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Comparison of the Occurrence of Musculoskeletal Pain in Professional and Amateur Golfers

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Abstract

This research aimed to determine and compare the annual prevalence of musculoskeletal problems (MSKP), such as aches, pains, discomfort, and numbness, for professional (PRO) golfers and amateur (AM) golfers. In total, 144 golfers participated in our research: 45 PRO golfers from 18 countries and 99 AM golfers. The primary research method was a non-standardized online questionnaire. The part of the questionnaire focused on the occurrence of musculoskeletal pain in golfers contained questions from the standardized Örebro Musculoskeletal Pain Questionnaire (ÖMPQ). We collected responses from late July 2024 to mid-September 2024. A chi-square test of homogeneity showed that there was a significant difference in the annual prevalence of MSKP between PRO golfers and AM golfers in the shoulder (PRO=40.00%, AM =20.20%, RR=2.63 (95% CI:1.22—5.70)), wrist/hand (PRO=44.44%, AM=23.23%, RR=2.64 (95% CI:1.25—5.60)), hips/thighs (PRO=40.40%, AM=18.18%, RR = 2.56 (95 % CI:1.17—5.59)), and neck (PRO=40,00%, AM=18.18%, RR=3.00 (95% CI:1.37—6.58). Significant associations were found between MSKP and training load, competitive frequency, breaks from golf, age, and gender. Professional golfers reported higher prevalence of MSKP than amateurs, except for the elbows, where amateurs were more affected. Understanding these differences highlights the impact of training load and demographic factors on injury risk, which can inform coaches and medical staff in optimizing training programs and reducing pain occurrence.

Keywords: *golf, musculoskeletal system, Örebro Musculoskeletal Pain Questionnaire, pain*

Introduction

In addition to many health benefits, playing any sport carries a certain risk of injury. Despite this risk, people should exercise (Novotný, 2023). The more we minimize the risk of injury, the healthier the sport becomes and the longer one can do it. This principle also applies to golf. Although people of any age can start playing golf, it is a sport that requires a precise technique and a high degree of skill. The golf swing loads the body asymmetrically. With our research, we want to contribute to an understanding of the problem of MSKP in golfers. We understand that pain can have many causes and that an injury is more serious than just experiencing pain. Given this, we expected the incidence of pain to be greater than the incidence of injury in golfers. The most significant physical benefit from golf can be obtained by players who walk and push their clubs on a trolley. During 18 holes, the players cover an average distance of 10.33 km with an average heart rate of 115 beats per minute and burn 1419 kcal (Kunčická, 2012).

The key to a golf swing movement is the coordination of trunk rotation and arm swing. During golf swings, the spine is exposed to significant axial rotation, compression, anteroposterior shear, and lateral bending. The compression forces can reach up to eight times the body weight. These forces can result in muscle strains, damage to spine discs, spondylolysis, and facet joint arthropathy. A sufficient warm-up and proper swing technique or a program to improve the lower part of the spine are ways to prevent these injuries (Hosea & Gatt, 1996). This combination of movements is unhealthy for the body when repeated frequently; therefore, injuries occur. The most common golfer injuries are lumbar spine pain, golfer's elbow, and tendinopathy (inflammation of the tendons) of the wrist (Novotný, 2023). A traumatic event or overuse can cause the injury. According to Wiliamson et al. (2024), more

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injuries in golf are happening because of excessive wear and tear (41.0%) and less because of a traumatic event during the swing (31.5%). Thomas and Wilk (2023) state similarly that more injuries in golf come from overuse (52.6%), and only a small percentage of injuries happen in a single traumatic event (17.4%). The annual prevalence of injuries is 15.8–40.9% for AM golfers and 31% for PRO golfers. Injuries to golfers most commonly occur in the lower back and wrists. Wiliamson et al. (2024) found in a systematic review and meta-analysis of the epidemiology of musculoskeletal injury in PRO and AM golfers that the lifetime injury prevalence is 56.6% for AM golfers and 73.5% for PRO golfers. PRO golfers are three times more likely than AM golfers to injure their lower back (PRO=40.9%, AM=16.2%) and hand & wrist (PRO=51.5%, AM=13.2%). AM golfers suffer the most from the lifetime injury prevalence of elbow & forearm (Wiliamson et al., 2024). Interestingly, PRO golfers have the highest incidence of lumbar discs injuries of any sports professional (Watkins, 2002). The average PRO golfer hit over 2,000 shots during a competition week (Bishop et al., 2022). Enduring these forces is the most significant benefit of regular S&C training for golfers. Golfers must learn to control the power and energy they generate (Williams, 2017). Unfortunately, according to Bishop et al. (2022), no study has shown that improving movement skills has reduced the risk of injury in golf.

