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REVIEW OF THE MOST COMMON KNEE INJURIES IN BASKETBALL

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Abstract The aim of the study was to determine the incidence and localization of knee pain in female basketball players by applying the newly constructed *Questionnaire on the incidence of knee pain and injuries* which was filled out anonymously, and to determine the basic metric characteristics of the applied questionnaire, as well as the differences based on chronological age and playing position. The sample of participants included 44 active Croatian female basketball players aged 16 to 39 years. The players' mean chronological age was 23.05 ± 5.28 years, their mean body mass was 67.77 ± 7.34 kg, body height was 176.76 ± 6.35 cm, and body mass index (BMI) was 21.65 ± 1.49 $\text{kg} \cdot \text{m}^{-2}$. The *Questionnaire on the incidence of knee pain and injuries* has good metric characteristics, thus it is a quality instrument for measuring the incidence of pain and injuries in basketball players. The reported incidence of knee pain and injuries in basketball players was at medium level, however, 45% of players reported knee pain and injuries. Out of the total sample of participants, 39% players reported previous knee injuries. There were no significant differences between players in different age groups (younger - under 22 years, and older - over 23 years) regarding the level of *incidence of knee pain and injuries* in any of the measured variables. Future studies should include more participants, especially more players at "center" position, and include more variables, possibly related to movements in basketball.

Key words: metric characteristics, pain incidence, female basketball players, differences, playing positions

INTRODUCTION

Basketball is an acyclic, polystructural, unconventional sport in which two teams compete [1]. Teams are composed of 12 players, with 5 of them actively playing on the court. The goal is to win more points than the opponent and the points are won by throwing the ball into the hoop. Basketball has two phases: offense and defense. In the offense, the players try to win a point as simply as possible by throwing the ball into the opponents' hoop while their defense is preventing them with their active movement. There are five basic positions which are denoted numerically (1, 2, 3, 4, 5) or textually, (center, power forward, point guard, shooting guard, small forward). Each position demands players to execute individual or collective tasks and take responsibility in defense or offense. Thus, susceptibility to injuries mostly depends on the players' position and the tasks put before them.

Basketball players are prone to many acute and chronic injuries (overstrain syndrome) of the knee. Concerning the anatomic location of injuries in basketball, lower extremities are exposed to a much greater risk of injury than the upper extremities, as basketball is a sport which includes many jumps and sudden changes of direction during jumps [7]. The majority of injuries occur during the non-contact part of the game, i.e., 62.5% of them [7].

Knee injuries are the second most common injuries in basketball (14% of all injuries), and according to the NCAA study, they are three times more common in female players. The most common injuries are meniscus injury, medial collateral ligament injury, and anterior cruciate ligament injury. The injuries that are characteristic for basketball are anterior cruciate ligament injury and "jumper's knee", which mostly affects the proximal part of the patellar tendon and accounts for 70% of the total injuries of this tendon. Impairments of the anterior cruciate ligaments are the second most common injury. Pain, and consequently arthrosis, often occur in repetitive activities such as running and jumping; therefore, it is not surprising that basketball is "fertile ground" for such injuries [3]. Mesarić [6] determined that the possibility of knee ligament injury is

extremely high due to frequent alterations of acceleration and deceleration, and internal and external rotation of lower leg and pivoting. Jumper's knee occurs during repetitive jumping movements, and the factors that lead to jumper's knee are as follows: unequal leg length, long-term training load, exercising on hard surfaces, and mechanical characteristics of the tendon and the tendon-bone junction zone. Jumper's knee occurs when mechanical load exceeds the adjustability of the tissue [6].

The anterior cruciate ligament is most often susceptible to ruptures, which are then treated by operation or physical therapy. The knee is surrounded by several levels of defense preventing injuries: muscles, knee joint socket with internal ligaments, and menisci. The internal ligaments that stabilize the knee are anterior crucial ligament and posterior crucial ligament [9].

In accordance with all the above, the aim of the study was to determine the incidence and localization of knee pain and injuries in female basketball players by applying the *Questionnaire on the incidence of knee pain and injuries*, to determine the basic metric characteristics of the applied questionnaire, and to determine the differences in the incidence of knee pain and injuries in female basketball players based on chronological age and playing position

METHODS AND MATERIALS

The sample of participants included 44 active Croatian female basketball players from all parts of Croatia, aged 16 to 39 years. Their mean chronological age was 23.05 ± 5.28 years, mean body mass was 67.77 ± 7.34 kg, mean body height was 176.76 ± 6.35 cm, and body mass index (BMI) was 21.65 ± 1.49 kg·m⁻². Most of the players had finished high school (N=18), whereas 23 players had higher or high education.

