Low Back Pain in Commercial Airline Pilots

Matthias Albermann; Maria Lehmann; Christian Eiche; Joachim Schmidt; Johannes Prottengeier

BACKGROUND: In their working life, airline pilots are exposed to particular risk factors that promote nonspecific low back pain (LBP). Because of the varying incidence internationally, we evaluated the point prevalences of acute, subacute, and chronic nonspecific LBP, as well as the current prevalences in German airline pilots. Furthermore, we compared the prevalence to the general German population and to European counterparts.

METHODS: An anonymous online survey of 698 participating German airline pilots was evaluated. The impairment between groups was analyzed. Prevalences from our data were compared to existing data.

RESULTS: The following point prevalences were found: 8.2% acute, 2.4% subacute, 82.7% chronic LBP; 74.1% of all individuals were suffering from current LBP when answered the questionnaire. A total time spent flying greater than 600 h within the last 12 mo was significantly related to acute nonspecific LBP. Individuals with any type of LBP were significantly impaired compared to those unaffected. It was found that German airline pilots suffer more often from current LBP than the general population and have a higher point prevalence of total LBP than their European counterparts.

CONCLUSIONS: The evaluation showed a surprisingly high, previously unidentified, prevalence of nonspecific LBP in German airline pilots. Why German airline pilots suffer more often from LBP remains uncertain. The number of flying hours appears to have a negative effect on developing acute low back pain, but causation cannot be concluded. Other risk factors could not be confirmed.

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Low back pain (LBP) is an increasing health problem worldwide.[15] It is one of the most common health problems in the general population and the leading cause of pain, disability, and absence from work.[15] The majority of affected individuals suffer from nonspecific LBP for which no pathoanatomical cause can be found.[13] Geographical regions with a high income tend to have higher prevalences of nonspecific LBP compared to low-income regions,[9] and the prevalence can differ widely between seemingly similar countries. The overall risk is composed of socioeconomic factors and individual factors such as working conditions and lifestyles.[24] One population that is exposed to several individual risk factors is commercial airline pilots. This is reflected in a 12-mo prevalence of LBP of at least 40%,[8] as described in recent studies. The point prevalence of nonspecific LBP according to the classification of different national guidelines remains uncertain, despite such classifications being used for therapeutic decision making.[17] Regardless of this inconsistency, high prevalence rates of LBP result in an increased burden on the health care system[20] and a loss of productivity.[22] This becomes more important when numbers of air passengers are increasing again in the future and a shortage of specialist workers might occur.[6]

The objective of the present study was to determine the point prevalences of acute, subacute and chronic nonspecific LBP in commercial airline pilots on the basis of national guidelines.[3] Furthermore, we aimed to identify any additional risk factors and acquire up-to-date cross-sectional data on airline pilots with regard to the point prevalence of nonspecific LBP.

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METHODS

Our survey was endorsed by the German pilots' union Vereinigung Cockpit e. V. and was advertised and distributed through their online communications. Participation in our study was voluntary, unpaid, and anonymous. A certificate of nonobjection was provided by the research ethics committee of the University of Erlangen-Nuremberg (decision number 97_19 Bc). The questionnaire was conducted by means of the online platform Sosci-Survey from June until September 2016.

Questionnaire

The questionnaire had five sections to gather information on sociodemographic data, medical history, career, working conditions and characteristics of LBP. Individual data consisted of sex, age, height and weight (from which we calculated the body mass index), and marital status (in a partnership or single). Regarding the medical history, we asked for the history of operations, infections, and tumors of the dorsum. The section on career and working conditions included details about the position in the cockpit, total length of air service, total time spent flying for work, total time spent flying in the last 12 mo, and the most common flight length (short, medium, or long haul). Further, the questionnaire asked for the duration spent sitting in the cockpit, general comfortability of the cockpit seat and the attitude toward changing jobs due to the working conditions. The topic of LBP was covered by questions about the total duration and frequency of pain, avoidant behavior, and current pain in the low back. All subjects were grouped with reference to their pain duration into acute, subacute, chronic, and without LBP (no LBP) according to the original questions of the national German guidelines[3] (survey question BA07: For how long have you been suffering from back pain?). Following the guidelines, LBP for less than 6 wk was classified as acute. Persistent LBP for more than 6 wk and less than 12 wk was classified as subacute. LBP for more than 12 wk was classified as chronic. The remaining individuals were considered to have no LBP.