According to Thomas and Wilk (2023), studies have yet to be conducted to address the effectiveness of a golf-specific program in reducing injury risk by improving strength and mobility and optimizing performance. Such injury prevention programs have been successful in other sports, which is why Thomas and Wilk (2023) compiled three exercise programs for golfers. The Fore, Fore +, and Andvaced Fore + programs differ in difficulty and are freely available. Golfers can train individually based on their current performance. Currently, the effectiveness of the Golf Related Injury Prevention Program (GRIPP) for the prevention of injuries compared to classical warm-up is also being investigated (Gladdines et al., 2022).

From research, but also from the conditions we observe on golf courses, we know that the approach to golf as a sporting activity could be more responsible and vary depending on the individual. As Coughlan and Tilley (2023) state, at the recreational level, less than 30% of golfers do a targeted warm-up, and most golf courses do not have a gym. Fitness training does not have a strong tradition in either PRO or AM golf. However, the fact that fitness training has an understanding not only for health, but also for golf performance, is currently spreading thanks to PRO golfers, for whom fitness training is an essential part of the training process. Michal and Bolčíková (2024), in a study where they dealt with the comparison of strength and fitness training of professional and amateur golfers, found that in the group of PRO golfers, unlike AM golfers, there is a statistically significant difference in how much time they devote to fitness training on average per week in the competitive and non-competitive periods. A more detailed comparison of PRO and AM golfers based on the responses collected to the questionnaire of this research is presented in the results section of this article.

The goal of our research was to verify the significance of differences in the occurrence of musculoskeletal problems (MSKP), such as aches, pains, discomfort, and numbness, in professional (PRO) golfers and amateur (AM) golfers' annual prevalence.

Material and methods

Participants

Our research file was compiled based on availability. The questionnaire was anonymous, and we divided the participants into two groups: AM golfers and PRO golfers (tab. 1, tab. 2). We sent out a link to our questionnaire to female players of LETAS (the second-highest European women's professional tour), members of PGA SK (the Slovak association of professional golfers, pro-

Table 1. Characteristics of the research set

GENDER	AM	PRO
female	31	30
standardized residual (ri)	-1.7	2.5
male	68	15
standardized residual	1.4	-2.1
overall	99	45
$\bar{x}$ AGE [years]	AM	PRO
females	35.81 ± 16.12	26.53 ± 5.16
males	43.00 ± 14.86	35.13 ± 16.08
overall	40.75 ± 15.55	29.40 ± 10.80
$\bar{x}$ BODY MASS [kg]	AM	PRO
females	65.61 ± 10.20	65.77 ± 9.19
males	87.88 ± 16.80	85.80 ± 17.28
$\bar{x}$ BODY HEIGHT [cm]	AM	PRO
females	169.61 ± 8.04	168.87 ± 7.07
males	181.09 ± 7.04	179.07 ± 10.09
$\bar{x}$ BMI [kg/m^2]	AM	PRO
females	22.77 ± 2.92	23.04 ± 2.58
males	26.70 ± 4.28	26.77 ± 5.41
overall	25.47 ± 4.30	24.28 ± 4.16

fessional golf coaches and golf teachers), members of SKGA (the Slovak Golf Association) and ČGF (the Czech Golf Federation).

In total, 144 golfers completed our questionnaire: 45 PRO golfers and 99 AM golfers from 18 countries (Slovakia, Czech Republic, France, Italy, England, Slovenia, USA, Spain, Austria, Switzerland, Scotland, Morocco, Norway, Iceland, Singapore, Sweden, Malaysia, and the Netherlands). The age of our AM golf respondents was statistically different from our PRO golf respondents ($p<0.001$). By chi-square test, we found that there was a statistically significant association between golf status (AM/PRO) and the gender of respondents. Our PRO responders were more represented by women, and our AM responders were represented more by men (table 1). Using a chi-square test, we found that the number of competitive rounds per season strongly depends on the golfer's AM/PRO status ($p<0.001$, phi=0.547).