Table 1. Cumulative frequencies and relative values by *playing position*, on the total sample of participants (N=44)

Variables				
Playing position	F	CF	%	C %
1 – Point guard	12	12	27.27	27.27
2 – Shooting guard	23	35	52.27	79.55
3 – Small forward	2	37	4.55	84.09
4 – Power forward	5	42	11.36	95.45
5 – Center	2	44	4.55	100.00

Legend: **F** - frequency; **CF** - cumulative frequency; **%** - relative, percentage value; **C%** - cumulative relative, percentage value.

It can be seen in Table 1 that the majority of participants, 23 of them (52.27%) play the position of shooting guard (position 2). On the total sample of participants (N=44), the least represented playing positions were small forward (9.1%, N=4) and center (11.36%, N=5).

QUESTIONNAIRE ON THE INCIDENCE OF KNEE PAIN AND INJURIES

The variable sample was collected by an on-line questionnaire on *the incidence of knee pain and injures* [8], which was adapted for basketball for the purposes of this study. The questionnaire consists of a number of closed-ended and open-ended questions, with the possibility of multiple answers. The assessments of the *incidence of pain* included answers on a 5-point Likert scale (1 - never; 2 - very rarely; 3 - rarely; 4 - sometimes; 5 - often), whereas the assessment of the *incidence of injury* included answers on a dichotomous scale with answers 1 (*NO, I have never had a knee injury before*) and 2 (*YES, I have had a knee injury before*). Besides the assessments on the *incidence of knee pain and injuries*, the questionnaire also included several questions on demographic characteristics and targeted elements related to the experience of playing basketball (playing position; the age of specialization for the playing position; weekly hours of basketball training; localization of knee pain; availability of an expert for diagnostics and/or rehabilitation of knee injuries in the club, etc.).

After the research theme had been approved for the conduction of this study, and after obtaining oral consent from club coaches and/or personal consent from basketball players, the players were given the link for a *Google Docs* questionnaire, which they later filled out on their own. Players under the age of 18 were asked to personally inform their parents about the aim and methods of the study, emphasizing that they can participate in the study only after their parents give their consent. After that, each basketball player read the *informed consent* on the link, and after giving her consent proceeded with filling out the anonymous *Questionnaire on the incidence of knee pain and injuries* [8], which was available on the same link.

STATISTICAL ANALYSIS

In the analysis of the collected data, the following *descriptive statistics* was used to determine the characteristics and test the differences: frequency and percentages (when necessary, also cumulative frequency), measures of central tendency and spread (standard deviation; minimum and maximum result), tests for determining the differences between independent groups (t-test or one-way ANOVA).

To determine the basic *metric characteristics* of the questionnaire the following were used: Cronbach's alpha coefficient (to determine reliability), Kolmogorov-Smirnov test of "normality" of result distribution, and measures of asymmetry and peakedness of result distribution (to determine sensitivity). In the final phase of research, a matrix was constructed, and the obtained data were analyzed by the *Statistica Ver. 13.00* computer program.

RESULTS

Descriptive characteristics of the incidence of knee pain and injuries in female basketball players on the total sample of participants (N=44) are presented in Table 2.

Table 2. Descriptive characteristics of the incidence of knee pain and injuries in female basketball players

Variable	AM	SD	MED	MIN	MAX	SKEW	KURT
PAIN_BEFORE_SP_ACT	2.00	1.06	2.00	1	4	0.74	-0.65
PAIN_SPORT_ACT	2.43	1.15	2.00	1	4	0.13	-1.41
PAIN_STOPS	2.43	1.34	2.00	1	5	0.37	-1.35
PAIN_CHANGE_DIRECT	2.45	1.34	2.00	1	5	0.50	-0.95
PAIN_LANDING	2.39	1.22	2.00	1	5	0.48	-0.87
PAIN_SLIDING	2.16	1.26	2.00	1	5	0.86	-0.24
PAIN_BEG_SP_ACT	2.20	1.30	2.00	1	5	0.79	-0.58
PAIN_AFTER_SP_ACT	2.64	1.35	3.00	1	5	0.17	-1.19
PAIN_EXER_CESS	1.80	1.00	1.50	1	5	1.30	1.40
PAIN_NORM_DAILY_ACT	1.89	1.02	2.00	1	4	0.93	-0.22
INJURY_NO-YES	0.39	0.49	0.00	0	1	0.48	-1.85
QUESTIONNAIRE TOTAL	24.93	10.96	24.50	11	45	0.34	-1.05

Cronbach's alpha coefficient: 0.93

Legend: **AM** - arithmetic mean; **SD** - standard deviation; **MED** - median; **MIN** - minimum result; **MAX** - maximum result; **SKEW** - coefficient of asymmetry of result distribution; **KURT** - coefficient of peakedness of result distribution.