The grade of impairment due to LBP was evaluated by the Oswestry Low Back Pain Disability Index (ODI).[7] Based on 10 sections, this index assesses the everyday intensity of and impairment due to LBP.

Statistical Analysis

ODI scores between different prevalence groups were compared using Mann-Whitney *U*-tests. The *P*-values obtained from these tests were adjusted for multiple testing using the method proposed by Benjamini and Hochberg.[2] The prevalence of LBP in our sample was compared to the prevalences found in other studies using the Wald test. A $P < 0.05$ (two-sided) was considered significant for all statistical tests. To identify variables associated with the three different types (acute, subacute, chronic) of LBP, we performed three separate logistic regression analyses, including stepwise variable selection, using the specific type of LBP as an event and having none of these types of LBP as a comparison. The variables included in this analysis were age, height, BMI, sex, marital status, total time spent flying for work, total time spent flying in the last 12 mo, common flight length, percentage of time spent sitting, and comfortability of the cockpit seat. SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA) and R version 3.5.1 (R Core team, 2018) were used for the statistical analysis.

RESULTS

In total, 791 pilots participated in the online questionnaire. This equates to a response rate of 8.2% of the approximately 9600 unionized cockpit crewmembers. Of the respondents, 29 pilots (3.6%) were not included in the analysis because of a previous operation on the back. Other causes of specific LBP, such as fractures, infections, or tumors, were considered reasons for exclusion as well, but were not found in our cohort. Another 64 subjects were excluded from the analysis because they provided inconsistent data regarding the frequency of their LBP; therefore, their subtype of LBP could not be classified. In total, 698 pilots were evaluated in our analysis. Regarding descriptive data for single items, the number of pilots from this dataset who provided an answer for this specific question was used as the denominator for the relative frequencies.

Our cohort consisted of 54 women (7.8%) and 639 men (92.2%). The average age was 39.9 yr (SD $\pm$ 8.6), with an average BMI of 24.4 kg $\cdot$ m^{-2} (SD $\pm$ 2.7). The marital status of 614 subjects was "in a relationship" (88.6%), whereas 79 were single (11.4%). The median total lifetime hours of flying were 8000 (Q1: 5000; Q3: 12,000) hours, with a median total hours of flying in the last 12 mo of 600 (Q1: 500; Q3: 700) hours. In total, 271 pilots (38.9%) predominantly worked on short flights, 94 (13.5%) on medium length flights, and 280 (40.2%) on long haul flights. In 51 (7.3%) pilots, the common flight length

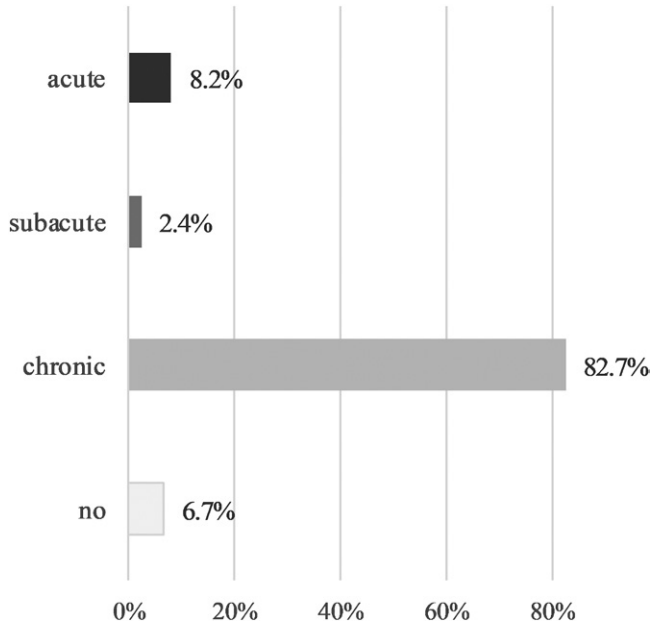

Fig. 1. Point prevalences for acute, subacute, chronic and no low back pain.