Table 2. Golf characteristics

[interval]	**HOW MANY YEARS HAVE YOU BEEN PLAYING GOLF?**	
	AM	**PRO**
3 years and less	11.1 %	0.0 %
4 – 7 years	20.2 %	6.7 %
8 – 11 years	14.1 %	6.7 %
12 – 15 years	29.3 %	20.0 %
16 – 19 years	15.2 %	24.4 %
20 – 23 years	6.1 %	28.9 %
24 years and more	4.0 %	13.3 %
[interval]	**COMPETITION ROUNDS PER ONE SEASON (1 competitive round = 18 holes in a tournament)**	
	AM	**PRO**
3 and less rounds	9.9 %	0.0 %
4 – 10 rounds	24.8 %	2.1 %
11 – 20 rounds	13.5 %	3.5 %
21 – 33 rounds	9.2 %	5.7 %
34 – 49 rounds	4.3 %	6.4 %
50 – 68 rounds	4.3 %	8.5 %
69 and more rounds	2.1 %	5.7 %
[interval]	**WHAT IS YOUR LONGEST BREAK FROM GOLF IN 12 MONTHS?**	
	AM	**PRO**
1 day max.	0.7 %	0.0 %
1 week max.	0.7 %	0.0 %
2 x 1 week	6.3 %	7.6 %
3 x 1 week	7.6 %	3.5 %
2 weeks	1.4 %	4.2 %
3 weeks	7.6 %	2.1 %
1 month	3.5 %	5.6 %
2 x 1 month	10.4 %	6.3 %
3 x 1 month	0.7 %	0.0 %
2 – 3 moths	16.7 %	1.4 %
4 – 6 moths	13.2 %	0.7 %
	HAND DOMINANCE, IN GENERAL	
	RIGHT-HANDED	**LEFT-HANDED**
AM	93.88%	6.12%
PRO	95.56%	4.44%
	HAND DOMINANCE IN GOLF	
	RIGHT-HANDED (hitting a ball from right to left)	**LEFT-HANDED (hitting a ball from left to right)**
AM	84.85 %	15.15 %
PRO	91.11 %	8.89 %

Our AM golfers have been playing golf statistically fewer years than PRO respondents ($p<0.001$) (table 2). We found that the time spent on general as well as golf specific warm-ups before playing golf was strongly related ($V>0.5$) to golf status ($p<0.001$). The average amount of time spent on S&C training per week during the competition period was not statistically significantly different between AM and PRO responders ($p>0.001$). On the other hand, the average amount of time spent on S&C training per week during the non-competition period was statistically significantly different between AM and PRO responders ($p<0.001$) (table 3).

Procedure

The primary research method for obtaining information was an online Google Forms non-standardized questionnaire with two versions, one in two language mutations (for AM golfers and PRO golfers in Slovak and English). The questionnaire consisted of 43 questions divided into four sections. Respondents had the option of choosing answers and free answers. The questionnaire section focused on golfers' MSKP included partially modified questions from the standardized questionnaire focused on the incidence of musculoskeletal pain Örebro Musculoskeletal Pain Questionnaire (ÖMPQ) (Linton, 1999). The questions were aimed at collecting data on the localization of MSKP in golfers, identification of the occurrence of acute and chronic MSKP (occurrence was monitored for the last week and the last year), and limitations caused by MSKP in normal work and in playing golf. We also found out in which part of the season and during which activity MSKP started, how often MSKP recurred, and how intense they were. Golfers also answered whether they had undergone musculoskeletal surgery during their sports career and what type of surgery it was. At the end of the questionnaire, we asked golfers what activities they did to prevent MSKP and how they coped with MSKP when they had already occurred. Our modified questions were focused on the golf volume, preparation before playing golf and S&C training volume. Considering the nature of the work, we created and added our questions. Respondents had to complete the questionnaire from the end of July 2024 to the middle of September 2024.

Statistical analysis

We evaluated the data using descriptive statistics. We calculated the nominal data's average values and standard deviations, which characterize our research files. We used an independent samples t-test to determine whether our AM respondents were statistically different in age from our PRO respondents. For questions in which respondents could choose an option in interval format, we evaluated the percentage representation of each interval and presented it in tables. Descriptive statistics were used to represent the percentage of MPSK occurrence in each body part in the AM and PRO groups. We identified the standard error and the lower and upper bounds for the 95% confidence interval. We evaluated the statistical differences in all body parts between PRO golfers and AM golfers with inferential statistics. We verified our hypotheses with the chi-square homogeneity test at the statistical significance level $\alpha=0.05$. We calculate the risk ratio and 95% confidence interval. We used a Chi-square test of independence to determine whether there was a statistically significant association between the various characteristics we collected. We then examined the relationship of MSKP of individual body parts with the duration of golf playing, number of competitive rounds per year, volume of general warm-up, volume of specific warm-up, duration of break from golf during the year, volume of S&C training during the competitive season, as well as S&C training during the non-competitive season, and by gender. All calculations were performed in the IBM SPSS software program.

Results

Among the AM golfers we studied, the three most frequent body parts affected by annual prevalence of MSKP were the lower back (47.47%, stderr =0.050 (95% CI: 38%—59%)), upper back (26.26%, stderr =0.044 (95% CI:17 %—35%)), and knees (25.25%, stderr =0.44 (95% CI:17%—35%)) (fig. 1). From the point of view of the lateral dominance of the occurrence of MSKP, we noted that AM golfers were more susceptible to the right shoulder, left elbow, right hand/wrist, left knee, and left ankle/foot.