Female basketball players mostly reported knee pain during the following activities: *after sports activity* (2.64), *during change of direction* (2.45), *during sudden stops* (2.43), *during sports activity* (2.43), and *during landing* (2.39). Knee pain was least reported for the following: *pain is caused by exercise cessation* (1.80), *during normal daily activities* (1.89), and *before sports activity* (2.00).

Average results of some questions of the questionnaire vary around the value 2 (*very rarely*), but the dispersions at these questions are very high (all above 1.00).

The *frequency of knee injuries* in basketball players is 39%, which indicates that basketball players often injure their knees during their career.

The average result of the total values of the questionnaire is 24.93±10.96, which indicates that, on average, knee pain occurs *very rarely*, and the distribution of the total results of the questionnaire does not deviate from normal distribution. Internal reliability of the questionnaire, i.e., *Cronbach's alpha* is very good (0.93). These findings indicate that the questionnaire has *good* metric characteristics. Furthermore, the frequency of injured players (39%) and very high dispersion on the total results of the questionnaire (10.96) indicate a generally very high prevalence of knee injuries in women's basketball.

All these variables have result distributions which do not deviate much from normal distribution, considering that the indices of asymmetry and peakedness of result distribution do not exceed the cut-off values of ± 2.00. This allows further use of parametric statistical procedures for testing the following hypotheses.

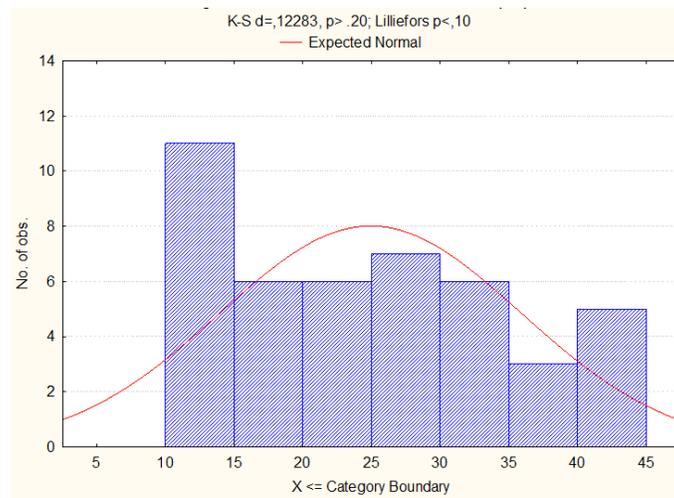


Figure 1. Distribution of the *Questionnaire on the incidence of knee pain and injuries* in female basketball players

The total results of the questionnaire presented in Figure 1 indicate that 25% of basketball players reported *very low* knee pain and injuries (their results range between 10 and 15). However, around 48% players reported a *very high level* of knee pain and injuries (their results equal or exceed 25). This figure points to the necessity of further and detailed research of the incidence of knee pain and injuries in basketball players.

The testing of differences in the *Incidence of pain and injuries* between younger and older basketball players is presented in Table 3.

Table 3. Differences in the *incidence of knee pain* among female basketball players by *chronological age*

VARIABLES	CHRONOLOGICAL AGE OF BASKETBALL PLAYERS				t-test	p
	UNDER 22 YEARS (N=22)		OVER 23 YEARS (N=22)			
	AM	SD	AM	SD		
PAIN_BEFORE_SP_ACT	1.77	0.97	2.23	1.11	-1.44	0.16
PAIN_SPORT_ACT	2.27	1.20	2.59	1.10	-0.92	0.36
PAIN_STOPS	2.36	1.47	2.50	1.22	-0.33	0.74
PAIN_CHANGE_DIRECT	2.32	1.43	2.59	1.26	-0.67	0.51
PAIN_LANDING	2.14	1.25	2.64	1.18	-1.37	0.18
PAIN_SLIDING	2.18	1.33	2.14	1.21	0.12	0.91
PAIN_BEG_SP_ACT	1.86	1.04	2.55	1.47	-1.78	0.08
PAIN_AFTER_SP_ACT	2.45	1.37	2.82	1.33	-0.89	0.38
PAIN_EXER_CESS	1.59	0.91	2.00	1.07	-1.37	0.18
PAIN_NORM_DAILY_ACT	1.82	1.01	1.95	1.05	-0.44	0.66
INJURY_NO-YES	0.36	0.49	0.41	0.50	0.30	0.76
QUESTIONNAIRE_1-5	23.23	10.67	26.64	11.23	-1.03	0.31

