REVIEW

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Prevalence of Back Pain in Elite Athletes

Prävalenz von Rückenschmerzen bei Elitesportlern

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Summary

› **Objectives:** The primary objectives of this investigation were to provide an overview of data about back pain prevalence in athletes, to analyse the prevalence in the German elite athletic population, and to compare it with physically-active individuals.
› **Methods:** 1. A comprehensive analysis of the literature was undertaken, using specifically developed search strategies for relevant epidemiological research on back pain. 2. An online back pain questionnaire was sent to approximately 4,000 German elite athletes and a control group of 253 physically-active individuals.
› **Results:** Lifetime and point prevalence were the most commonly researched episodes and the lower back was the most common location of pain. Lifetime prevalence of low back pain in athletes was 1-94%, and point prevalence was 18-65%. In German elite athletes, prevalence rates were 77% and 34%, respectively, and were slightly higher in athletes than in active controls (71% and 29%, respectively) and the general population (11-84% and 7-33%, respectively). Prevalence of back pain varied between athletes of different disciplines.
› **Conclusion:** Back pain is a common complaint in athletes and in the general population. A high training volume in athletes and a low training volume in the general population might increase prevalence rates. Our findings indicate the necessity for specific prevention programs, especially in high-risk sports. Further research should investigate the optimal dose-effect relationship of sporting activity to prevent back pain.

KEY WORDS:
Back Pain, Neck Pain, Spine, Prevalence, Elite Sport, Athletes

Zusammenfassung

› **Ziele:** Hauptziel dieser Untersuchung war es, eine Übersicht zur Rückenschmerzprävalenz von Sportler*innen zu erstellen, die Prävalenz in der deutschen Leistungssportelite zu analysieren und diese mit körperlich aktiven Personen zu vergleichen.
› **Methodik:** 1. Es wurde eine umfassende Literaturanalyse mit speziell entwickelten Suchstrategien für relevante epidemiologische Rückenschmerzforschung durchgeführt. 2. Ein Online-Rückenschmerzfragebogen wurde an ca. 4000 deutsche Leistungssportler*innen und eine Kontrollgruppe von 253 körperlich aktiven Personen verschickt.
› **Ergebnisse:** In der internationalen Literatur waren Lebenszeit- und Punktprävalenz die am häufigsten untersuchten Episoden und der untere Rücken war die häufigste Lokalisation für Schmerzen. Die Lebenszeitprävalenz von Rückenschmerzen bei Sportler*innen betrug 1-94% und die Punktprävalenz betrug 18-65%. Bei deutschen Spitzensportler*innen lagen die Prävalenzen bei 77% bzw. 34% und waren höher im Vergleich zur aktiven Kontrollgruppe (71% bzw. 29%) und der Allgemeinbevölkerung (11-84% und 7-33%). Die Prävalenz von Rückenschmerzen variierte zwischen Sportler*innen verschiedener Disziplinen.
› **Schlussfolgerung:** Rückenschmerzen sind ein häufiges gesundheitliches Problem bei Sportler*innen und in der Allgemeinbevölkerung. Ein hohes Trainingsvolumen bei Sportler*innen und ein niedriges Trainingsvolumen in der Allgemeinbevölkerung könnten die Prävalenzraten erhöhen. Die vorliegenden Ergebnisse weisen auf die Notwendigkeit spezifischer Präventionsprogramme hin, insbesondere in risikoreichen Sportarten. Weitere Forschung sollte die optimale Dosis-Wirkungs-Beziehung sportlicher Aktivität untersuchen, um Rückenschmerzen zu verhindern.

SCHLÜSSELWÖRTER:
Rückenschmerzen, Nackenschmerzen, Wirbelsäule, Prävalenz, Leistungssport, AthletInnen

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Introduction

Back pain (BP) represents a large socioeconomic burden for both patients and the general society (18). In the Global Burden of Disease Study, pain in the lower back was ranked highest in terms of years lived with disability in Europe (2).