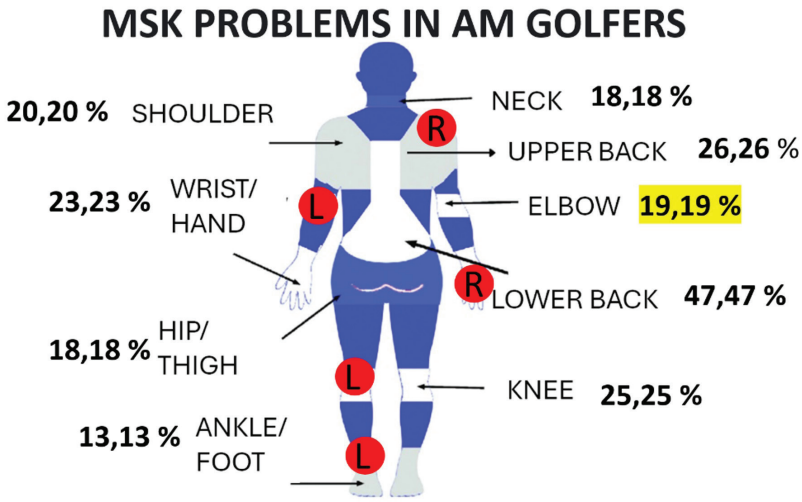

FIGURE 1. Musculoskeletal problems in AM golfers

In PRO golfers, we recorded the most frequent annual prevalence of MSKP in the lower back (57.78%, stderr =0.075 (95% CI:40%—71%)), wrists/palms (44.44%, stderr =0.075 (95% CI:29%—60%)), shoulders (40.00%, stderr =0.075 (95% CI:25%—55%)), hips/thighs (40.00%, stderr =0.073 (95% CI:23%—53%)), and neck (40.00%, stderr =0.074 (95% CI:

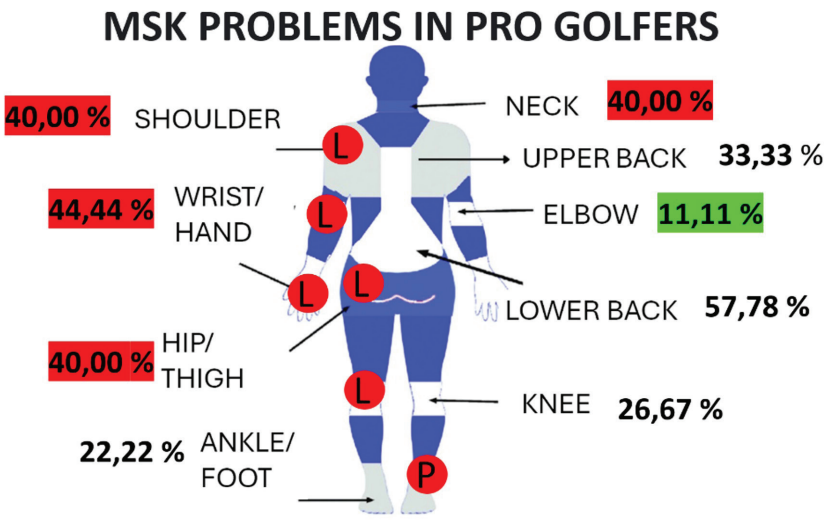

FIGURE 2. Musculoskeletal problems in PRO golfers

25%—55%)). In PRO golfers, the occurrence of MSKP in all body parts was on the left side, except the ankle/foot, where the right side predominated (fig. 2).

The only area of the body where AM golfers had a higher annual prevalence of MSKP than PRO golfers was the elbows (AM: 19.19%, stderr =0.040 (95% CI: 11%—27%), PRO: 11.11%, stderr =0.047 (95% CI: 2%—21%) PRO golfers). In addition to this area, PRO golfers are more often troubled by MSKP (tab. 3). Using the chi-square test of homogeneity, we evaluated that there is a statistically significant difference in the annual prevalence of MSKP between PRO golfers and AM golfers in the shoulders (p=0.012), wrists/hands (p=0.010), hips/thighs (p=0.005), and neck (p=0.005) (tab. 3).