Legend: **AM** - arithmetic mean; **SD** - standard deviation; **p** - level of statistical significance; * - statistically significant difference at level $p < 0.05$; ** - statistically significant difference at level $p < 0.01$.

The findings indicate that no statistically significant differences were found in the incidence of pain and injuries between younger and older players as none of the coefficients reach the level of statistical significance of 5%. In general, all the values of the questionnaire are somewhat higher for older players, but the differences between those values do not reach the level of statistical significance. However, there is one variable with the level of significance of 0.08, which can be considered as significant tendency. Namely, knee pain *at the beginning*

of sports activity was reported somewhat higher by older players as compared to younger players. Thus, it can be recommended for older players to undergo a longer and better preparation of the whole body (therefore also the knees) before any sports activity, whether it be training or competitive activity.

The percentages of experienced knee injuries in younger and older players are similar (36% and 41%, respectively). Among younger players, 8 out of 22 players reported injuries, whereas among older players, 9 out of 22 players reported previous injuries. Considering that older players have been training and playing basketball longer, a higher percentage could have been expected, as well as a possible significant difference in the *incidence of knee injuries* "in favor" of older players. The total result of the questionnaire is also somewhat higher for older players, but there is no significant difference ($p=0.31$).

The results of a one-way analysis of variance *by playing position* are presented in Table 4. As the number of participants who play at positions 3, 4, or 5 was very small, they were put in the same group of only 9 participants. Normally, positions 3, 4, or 5 in basketball are played by taller persons with longer extremity leverages, and often with greater body mass as opposed to the players at *guard* positions.

Table 4. Analysis of variance among basketball players at different playing positions (N=44)

VARIABLE	CHRONOLOGICAL AGE OF BASKETBALL PLAYERS						F	P
	POINT GUARD (N=12)		SHOOTING GUARD (N=23)		OTHER POSITIONS (N=9)			
	AM	SD	AM	SD	AM	SD		
PAIN_BEFORE_SP_ACT	1.50	0.90	2.04	1.07	2.56	1.01	2.83	0.07
PAIN_SPORT_ACT	1.92	0.90	2.39	1.20	3.22	0.97	3.78	0.031*
PAIN_STOPS	2.00	1.13	2.17	1.34	3.67	0.87	6.05	0.005**
PAIN_CHANGE_DIRECT	1.75	0.75	2.39	1.44	3.56	1.01	5.80	0.006**
PAIN_LANDING	2.00	0.95	2.22	1.24	3.33	1.12	4.00	0.026*
PAIN_SLIDING	1.67	0.89	2.17	1.19	2.78	1.64	2.12	0.13
PAIN_BEG_SP_ACT	1.58	0.90	2.26	1.29	2.89	1.54	2.85	0.07
PAIN_AFTER_SP_ACT	2.25	1.22	2.52	1.34	3.44	1.33	2.33	0.11
PAIN_EXER_CESS	1.33	0.49	1.91	1.16	2.11	0.93	1.97	0.15
PAIN_NORM_DAILY_ACT	1.50	0.67	2.00	1.09	2.11	1.17	1.24	0.30
INJURY_NO-YES	0.50	0.52	0.39	0.50	0.22	0.44	0.81	0.45
QUESTIONNAIRE_1-5	20.50	8.62	24.65	12.28	31.56	7.06	2.86	0.07

Legend: **AM** - arithmetic mean; **SD** - standard deviation; **F** - coefficient of analysis of variance; **P** - level of statistical significance; * - statistically significant difference at level $p<0.05$; ** - statistically significant difference at level $p<0.01$.

By analysis of variance, significant differences between players at different playing positions were determined in several individual questions and variables of the questionnaire: *pain during sudden stops* ($p=0.005$), *pain during change of direction* ($p=0.006$), *pain during landing* ($p=0.026$), and *pain during sports activity* ($p=0.031$). Two other variables demonstrate a difference tendency and are very close to the cut-off value of statistical significance: *pain before sports activity* ($p=0.07$), and *pain at the beginning of sports activity* ($p=0.07$).