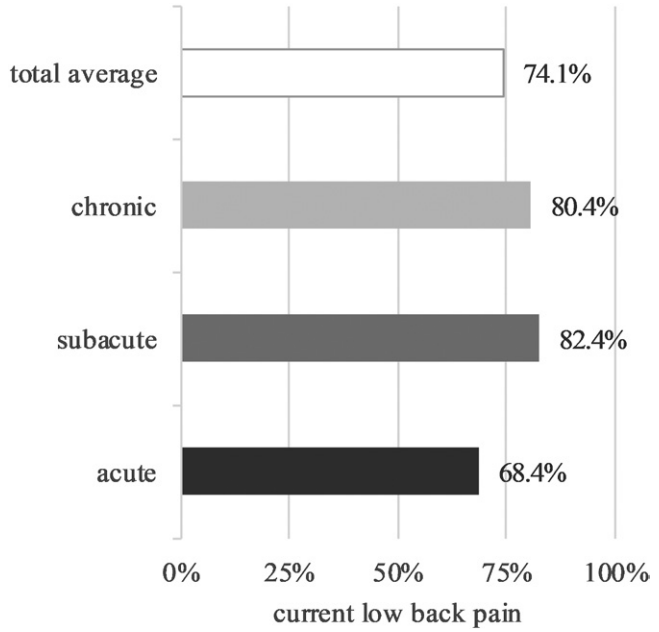

Fig. 2. Percentages of all subjects with current low back pain in the total population and individual subgroups.

varied. The median percentage of time spent sitting during work was subjectively rated as 90% (Q1: 80%; Q3: 95%). When asked about their LBP-avoidant behavior, 85.0% of the pilots answered that they changed their posture systematically, 84.2% optimized their seat, 13.6% used positioning aids such as extra cushions, 43.0% left their seat as often as possible and 15.8% just withstood the pain. A multiple item selection was possible in this section. The overall comfortability of the cockpit seat was rated by 78 (11%) pilots as being "comfortable" or "very comfortable", 310 (44%) as being "neither/nor" and by 310 (44%) as being "uncomfortable" or "very uncomfortable".

The grouping with respect to the type of LBP showed that 57 pilots suffered from acute LBP (point prevalence: 8.2%), 17 from subacute LBP (point prevalence: 2.4%) and 577 from chronic nonspecific LBP (point prevalence: 82.7%), whereas 47 pilots (point prevalence: 6.7%) did not experience any LBP (no LBP) (**Fig. 1**). This was summed to a point prevalence of 93.3% (651/698) of the pilots having some type of nonspecific LBP at the time of the survey (total LBP).

A total of 517 subjects suffered from current LBP when answering the questionnaire. In reference to all pilots with any type of LBP, 79.4% (517/651) were affected, and 74.1% (517/698) of all subjects were affected (**Fig. 2**). All descriptive data are shown in **Tables I, II** and **III**.

The analysis of LBP intensity revealed significant differences in the ODI score. Subjects without any LBP had a median ODI score of 0 (Q1: 0; Q3: 2). In contrast, pilots with acute LBP had a median score of 8 (Q1: 4; Q3: 12), those with subacute LBP had a median score of 4 (Q1: 8; Q3: 22), and those with chronic LBP had a median score of 10 (Q1: 6; Q3: 18) (**Fig. 3**). The score for each individual group with LBP differed significantly from the group without any LBP (acute LBP vs. no LBP $P < 0.0001$; subacute LBP vs. no LBP $P < 0.0001$; chronic LBP vs. no LBP $P < 0.0001$).

Two aspects of the present study were compared to those observed in previous studies on LBP.

1) The prevalence of current LBP was 74.1% (question ODI-1: I have no pain. The pain is very mild/moderate/fairly severe/very severe/the worst imaginable at the moment) in this study compared to the prevalences in the studies by Neuhauser et al.[16] ($N = 8318$, prevalence 22.3%, degree of freedom = 1, variance = 0.000021) and Schmidt et al.[21] ($N = 9263$, prevalence 37.1%, degree of freedom = 1, variance = 0.000025) about LBP in the general German population.

Table I. Descriptive Data: Collective.