The epidemiology of BP, and especially low back pain (LBP), has been well-researched in the general population as well as in specific subpopulations such as office workers, industrial workers and school children. Various studies have suggested that risk factors such as high spinal load due to occupational exposure, strenuous workloads, and frequent lifting, bending and twisting might be responsible for BP and related injury (7, 22). Simultaneously, an inactive or sedentary lifestyle has been associated with BP complaints. Thus, the relation

Table 1

Prevalence data of back pain in athletes (5, 20), physically actives (5), and the general population (10, 23). [a]=in disciplines with minimum sample size N=15, [b]=concerning back pain during the last 3 months, sd=standard deviation, BP=back pain, NP=neck pain, UBP=upper back pain, LBP=low back pain.

		SYSTEMATIC REVIEW (20)	ATHLETES SURVEY (5)		SYSTEMATIC REVIEWS (10, 23)
		ATHLETES	GERMAN ELITE ATHLETES	PHYSICALLY ACTIVE CONTROLS	GENERAL POPULATION
		% (range)	% (range[a])	%	% (range)
Lifetime prevalence	BP	(47-90)	89 (56-100)	81	-
	NP	(3-22)	63 (36-83)	50	-
	UBP	(6-17)	46 (0-65)	39	-
	LBP	(1-94)	77 (33-96)	71	39 (11-84)
12-month prevalence	BP	-	81 (44-96)	70	-
	NP	21	52 (27-79)	39	-
	UBP	20	36 (14-63)	27	-
	LBP	(24-66)	65 (31-86)	58	38 (10-65)
3-month prevalence	BP	26	68 (33-87)	59	-
	NP	-	37 (25-56)	30	-
	UBP	-	27 (0-58)	22	-
	LBP	54	50 (27-78)	46	-
7-day prevalence	BP	-	49 (28-74)	43	-
	NP	4	23 (6-43)	22	-
	UBP	6	16 (0-47)	15	-
	LBP	(18-65)	34 (19-57)	29	18 (7-33)
worst pain intensity[b] (mean±sd)	BP	-	3.8±2.9	3.0±2.5	-
average pain intensity[b] (mean±sd)	BP	-	2.4±2.1	1.8±1.8	-

ship between activity level and BP can be visualized using a U-shaped curve (3, 8). Insufficient and excessive activity have been found to negatively impact spinal health (15, 22), although the relationship between sports and spinal health has not been adequately clarified.

Athletes engage in a higher level of physical activity, which might increase their risk of developing BP. The high volume of time spent with training and competing represents a great deal of mechanical strain, and thus, a high level of stress on the musculoskeletal system. Thus, BP is a relevant topic for sports medicine professionals as well as for athletes, coaches, and physiotherapists. We are particularly interested in whether sports in general, as well as specific sports, are associated with a higher or lower prevalence of BP, and how training and competition intensities affect BP prevalence. We are also interested in the risk of BP in adult German elite athletes. This information could assist in the identification of possible risk factors as well as the development of prevention strategies in athletes who are at high-risk for developing BP.

To address these topics, we aimed to provide a summary review of two studies on BP in athletes (5, 20):

1. a systematic review of the literature (20) that summarized BP prevalence rates in athletes during different time periods and in different spinal areas, and that examined different risk factors that might be responsible for the development of BP in athletes.
2. a survey (5) that examined the prevalence of BP in different spinal locations in adult elite athletes on the highest German competition level from different Olympic disciplines.

Material and Methods

In a first step, a comprehensive search of articles published through May 2015 was conducted. Two independent reviewers used specifically developed search strategies to search six databases (PubMed, Embase, MEDLINE, Cochrane Library, PsycINFO and PSYNDEX) for relevant epidemiological research on BP in athletes from Olympic disciplines. The reviewers independently evaluated the methodological quality of reviewed articles that met specific inclusion criteria to identify potential sources of bias. Relevant data were extracted from each study. The methods in more detail can be read elsewhere (20).

In a second step, the prevalence of BP in a large cohort of adult German elite athletes and a control group containing non-professional physically active individuals was examined. A standardized and validated online BP questionnaire was sent by the German Olympic Sports Confederation to approximately 4,000 German elite athletes (all A, B, C and D squad athletes), and a control group of 253 physically active but non-elite sports students. The questionnaire was based on the Nordic Questionnaire (13) and a questionnaire devised by von Korff et al. (11, 12). In addition to the standard questions, questions on symptoms related to sports activity were developed and thoroughly pilot tested. More details can be read elsewhere (5).