Table 3. S&C characteristics

[interval]	HOW MUCH TIME DO YOU SPEND WARMING UP BEFORE PLAYING GOLF?			
	GENERAL WARM-UP		SPECIAL WARM-UP	
	AM	PRO	AM	PRO
I never warm-up	0.0 %	0.7 %	2.1 %	0.0 %
1 min – 5 min	34.0 %	2.1 %	18.2 %	0.0 %
6 min – 10 min	23.6 %	9.0 %	13.3 %	2.1 %
11 min – 20 min	5.6 %	9.7 %	9.8 %	1.4 %
21 min – 30 min	3.5 %	3.5 %	7.7 %	0.0 %
31 min – 1 h	0.7 %	4.2 %	11.2 %	10.5 %
1h – 1.5 h	1.4 %	2.1 %	6.3 %	17.5 %
[interval]	**HOW MUCH TIME ON AVERAGE PER WEEK DO YOU SPEND ON S&C TRAINING?**			
	DURING THE COMPETITION PERIOD		DURING THE NON-COMPETITION PERIOD	
	AM	PRO	AM	PRO
I don't do any	18.2 %	4.4 %	18.2 %	0.0 %
less than 30 min	9.1 %	6.7 %	7.1 %	2.2 %
from 30 min – up to 1 h	10.10 %	11.1 %	6.1 %	2.2 %
from 1 h – up to 2 h	22.2 %	13.3 %	16.2 %	0.0 %
from 2 h – up to 3 h	15.2 %	26.7 %	13.1 %	8.9 %
from 3 h – up to 4 h	10.1 %	20.0 %	11.1 %	15.6 %
from 4 h – up to 5 h	5.1 %	6.7 %	10.1 %	17.8 %
from 5 h – up to 6 h	3.0 %	2.2 %	7.1 %	13.3 %
from 6 h – up to 7 h	1.0 %	2.2 %	5.1 %	15.6 %
from 7 h – up to 8 h	2.0 %	2.2 %	1.0 %	6.7 %
from 8 h – up to 10 h	3.0 %	2.2 %	4.0 %	6.7 %
from 10 h – up to 15 h	0.0 %	0.0 %	0.0 %	6.7 %
more than 15 h	1.0 %	2.2 %	1.0 %	4.4 %

Using the Chi-square test of independence, we determined whether there was a statistically significant association between the various characteristics we collected. We found statistically significant relationships of moderate strength between the occurrence of MSKP in the hips/thighs and the average number of competitive rounds played during the season (p=0.045, V=0.373), the average number of hours per week devoted to fitness training in the competitive period (p=0.045, V=0.373), the average number of hours per week devoted to fitness training in the non-competitive period (p=0.045, V=0.385). For the occurrence of MSKP in the ankles/feet, we discovered statistically significant relationships of moderate strength between and the duration of average break from golf during the year (p=0.016, V=0.390). We found significant relationships of moderate strength between the occurrence of MSKP in the lower back and the average number of hours per week devoted to fitness training in the competitive period (p=0.035, V=0.381). For the occurrence of MSKP in the neck, we found a statistically significant and strong relationship with age (p=0.023, V=0.718). We also found a statistically significant but weak relationship with the occurrence of MSKP in the neck and gender (p=0.025, 0.187, standardized risudual for an answer of yes for women=1.5 and for men=-1.3). With a gender, we also found a statistically significant but weak relationship with the occurrence of MSKP in the wrists or hands (p=0.12, V=0.208, standardized risudual for answer yes for women=1.6 and for men=-1.4) (table 4).

Table 4. Occurrence of musculoskeletal problems PRO golfers and AM golfers

BODY PART	AM	PRO	p-value	RR (95 % CI)
Shoulder/s	20.20 %	40.00 %	0.012	2.63 (1.22—5.70)
Elbow/s	19.19 %	11.11 %	0.228	0.53 (0.18—1.51)
Wrist/s or hand/s	23.23 %	44.44 %	0.010	2.64 (1.25—5.60)
Hip/s or thigh/s	18.18 %	40.00 %	0.017	2.56 (1.17—5.59)
Knee/s	25.25 %	26.67 %	0.817	0.91 (0.40—2.05)
Ankle/s or foot/feet	13.13 %	22.22 %	0.374	1.52 (0.63—3.82)
Neck	18.18 %	40.00 %	0.005	3.00 (1.37—6.58)
Upper back	26.26 %	33.33 %	0.383	1.40 (0.65—3.02)
Lower back	47.47 %	57.78 %	0.431	1.33 (0.65—2.70)

Discussion

Wiliamson et al. (2024), in a systematic review and meta-analysis of the epidemiology of MSK injuries in PRO golfers and AM golfers, analyzed 20 studies (9221 golfers, 71.9% men, 28.1% women) with a mean age of 46.8 years. The authors found that the prevalence of injury was significantly higher in PRO golfers (73.5% (95% CI: 47.3–93.0) than in AM golfers (56.6% (95% CI: 47.4–65.5) ((RR)=1.50, p<0.001). PRO golfers had a statistically higher incidence of hand and wrist injuries (RR=3.33, p<0.001) and lower back (RR=3.05, p<0.001). Two studies report a greater risk of injury in AM golfers who play more than 3-4 rounds per week (Wiliamson et al., 2024).

