%	48 63.2%	32 47.8%	45 57.0%	0.253
Jump and push	32 41.0%	37 55.2%	32 48.5%	44 57.9%	34 50.7%	35 44.3%	0.289
Jumping lunges	41 52.6%	34 50.7%	36 54.5%	41 53.9%	31 46.3%	35 44.3%	0.759
Single-leg deadlift (The diver)	42 53.8%	31 46.3%	31 47.0%	37 48.7%	33 49.3%	38 48.1%	0.957
Forward jumps	42 53.8%	30 44.8%	33 50.0%	38 50.0%	30 44.8%	38 48.1%	0.881
Single-leg squat	38 48.7%	32 47.8%	29 43.9%	30 39.5%	33 49.3%	39 49.4%	0.800
Jump turns	41 52.6%	34 50.7%	26 39.4%	38 50.0%	35 52.2%	34 43.0%	0.522
Single leg sideways hops	45 57.7%	29 43.3%	34 51.5%	40 52.6%	37 55.2%	38 48.1%	0.581
Flyer	41 52.6%	31 46.3%	30 45.5%	36 47.4%	38 56.7%	41 51.9%	0.753

Table 6. Comparison (one-way ANOVA) of the total score among the diverse types of sports

Sports	N	M	SD	SE	Min	Max	P-value
Basketball	119	7.99	1.695	.155	3	13	0.377
Handball	109	7.63	1.884	.180	2	12	
Soccer	102	8.04	1.990	.197	4	14	
Volleyball	103	7.80	2.093	.206	3	13	

N: number; M: mean; SD: standard deviation; SE: standard error; Min: minimum; Max; maximum

Table 7. Comparison (one-way ANOVA) of the total score among the Countries of the Gulf Cooperation Council (GCC)

Countries	N	M	SD	SE	Min	Max	P-value
Saudi Arabia	78	8.03	2.180	0.247	3	14	0.961
Bahrain	67	7.79	1.855	0.227	3	11	
Kuwait	66	7.73	1.934	0.238	3	12	
Oman	76	7.88	1.840	0.211	2	11	
Qatar	67	7.90	1.751	0.214	5	12	
United Arab Emirates	79	7.85	1.909	0.215	3	12	

N: number; M: mean; SD: standard deviation; SE: standard error; Min: minimum; Max; maximum

Each type of exercise was scored one point when reported by each participant in this study. The mean \pm SD of scores of exercises performed by the basketball players were 7.99 ± 1.69 , the handball players 7.63 ± 1.8 , the soccer players 8.04 ± 1.9 , and the volleyball players 7.8 ± 2.09 . There was no significant difference between the mean scores between the different sports ($P=0.37$), Table 6.

The mean \pm SD of scores of exercises performed by the participants from each country were as follows; Saudi Arabia 8.03 ± 2.18 , Bahrain 7.79 ± 1.8 , Kuwait 7.73 ± 1.9 , Oman 7.88 ± 1.8 , Qatar 7.9 ± 1.7 , and UAE 7.85 ± 1.7 . There was no significant difference in the mean of scores regarding participants from different countries ($P=0.96$), Table 7.

4. Discussion

Our study found that OSTRC Knee Injury Prevention Program was most frequently practiced by basketball players and least by volleyball players. The highest percentages of participants were from UAE and least from Kuwait. The most common exercise performed by participants includes squat, Nordic hamstring, single-leg sideways hop, jumping lunges, and flyer. There was no significant difference between exercise performed athletes in different sports and different countries. This study was conducted on players from the GCC countries who practice different sports, including basketball, handball, soccer, and volleyball. The percentages of participants regarding each sport and each country were similar; however, basketball players and participants from the UAE were the dominant participants in the study. The current study investigated 16 types of prevention exercises; the most performed exercises included squat plus, Nordic

hamstrings, single-leg sideways hop, jumping lunges, and flyer. The remaining exercises were reported by less than half of the participants. However, the single-leg squat was performed more by basketball and volleyball players compared to other players. It seems that all participants from countries performed different prevention exercises. The level of practicing the prevention exercises was also estimated according to the scoring system, where the sport's practice was scored for one point, so the total score for the exercises included will be 16. The mean score of practicing these exercises was evaluated based on different sports and countries. Soccer players showed the highest mean score (8.04), followed by basketball, volleyball, and handball players. However, the results did not show any significant differences among the mean scores of the different sports. This low score reflects the low implementation of such exercises, and soccer players were more prone to perform such exercises; however, this variation between players of different sports was not considerable. Also, the same findings were found regarding the countries in the study; the implementation of prevention exercises was not significantly different among the countries. The highest mean score for implementation of the exercise was recorded for Saudi Arabia, followed by Qatar, Oman, UAE, Bahrain, and Kuwait. However, there was no considerable difference in the mean scores among the countries. It should be stated that no study has evaluated the implementation of the OSTRC knee injury prevention program in other countries. Therefore, it was not possible to compare the results of the current study with similar results.

The current study results demonstrated that the rate of implementation of the OSTRC knee injury prevention program was low among athletes playing different sports.

This finding is important because a low rate of implementation of prevention exercises may place athletes at a greater risk of injuries. Therefore, decreased risk of injuries may be achieved by implementing prevention exercises that enhance athletic performance as well as athletes' lower extremity biomechanics and neuromuscular control. Several studies reported that players with high adherence significantly experienced lower injuries [17-19]. Moreover, the incidence of ACL injury was found to be lower among individuals with good adherence to recent neuromuscular training [20]. ACL injuries were lowered by 88% among players with high adherence compared to players with the lowest adherence [17]. The coach is responsible for the implementation of the prevention programs [21,22]. A previous study revealed that 70% of the coaches in Saudi Arabia follow an injury prevention program. Moreover, the Saudi coach had lower knowledge about injury prevention programs [23]. This may explain the low rate of implementation of the exercise among our participants. Coaches are supposed to have high knowledge about such programs and exercises and encourage players and athletes to follow and perform them, as the team coaches are the key to adopt and use the injury prevention exercise programs [24,25].

5. Conclusions

The implementation of prevention exercises in this study was low regardless of the country of participants and the type of sport. This may lead to knee injuries as the low implementation of such exercises is associated with a higher rate of ACL injuries. This indicates that the players and athletes should be aware of the importance of such exercise; increasing their awareness and knowledge about such exercise is necessary and can be performed through booklets distributed before practicing the sports. Therefore, increasing the athletes' awareness would increase the practice level of these prevention exercises, which might potentially reduce the risk of sustaining lower extremity injuries. Further studies can be done to investigate the knowledge of athletes about the importance and effectiveness of such exercise and investigate the reasons causing this low practice.

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