Results

In the systematic review (20) 43 studies were ultimately included in the qualitative synthesis. All studies were published between 1979 and 2015 and employed various ›

modes of data collection, including questionnaires, interviews, examinations, and medical reports. The final sample size of Olympic disciplines ranged from seven to 361. Recall periods varied from present to lifetime and described a full array of prevalence data. Most studies (22 studies) reported lifetime prevalence. Prevalence data for 26 different Olympic disciplines were extracted. The most frequently investigated disciplines were soccer, gymnastics, rowing, and field hockey, with nine, eight, seven, and six publications, respectively.

There was no consensus among the studies regarding the definition of BP, LBP, thoracic pain, or neck/cervical pain. The pain differed with respect to localization, intensity, frequency, and duration. Pain was defined in 29 of the 43 studies. Studies that used the term 'BP' either failed to identify which part of the back was involved, used it as a synonym for 'LBP', or were referring to pain in the thoracolumbar spine. The BP prevalence ranges of summarized studies can be seen for different spinal locations and time periods in Table 1.

The final sample of the survey (5) consisted of 1114 elite athletes from 42 Olympic disciplines (20.9±4.8 years, 176.5±11.5cm, 71.0±14.5kg, 18.2±7.7 weekly training hours) and 166 non-elite physical active controls (21.2±2.0 years, 180.0±8.9cm, 74.0±10.3kg, 10.8±5.0 weekly training hours).

In elite athletes, the lifetime prevalence of BP was 89%, 12-month prevalence was 81%, 3-month prevalence was 68%, and point prevalence was 49%. The lifetime prevalence was significantly lower in the physically active control group (81%, p=0.005), as was the case for the 12-month (70%, p=0.001) and 3-month (59%, p=0.018) prevalences. No significant difference was found in the point prevalence between groups (43% in the control group).

The lumbar area was the region that was most commonly affected for all time periods in the elite athletes and physically active controls (lifetime prevalence was 77% and 71%, 12-month prevalence 65% and 59%, 3-month prevalence 50% and 46%, and point prevalence 34% and 29%, respectively). The next commonly affected area was the neck, followed by the upper back.

BP prevalence in sports disciplines with a minimum sample size of n=15 was compared with the control group. The lifetime prevalence of BP ranged from 56% (triathlon) to 100% (diving, fencing, water polo), 12-month prevalence from 44% (triathlon) to 96% (fencing), 3-month prevalence from 38% (triathlon) to 90% (taekwondo), and point prevalence from 28% (volleyball) to 74% (water polo). Odds ratios were calculated for all time periods. The odds ratio for BP among elite triathletes was lower than that in physically active controls. Additionally, the odds ratios for BP were significantly higher in elite athletes who participated in rowing, dancing, fencing, gymnastics, underwater rugby, water polo, shooting, basketball, hockey, track and field athletics, ice hockey, and figure skating during specific time periods. Detailed results can be seen elsewhere (5).

Regarding training volume there was a significant positive correlation between BP prevalence and weekly training volume for the lifetime, 12-month and 3-month time periods for elite athletes ($p<0.05$). No correlations were found for the active control group.

Table 1 gives an overview of BP prevalence rates in elite athletes, physically active people and the general population. The BP and LBP prevalences of athletes of different disciplines are shown in Table 2.

Discussion

In conducting the analysis of the literature and the survey on BP in German elite athletes, we sought to 1) precisely determine the prevalence of BP in individuals who participate in different sports, 2) compare the prevalence of BP in different types of athletes, and 3) compare these rates with those in the general "non-sporting" population.