We found PRO golfers are more likely to have trouble with MSKP incidence than AM golfers, which concurs with the results of Wiliamson et al. (2024). Our results also showed a statistically higher incidence of MSKP in the wrists and hands in PRO players compared with AM golfers; however, our research did not reveal a significant difference in the incidence of MSKP in the lower part of the body between PRO golfers and AM golfers. Our research results did not confirm a statistically significant relationship between the annual prevalence of MSKP of any body part and length of golf playing, length of general and even special warm-up before playing golf (p>0.05).

Analyses of the biomechanics of the golf swing show that compression forces on the spine in PRO golfers during a full swing with woods and long irons exceed 7,000 N and shear forces over 600 N. Based on Newton's law of motion on action and reaction, it follows that during a club hit on the ball, the ball exerts an equally large force in the opposite direction because every action causes an equally significant reaction in the opposite direction (USGA, 2015). During a full golf swing, most work (more than 10% contribution) is done by the lumbar part of the spine (21.3–26.5%), right hip (17.2–20.5%), thoracic spine (17.8—19.5%) and in female players also left hip (11.9%) and right elbow (11.5%) (Nesbit & Serrano, 2005).

An injury survey of 522 golfers in Australia reported 185 injuries, of which 58 (31%) were reported in the lower back, 31 (17%) in the shoulder, and 19 (10%) in the elbow (Fradkin et al., 2005). Our research results concur with those of Frandkin et al. (2005). The lower back and shoulders are the most vulnerable parts of golfers' locomotor apparatus. We revealed 47.47% (AM golfers) and 57.78% (PRO golfers) annual prevalence of MSKP in the lower back and 20.20% (AM golfers) and 40.00% (PRO golfers) in the shoulders. Wiliamson et al.'s findings that AM golfers (20.5%) are more prone to elbow and forearm injuries than PRO golfers (13.6%) concur with our discovered incidence of MSKP in the elbows (19.19% in AM golfers; 11.11% in PRO golfers).

A one-year follow-up study on golf injuries in Australian amateur golfers by McHardy et al. (2007) revealed that only the amount of golf play and a change of clubs seem to be significantly associated with the risk of injury. Other risk factors, such as age, gender, handicap, practice, and warm-up habits, were insignificant. Our research also did not confirm the relationship between the annual prevalence of MSKP and golf-specific warm-up before playing golf, the number of competitive rounds played per season, duration of break from golf during the year, and the average length of one golf training session.

AM golfers suffer from back pain primarily due to incorrect technique and low physical condition, while PRO golfers suffer injuries from overtraining and overload. The most common areas of the body where golfers report injuries are the lower back, non-dominant shoulder, and elbow (Wadsworth, 2007). The golf swing exposes the lumbar spine to rapid, intense load more often in AM golfers than in PRO golfers (Hosea & Gatt, 1996). It is caused by inefficient or incorrect

swing technique in AM golfers.

There can be many causes of back pain, from less severe causes, such as muscle stiffness, spasms, or the sudden growth of young players, to more complicated causes, such as back pain radiating to the lower limb caused by a slipped or bulging intervertebral disc (herniated disc, most often L5-S1). Exposing the spine to hyperextension (swayed back position) can cause a herniated disc. We can end the calculation of causes of pain with the occurrence of arthrosis in older golfers or compression fractures of vertebrae and rib fractures (Reed & Wadsworth, 2010). With more than 300 swings per day, golfers experience minor traumatic spinal injuries that can result in the pathological condition of "repetitive traumatic discopathy" (RTD). RTD results from long-term impact stress on the spine, leading to early degeneration and back pain (Walker et al., 2019).

The technique of the modern golf swing itself can cause lower back pain. Compared to the classic swing, the modern swing separates the rotation of the torso and pelvis at the top of the swing (X-factor) by limiting the rotation of the hips and, simultaneously, turning the chest more; their difference in turning increases. As a result, elastic energy is created, which is gained to a power contribution. At the same time, players apply force during the longer path on the club, which is reflected in a higher head speed during the stroke. Performance golfers also use a shift of the pelvis towards the target, which also contributes to higher clubhead speed (Cole & Grimshaw, 2016). X-factor stretch refers to the maximal difference during the start of the downswing when the pelvis starts to rotate while the upper body remains stationary (Bishop et al., 2022). The modern swing also has a characteristic finish with the spine in hyperextension, in a "reverse C" position. The X-factor and resulting position in the finals can lead to lower back pain as the lumbar part of the spine does not tolerate rotation (Thomas & Wilk, 2023). In contrast, the classic swing, where the shoulders and hips rotated simultaneously, resulted in less rotational stress on the lumbar spine and less lateral leaning at impact (the moment of hitting the ball). Back pain can also be eliminated by shortening the backswing or changing the technique to the classical golf swing with a stable axis and harmonious body rotation (Reed & Wadsworth, 2010).