The incidence of *knee injuries* is not statistically significant, and neither is the difference in total results of the questionnaire, but it was very close to the level of statistical significance ($p=0.07$).

In all the variables, the group of players playing at positions 3, 4, and 5 have higher results than the other two groups (point guards and shooting guards).

By applying a *post-hoc* LSD Fisher's test for precise determination of differences, it was determined that the group of players at positions 3, 4, and 5 differs significantly from the two groups of guards, whereas the two groups of guards do not differ from each other.

The frequency of localization of knee pain in female basketball players of different chronological age groups is presented in Table 5.

Table 5. Frequency of *localization of knee pain* in female basketball players

PAIN LOCATION	POINT GUARD (N=12)		SHOOTING GUARD (N=23)		OTHER POSITIONS (N=9)	
	FREQ.	%	FREQ.	%	FREQ.	%
Front/Anterior - below the patella	19	43.18	10	45.45	9	40.91
Front/Anterior - on the patella	5	11.36	3	13.64	2	9.09
Front/Anterior - above the patella	8	18.18	5	22.73	3	13.64
Outside/Lateral side of the knee	9	20.45	3	13.64	6	27.27
Inside/Medial side of the knee	11	25.00	7	31.82	4	18.18
Posterior (back of the knee)	9	20.45	4	18.18	5	22.73

Out of the 44 participants, 37 (84.09%) players reported *localization* of knee pain. Out of these 37 players, 18 (48.65%) players reported only one pain location, and 19 players (86.36%) reported two or more pain locations. Among younger basketball players, 19 (86.36%) out of 22 players reported knee pain, and out of these 19 players, 9 (47.37%) players reported only one pain location, whereas 10 (52.63%) players reported two or more pain locations. Among older basketball players, 18 (81.82%) out of 22 players reported knee pain, and out of these 18 players, 9 (50.00%) players reported only one location of pain, and 9 (50.00%) players reported two or more pain locations.

The most commonly reported localization of knee pain was in the area of the *front/anterior - below the patella* (43.18% of the total number of participants), followed by the *inside/medial side of the knee* (25%), and *outside/lateral side of the knee* and *posterior - back of the knee* (20.45% each).

DISCUSSION AND CONCLUSIONS

The Questionnaire on the incidence of knee pain and injuries has good metric characteristics, thus it is a quality instrument for measuring the incidence of pain and injuries in basketball players.

The reported incidence of knee pain and injuries in basketball players was at *medium level*, however, 45.46% of players, i.e., 20 players, reported knee pain and injuries. Out of the total sample of participants (N=44), 39% of them reported previous *knee injuries*. These findings are confirmed by Gray et al. [4], who stated that the knee is the most common site of injury among female basketball players (72% participants in their study). Furthermore, female basketball players suffer much more knee injuries than male basketball players [2], which can explain the high percentage obtained by applying the *Questionnaire on the incidence of knee pain and injuries* in female basketball players. Female basketball players within the sample differed significantly regarding the measured incidence of knee pain and injuries, and the *Questionnaire on the incidence of knee pain and injuries* in female basketball players has good metric characteristics.

There were no significant differences between players in different age groups (younger - under 22 years, and older - over 23 years) regarding the level of the *incidence of knee pain and injuries* in any of the measured variables.

Significant differences in the level of the incidence of *knee pain and injuries* between players at different playing positions were determined in several variables: pain during sudden stops, pain during change of direction, pain during landing, and pain during sports activity. Moreover, several other variables demonstrated a difference tendency, but did not reach statistical significance in differentiating the groups. It was determined that the group of players playing at positions of *center*, *power forward*, and *small forward* differ from the two groups of *guards* by higher incidence of specific knee pain and injuries. The results obtained by statistical analysis of the incidence of knee pain and injuries according to playing position are confirmed by a previous study [1]. This study determined that the knee injury is the most common injury of lower extremities among guards, but not among centers. Henry et al. [5] confirmed the existence of significant differences in knee injuries according to playing positions among basketball players and claimed that knee and ankle injuries are not only the most common injuries, but also the reason for 84% of unplayed games.

Similar research should be repeated on a larger number of participants, especially more players at "center" position, the study should include more variables, possibly related to movements in basketball and possibly related to the incidence of knee pain and injuries (e.g., *body mass*, *body height*, and *body mass index*).

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