The comparison with the general population represents the first evidence that some sports carry a higher risk for BP. However, as many previous studies suggest, a sedentary lifestyle can also increase BP prevalence (3, 8). The optimal dose-effect relationship between sports and BP remains unclear and needs to be examined in further research. Additionally, the influence of factors that have not yet been investigated, such as psychosocial factors (e.g. occupational stress, pain catastrophizing, fear-avoidance beliefs, depressive mood, and recovery and stress), require further examination. The results represent foundation for the future development of sport-specific BP prevention strategies. With this aim, it will be additionally important to understand exactly what type of strain in different sports involves the spine, and whether this strain is detrimental or beneficial. In general, when comparing the prevalence of BP in different sports, it is also important to consider sport-specific characteristics that might influence prevalence rates. These characteristics relate to differences in the contents of training and competition routines, body anthropometrics, and the age of peak competitive performance. Future research should precisely focus on the differences in sports disciplines and their specific risk factors using identical tools for data collection. This could lead to the development of special prevention strategies for BP. Additionally, athletes, coaches, physicians, and physiotherapists should be educated about BP in athletes and seek to integrate prevention programs in daily training (5, 20).

Risk Factors for Back Pain in Sports

In general, studies focusing on BP in sports have suggested that factors such as high training volume, repetitive motions, high physical loads, repetitive mechanical strain and extreme body positions might be responsible for increased prevalence rates of BP (4, 6, 9).

These risk factors might have also influenced the prevalence rates in the two summarized studies. For example, rowers, field hockey and ice hockey players often train and compete with their torsos in a hyperflexed position. Additionally, they are exposed to high loads due to contact with opponents. In basketball players, these issues, along with a high frequency of jumps and landings, may lead to BP. Similarly, dancers, gymnasts and figure skaters often carry high physical loads due to extreme body positions, landings after jumps and the high frequency of end-range lumbar spine positions (1). For some sports disciplines, similar risk factors did not lead to a significant difference in BP prevalence between athletes and controls (5). The preventive factors in such sports may outweigh the risk factors for BP. However, the sample sizes for nearly all investigated disciplines were small; therefore, low power may have affected statistical significance (5).

Regarding the training volume in German elite athletes, a significant correlation between BP prevalence and the number of weekly hours of training was found. Such a correlation was not found in the physically active control group: both, high and low amounts of exercise appeared to predispose respondents

to BP in this group. Control group respondents with a weekly training volume of less than 3 hours had a lifetime prevalence that was similar to that of elite athletes with high training volumes. As the prevalence of BP varied enormously between different disciplines with similar training volumes, we judge that the intensity, the content of training, and the physical and psychological constitution of an athlete are likely to be highly influential. These factors represent important directions for future research. We propose that different sports disciplines can positively influence health and assist in preventing BP, when respective training programs are implemented in a moderate way (5, 20).

Sport-Specific Prevalence of Back Pain

Regarding the two summarized studies, wide variability was found in the prevalence rates reported by athletes from different disciplines. The authors of the systematic review discussed the methodological heterogeneity of summarized studies to be partly responsible (20). However, the comparison of different studies in the systematic review and in German elite athletes also shows wide variability within the disciplines. For example, the prevalence of LBP in swimmers and gymnasts were 2% and 10% in the systematic review (20), and 73% and 91% in the German elite.

The results of the survey must also be interpreted with caution, as the sample sizes for some disciplines were very small. For some sports disciplines, however, nearly all of the squad athletes participated, so the sample size was close to the size of the total population of German elite squad members in these disciplines (5).

Compared to controls, significantly higher rates of BP were found in those who participated in elite rowing, dancing, fencing, gymnastics, underwater rugby, water polo, shooting, basketball, hockey, track and field athletics, ice hockey and figure skating. Only elite triathletes exhibited a significantly lower prevalence of BP compared with controls. The previously reported prevalence of BP in athletes from specific disciplines has varied widely, likely due to the methodological heterogeneity of studies (20). Nevertheless, the low prevalence of BP observed in elite triathletes reflects the findings of previous investigators. Villavicencio et al. (21) reported a lifetime incidence for LBP of 69% in triathletes, while Manninen and Kallinen (14) reported a lifetime prevalence of 59%, a 12-month prevalence of 32%, and a point prevalence of 12%. It has been proposed that running and swimming are not the primary cause of BP in triathletes.