We revealed a statistically significant relationships of moderate strength between the occurrence of MSKP in the hips/thighs and the average number of hours per week devoted to fitness training in the competitive period, and also in the non-competitive period, In both cases, a positive relationship emerged, which means that players with a higher annual prevalence of MSKP in the hips/thighs devote more time to fitness training in the competitive and in the non-competitive period of season. We infer that players who already feel pain in their locomotor apparatus pay more attention to preventing even more injuries or getting worse in those that they already have. We revealed a statistically significant relationship of moderate strength between the occurrence of MSKP in the lower back and the average number of hours per week devoted to fitness training in the competitive period, and we esxplaining this relationship samely. Not like a cause, bud oppositely, like the true of reality, those players who do not have MPSK do less fitness training in general.

Our research was limited by the number of respondents and the fact that the trustworthiness of the answers to the anonymous questionnaire cannot be verified. The fact that the questionnaire contained 43 questions could have been a deterrent to some players from completing it. In advance, it was impossible to remove some questions to shorten the questionnaire because verifying the relationships between the occurrence of MSKP and other factors was our secondary goal.

Conclusions

We have fulfilled the goal of our research with an international research group. A significant difference in the annual prevalence of MSKP between PRO golfers and AM golfers was observed in the in the shoulders (PRO=40.00%, AM=20.20%, RR=2.63 (95% CI:1.22—5.70)), wrists/hands (PRO=44.44%, AM=23.23%, RR=2.64 (95% CI:1.25—5.60)), hips/thighs (PRO=40.40%, AM=18.18%, RR=2.56 (95 % CI:1.17—5.59)), and neck (PRO=40.00%, AM=18.18%, RR = 3.00 (95% CI:1.37—6.58). We found a significant relationship between the annual prevalence of MSKP in the hips/thighs and the average number of competitive rounds played during the season, the average number of hours per week devoted to fitness training in the competitive and non-competitive period of a season. For the occurrence of MSKP in the ankles/feet, we discovered statistically significant relationships between and the duration of average break from golf during the year, for the MSKP in the lower back we discovered statistically significant relationships between the average number of hours per week devoted to fitness training in the competitive period. For the occurrence of MSKP in the neck, we found a statistically significant and strong relationship with age and gender. With gender, we also found a statistically significant relationship with the occurrence of MSKP in the wrists or hands. The only body area where AM golfers had a higher annual prevalence of MSKP than PRO golfers was the elbows (19.19% AM golfers, 11.11% PRO golfers). In addition to this area, MSKP PRO golfers have a higher prevalence of MSKP.

In further research with more responders, we recommend dividing golfers in the results not only according to AM and PRO status but also according to lateral dominance. Most of our PRO golfers (95.56%) and AM golfers (93.88%) respondents were right-handed. However, these percentages did not coincide with the lateral dominance in playing golf on the right side (PRO=91.11%; AM=84.85%). It is beyond the scope of our research to explore this mismatch and its impact on the incidence of MSKP in more depth. However, it would be interesting to address this issue, ideally with more respondents than we had in our research. We did observe that the annual prevalence of MSKP in the shoulders, hands/wrists, hips/thighs, and ankles/feet between PRO golfers and AM golfers are on opposite side in terms of laterality.

Based on our results, we recommend that future research reduce the number of questions in the questionnaire based on a less comprehensive but more profound research objective.

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Conflict of interest
The authors declare no conflict of interest.

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References

Bishop, Ch., Brennan, A., Ehlert, A., Wells, J., Brearley, S., & Coughlan, D. (2022). Strength and Conditioning for Golf Athletes: Biomechanics, Common Injuries and Physical Requirements. *Strength & Conditioning,*

63(3), 7–18. researchgate.net/publication/358727103

Cole, M. H., & Grimshaw, P. N. (2016). The Biomechanics of the Modern Golf Swing: Implications for Lower Back Injuries. *Sports Medicine (Auckland, N.Z.)*, *46*(3), 339–351. https://doi.org/10.1007/s40279-015-0429-1