	LOW BACK PAIN (LBP)				
	ACUTE *N* (%)	**SUBACUTE *N* (%)**	**CHRONIC *N* (%)**	**NO LBP *N* (%)**	**TOTAL *N* (%)**
Absolute Numbers	57 (100)	17 (100)	577 (100)	47 (100)	698 (100)
Point prevalence	57/698 (8.2)	17/698 (2.4)	577/698 (82.7)	47/698 (6.7)	698/698 (100)
Age, years					
≤29	17 (29.8)	5 (29.4)	55 (9.5)	6 (12.8)	83 (11.9)
30–39	24 (42.1)	10 (58.8)	256 (44.4)	18 (38.3)	308 (44.2)
40–49	9 (15.8)	2 (11.8)	172 (29.9)	12 (25.5)	195 (28.0)
50–59	6 (10.5)	0 (0)	86 (14.9)	8 (17.0)	100 (14.3)
≥60	1 (1.8)	0 (0)	7 (1.2)	3 (6.4)	11 (1.6)
Mean [SD]	36.0 [9.2]	34.4 [6.3]	40.3 [8.3]	41.6 [8.3]	39.9 [8.6]
Sex					
Women	5 (8.8)	1 (5.9)	48 (8.4)	0 (0)	54 (7.8)
Men	52 (91.2)	16 (94.1)	524 (91.6)	47 (100)	639 (92.2)
BMI ($kg \cdot m^{-2}$)					
<25	40 (70.2)	14 (82.4)	351 (61.1)	25 (53.2)	430 (61.8)
25–< 30	16 (28.1)	3 (17.6)	203 (35.4)	21 (44.7)	243 (35.0)
≥30	1 (1.8)	0 (0)	20 (3.5)	1 (2.1)	22 (3.2)
Mean [SD]	23.7 [2.5]	23.5 [2.2]	24.5 [2.7]	25.2 [2.9]	24.4 [2.7]
Marital status					
In a relationship	47 (82.5)	15 (88.2)	514 (89.7)	38 (82.6)	614 (88.6)
Single	10 (17.5)	2 (11.8)	59 (10.3)	8 (17.4)	79 (11.4)

Table II. Descriptive Data: Profession.

	LOW BACK PAIN (LBP)				
	ACUTE *N* (%)	**SUBACUTE *N* (%)**	**CHRONIC *N* (%)**	**NO LBP *N* (%)**	**TOTAL *N* (%)**
Position in cockpit					
Captain	20 (35.1)	7 (41.2)	257 (44.5)	23 (48.9)	307 (44.0)
Senior 1st officer	2 (3.5)	2 (11.8)	101 (17.5)	7 (14.9)	112 (16.0)
1st officer	35 (61.4)	8 (47.1)	217 (37.6)	17 (36.2)	277 (39.7)
2nd officer	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Other	0 (0)	0 (0)	2 (0.3)	0 (0)	2 (0.3)
Total air service (years)					
≤5	17 (29.8)	4 (23.5)	59 (10.2)	5 (10.6)	85 (12.2)
>5–≤ 10	20 (35.1)	6 (35.3)	130 (22.5)	12 (25.5)	168 (24.1)
>10–≤ 15	5 (8.8)	5 (29.4)	120 (20.8)	5 (10.6)	135 (19.3)
>15–≤ 20	6 (10.5)	0 (0)	108 (18.7)	13 (27.7)	127 (18.2)
>20	9 (15.8)	2 (11.8)	160 (27.7)	12 (25.5)	183 (26.2)
Mean [SD]	11.9 [9.9]	10.6 [6.7]	15.8 [8.3]	17.4 [11.1]	15.5 [8.7]
Total hours spent flying for work					
≤5000	28 (50.0)	7 (41.2)	131 (23.1)	13 (27.7)	179 (26.1)
>5000–≤ 10,000	15 (26.8)	7 (41.2)	239 (42.2)	14 (29.8)	275 (40.0)
>10,000–≤ 15,000	7 (12.5)	2 (11.8)	122 (21.5)	12 (25.5)	143 (20.8)
>15,000–≤ 20,000	4 (7.1)	1 (5.9)	59 (10.4)	6 (12.8)	70 (10.2)
>20,000–≤ 25,000	2 (3.6)	0 (0)	16 (2.8)	2 (4.3)	20 (2.9)
Median [Q1; Q3]*	5100 [2722; 8875]	6000 [3700; 9000]	8500 [5500; 12,250]	8000 [5000; 13,000]	8000 [5000; 12,000]
Total hours spent flying in the last 12 mo					
<600	14 (25.0)	6 (35.3)	187 (32.5)	21 (45.7)	228 (32.9)
≥600–< 700	25 (44.6)	5 (29.4)	182 (31.7)	13 (28.3)	225 (32.4)
≥700	17 (30.4)	6 (35.3)	206 (35.8)	12 (26.1)	241 (34.7)
Median [Q1, Q3]	600.0 [587.5; 700.0]	600.0 [530.0; 700,0]	600.0 [500.0; 700.0]	600.0 [457.5; 689.2]	600.0 [500.0; 700.0]
Most common flight length					
Short haul	28 (49.1)	6 (35.3)	221 (38.4)	16 (34.8)	271 (38.9)
Medium haul	9 (15.8)	4 (23.5)	79 (13.7)	2 (4.3)	94 (13.5)
Long haul	18 (31.6)	6 (35.3)	232 (40.3)	24 (52.2)	280 (40.2)
Varied	2 (3.5)	1 (5.9)	44 (7.6)	4 (8.7)	51 (7.3)

* Q1, first quartile; Q3, third quartile.