Specifically, Triki et al. (19) suggested that swimming might prevent BP while cycling may provoke the condition (14). It is most likely that the variation in training disciplines in triathlon decrease the risk of BP, but this hypothesis will require further research. Consistent with previous findings (9, 16, 17), our investigation revealed that rowing is associated with a very high prevalence of BP, suggesting that high training volume, high loads during resistance training, highly repetitive movements including lumbar hyperflexion can have a negative influence. In this context, Howell (9) reported a strong relationship between excessive lumbar flexion and the incidence of LBP or discomfort in a group of elite lightweight female rowers, and suggested that mechanical stress on non-contractile tissue sufficient to stimulate musculoskeletal pain receptors in the low back could result from intermittent or continuous hyperflexion of the lumbar spine (5, 20).

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Förderung

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Table 2

Prevalence of back pain and low back pain in the survey of German elite athletes (5) and the systematic review (20). LT-P=lifetime prevalence, 12m-P=12-month prevalence, 7day-P=point prevalence.

			BACK PAIN			LOW BACK PAIN					
	SURVEY	REVIEW	LT-P [%]	12-M-P [%]	7-DAY-P [%]	LT-P [%]		12-M-P [%]		7-DAY-P [%]	
	N	N (RANGE)	SURVEY			SURVEY	REVIEW (RANGE)	SURVEY	REVIEW (RANGE)	SURVEY	REVIEW (RANGE)
All athletes	1114	(7-361)	89	81	49	77	(1-94)	65	(24-66)	34	(18-65)
Archery	7		86	86	86	71		57		57	
Badminton	10		80	80	70	80		80		50	
Basketball	21	(100-150)	91	91	67	91	(46-53)	86	18 - 21	43	35
Beachvolleyball	10		90	80	60	70		60		40	
Bobsleigh	7		100	100	57	100		86		43	
Boxing	7		71	57	57	57		43		43	
Canoe	33		94	85	55	79		55		21	
Curling	12		92	92	42	75		67		17	
Cycling	29	109	86	83	55	83	65	72	58	41	
Dancing	22	31	96	91	59	96	3	78		41	
Diving	10		100	80	40	70		40		20	
Fencing	23		100	96	35	87		78		35	
Figure skating	15		93	80	67	80		73		53	
Golf	1		100	100	0	100		100		0	
Gymnastics	32	21	94	88	47	91	10	84		41	
Handball	31	190	84	84	36	81	63	74	59	26	26
Hockey	116	(61-90)	86	83	45	76		65	(33-67)	29	
Horse riding	8		88	88	75	88		63		63	
Ice hockey	27		89	85	63	82		82		41	
Judo	34		91	79	56	82		71		38	
Karate	28		79	71	36	61		39		25	
Luge	9		100	100	67	89		56		33	
Modern pentathlon	2		100	100	100	100		100		50	
Orienteering		227					57		50		19
Rowing	83	(23-235)	96	95	68	87	(63-94)	82	(26-55)	48	(25-65)
Rugby	30	327	83	73	30	67	29	47		23	
Sailing	6		83	83	0	83		67		0	
Shooting	23		96	87	70	83		78		57	
Skiing	49	(34-257)	88	74	45	74	(44-65)	65	63	31	24
Soccer	2	(23-361)	100	100	50	50	(1-61)	0	(24-64)	0	(24-32)
Speed skating	33	(37-75)	94	84	52	82		70	(54-66)	39	
Swimming	45	84	89	73	38	73	2	53		29	
Synchronised swimming	3		67	67	33	33		33		33	
Table tennis	1		0	0	0	0		0		0	
Taekwondo	10		90	90	70	90		80		50	
Tennis	14	35	86	79	43	57	3	57		36	
Track and field	99	116	87	84	44	73	2	67		30	
Triathlon	16		56	44	31	44		31		31	
Underwater rugby	29		90	90	59	72		59		28	
Volleyball	36	(24-205)	92	69	28	86	(8-63)	61		19	(22-34)
Waterpolo	19		100	90	74	79		63		42	
Weightlifting	35		83	71	43	80		63		37	
Wrestling	18	61	78	67	50	61	3	50		39	

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