Coughlan, D., Tilley, N., Mackey, L., Scott, F., Brearley, S. & Bishop, Ch. (2023) Physical preparation for golf. *Aspetar Sports Medicine Journal: Targeted Topic - Sports Medicine in Golf, 12*, 116-122 . https://journal.aspetar.com/en/archive/volume-12-targeted-topic-sports-medicine-in-golf

Fradkin, A. J., Cameron, P. A., & Gabbe, B. J. (2005). Golf injuries--common and potentially avoidable. *Journal of Science and Medicine in Sport*, *8*(2), 163–170. https://doi.org/10.1016/s1440-2440(05)80007-6

Gladdines, S., Gerhardt, A. L., Verhagen, E., Beumer, A., & Eygendaal, D. (2022). The effectiveness of a golf injury prevention program (GRIPP intervention) compared to the usual warm-up in Dutch golfers: protocol design of a randomized controlled trial. *BMC Sports Science*, *Medicine and Rehabilitation, 14*(144). doi.org/10.1186/s13102-022-00511-4

Hosea, T. M., & Gatt, C. J., Jr (1996). Back pain in golf. *Clinics in Sports Medicine*, *15*(1), 37–53. https://pubmed.ncbi.nlm.nih.gov/8903708/

Kunčická, Z. (2012). *Intenzita zatížení hráčů golfu v průběhu hry. [The intensity of the load on golfers during the game; bachelor thesis]*. Univerzita Karlova.

Linton S.J. (1999). Manual for the Musculoskeletal Pain Screening Questionnaire in Orebro: the early identification of patients at risk of chronic pain. *Orebro Sweden: Orebro University*; 1999. p. 71.

McHardy, A., Pollard, H., & Luo, K. (2007). One-year follow-up study on golf injuries in Australian amateur golfers. *The American Journal of Sports Medicine*, *35*(8), 1354–1360. https://doi.org/10.1177/0363546507300188

Michal, J. & Bolčíková, A. (2024). Komparácia kondičnej prípravy profesionálnych a amatérskych golfistov [Comparison of fitness training of professional and amateur golfers]. In *2024 Telesná výchova a šport v živote človeka: Konferenčný recenzovaný zborník vedeckých prác (pp 206-216). https://utvs.tuzvo.sk/sites/default/files/zbornik_2024_0.pdf*

Nesbit, S. M., & Serrano, M. (2005). Work ans power anapysis of the golf swing. *Journal of Sports Science & Medicine, 4*(4), 530–533. https://pmc.ncbi.nlm.nih.gov/articles/PMC3899668/

Novotný, M. (2023). *Užívejte si pohyb, zbavte se zraňení a chytře jim předcházejte [Comparison of fitness training of professional and amateur golfers]*. Jan Melvil Publishing.

Reed, J. J., & Wadsworth, L. T. (2010). Lower back pain in golf: a review. *Current Sports Medicine Reports*, *9*(1), 57–59. https://doi.org/10.1249/JSR.0b013e3181cab8ba

Thomas, Z. T., & Wilk, K. E. (2023). The Golfer's Fore, Fore +, and Advanced Fore + Exercise Program: An Exercise Series and Injury Prevention Program for the Golfer. *International Journal of Sports Physical Therapy, 18*(3), 789–799. doi.org/10.26603/001c.74973

United States Golf Association (USGA). (2015). *Science of Golf: Newton's third law of motion* [Video]. YouTube. https://www.youtube.com/watch?v=hRjA6VNh4D4

Wadsworth, L. T. (2007). When golf hurts: Musculoskeletal problems common to golfers. *Current Sports Medicine Reports, 6*, 362–365. https://link.springer.com/article/10.1007/s11932-007-0052-5

Walker, C. T., Uribe, J. S., & Porter, R. W. (2019). Golf: a contact sport. Repetitive traumatic discopathy may be the driver of early lumbar degeneration in modern-era golfers. *Journal of Neurosurgery. Spine*, *31*(6), 914–917. https://doi.org/10.3171/2018.10.SPINE181113

Watkins R. G. (2002). Lumbar disc injury in the athlete. *Clinics in Sports Medicine*, *21*(1), 147–165. https://doi.org/10.1016/s0278-5919(03)00063-2.

Wiliamson, T., Kay, R. Murray, A., & Clement, N. (2024). The epidemiology of musculoskeletal injury in professional and amateur golfers: a systematic review and meta-analysis. *British Journal of Sports Medicine, 58*(11), 606–614. bjsm.bmj.com/content/58/11/606

Willimas, K. (2017). *Tréningový manuál ČGF 2th ed. [CGF Training Manual]*. https://fls.cgf.cz/DBFL/CGSRedaction/Documents/Treninkovy%20manual%20CGF%20druhe%20vydani%202017.pdf