2) The prevalence of total LBP (Question BA07: Have you been suffering from LBP for 1 – 3 d/4 – 7 d/8 d to 6 wk/6 – 12 wk/12 wk to one year/more than one year) was compared to the prevalence of total LBP in Norwegian pilots (Omholt et al.,[18] $N = 416$, prevalence 53%, degree of freedom = 1, variance = 0.000599). The statistical analysis showed that German commercial airline pilots have significantly more current LBP than the general German population ($P < 0.001$ both) and have more total LBP than Norwegian airline pilots ($P < 0.001$).

The results of three separate logistic regression analyses including stepwise variable selection performed for the three different types of LBP can be found in **Table IV**. We computed that each group with LBP rated the comfort of their cockpit seat as significantly less comfortable compared to the rating of the no LBP group:

- acute LBP vs. no LBP—"neither comfortable nor uncomfortable" vs. "(very) comfortable": OR 95% CI = 1.583 [0.542, 4.622]; "(very) uncomfortable" vs. "(very) comfortable": OR 95% CI = 10.480 [2.420, 45.393];
- subacute LBP vs. no LBP—"neither comfortable nor uncomfortable" vs. "(very) comfortable": OR 95% CI = 3.033 [0.338, 27.213]; "(very) uncomfortable" vs. "(very) comfortable": OR 95% CI = 29.250 [2.789, 306.806];
- chronic LBP vs. no LBP—"neither comfortable nor uncomfortable" vs. "(very) comfortable", OR 95% CI = 1.896 [0.930, 3.866]; "(very) uncomfortable" vs. "(very) comfortable", OR 95% CI = 16.010 [5.036, 50.903].

Odds ratios were adjusted to variables included in the logistic model after stepwise variable selection.

Pilots suffering from any type of LBP evaluated their cockpit seat as "very uncomfortable/extremely uncomfortable" significantly more often than those with no LBP. Furthermore, pilots with more than 600 flying hours in the last 12 mo were significantly more often represented in the group with acute LBP (≥ 600 h – < 700 h vs. < 600: OR 95% CI = 4.000 [1.405, 11.387]; ≥ 700 h vs. < 600 h: OR 95% CI = 2.119 [0.706, 6.357], odds ratios adjusted to variables included in the logistic model after stepwise variable selection) compared to the no LBP group. The remaining results of the univariate logistic regression analysis are included in **Table V**.

DISCUSSION

The aim of our online questionnaire was to determine the current point prevalences of acute, subacute, and chronic LBP in commercial airline pilots, as well as to find any specific risk

Table III. Descriptive Data: Working Conditions.

	LOW BACK PAIN (LBP)				
	ACUTE *N* (%)	**SUBACUTE *N* (%)**	**CHRONIC *N* (%)**	**NO LBP *N* (%)**	**TOTAL *N* (%)**
Proportion of time spent sitting during work (%)					
≤20	0 (0)	0 (0)	4 (0.7)	1 (2.1)	5 (0.7)
>20–≤ 39	0 (0)	0 (0)	3 (0.5)	1 (2.1)	4 (0.6)
>40–≤ 60	1 (1.8)	0 (0)	15 (2.6)	2 (4.3)	18 (2.6)
>60–≤ 80	18 (31.6)	3 (17.6)	173 (30.1)	23 (48.9)	217 (31.2)
>80	38 (66.7)	14 (82.4)	380 (66.1)	20 (42.6)	452 (64.9)
Median [Q1, Q3]*	90 [80; 95]	90 [90; 95]	90 [80; 95]	80 [75; 90]	90 [80; 95]
Avoidant behavior (multiple selections possible)					
Posture change	45 (78.9)	14 (82.3)	504 (87.3)	30 (63.8)	593 (85.0)
Optimize seat	50 (87.7)	16 (94.1)	493 (85.4)	29 (61.7)	588 (84.2)
Positioning aide	4 (7.0)	1 (5.9)	89 (15.4)	1 (2.1)	95 (13.6)
Leave seat	29 (50.9)	8 (47.1)	248 (43.0)	15 (31.9)	300 (43.0)
Withstand the pain	9 (15.8)	2 (11.8)	99 (17.2)	0 (0)	110 (15.8)
Thinking of job change due to low back pain					
Always	0 (0)	0 (0)	5 (0.9)	0 (0)	5 (0.7)
Often	1 (1.8)	0 (0)	21 (3.6)	0 (0)	22 (3.2)
Occasionally	5 (8.9)	1 (5.9)	64 (11.1)	0 (0)	70 (10.1)
Rarely	14 (25.0)	3 (17.6)	139 (24.1)	2 (4.7)	158 (22.8)
Never	36 (64.3)	13 (76.5)	348 (60.3)	41 (95.3)	438 (63.2)
Comfortability of cockpit seat					
Very comfortable or comfortable	8 (14.0)	1 (5.9)	56 (9.7)	13 (27.7)	78 (11.2)
Neither uncomfortable nor comfortable	28 (49.1)	7 (41.2)	245 (42.5)	30 (63.8)	310 (44.4)
Uncomfortable or very uncomfortable	21 (36.8)	9 (52.9)	276 (47.8)	4 (8.5)	310 (44.4)
Current back pain when answering					
Negative	18 (31.6)	3 (17.6)	113 (19.6)	47 (100.0)	181 (25.9)
Positive	39 (68.4)	14 (82.4)	464 (80.4)	0 (0)	517 (74.1)
ODI score†					
0–20	51 (89.5)	12 (70.6)	498 (86.3)	47 (100.0)	608 (87.1)
21–40	6 (10.5)	5 (29.4)	79 (13.7)	0 (0)	90 (12.9)
>40	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Median [Q1, Q3]	8 [4; 12]	4 [8; 22]	10 [6; 18]	0 [0; 2]	10 [4; 16]

* Q1, first quartile; Q3, third quartile.
† ODI: Oswestry Low Back Pain Disability Index.

factors that are related to one or more of these three subtypes of LBP. Beyond that, we gathered descriptive data on nonspecific LBP to identify the current status quo in the particular subpopulation of airline pilots.

According to the national German guidelines,[3] we categorized all individuals with LBP into acute, subacute, and chronic phenotypes. Somewhat surprisingly, the point prevalence of chronic LBP was extremely high at 82.7%, followed by 8.2% for acute, and 2.4% for subacute LBP. Only 6.7% of pilots had not previously experienced LBP in their work life. Although the temporal classification is important for treatment according to the guidelines, we could not find previous studies that evaluated the distribution of acute, subacute and/or chronic LBP in any population. Many previous studies evaluated the 12-mo prevalence of different types of LBP with differing definitions or analyzed data on the point prevalence of total LBP (sum of acute, subacute, and chronic point prevalences) in general (for a systematic review see Hoy et al.[10]). Therefore, we cannot make comparisons of the identified acute, subacute, and chronic LBP point prevalences identified in this study with those identified in other investigations on LBP. To evaluate our findings, nonetheless, we statistically compared the prevalences against those identified in three recent and relevant studies on total LBP and current LBP. Two of these studies evaluated the general German population (Neuhauser et al.[16] 22.3%, Schmidt et al.[21] 37.1%) and the third focused on Norwegian aircrews (Omholt et al.[18] 53%). Our statistical analysis revealed that German airline pilots suffer significantly more often from current LBP at a given time and have a higher point prevalence for total LBP than the general German population ($P < 0.001$). Contributing to this finding could be previously identified factors that pilots are individually exposed to during their work and that have an adverse effect on LBP. Such factors are as follows: awkward postures, static work posture and, in helicopter pilots, whole body vibration (see review[1]), long flying times, high work pace and turbulence.[5,19,23] Compared to Norwegian airline pilots, German airline pilots also have a significantly higher point prevalence for total LBP ($P < 0.001$), even though all airline pilots are presumably exposed to similar working conditions. The reason for this might be the different socioeconomic backgrounds.[11] But we have to point out that is only speculative because no data were collected on socioeconomic factors. No causality can be drawn from this. A noticeable disparity is expressed when you compare the prevalence of LBP in the general population in Germany (Schmidt et al.[21] total LBP prevalence = 37.1%) vs. the general population in Norway (Ihlebaek et al.[12] total LBP

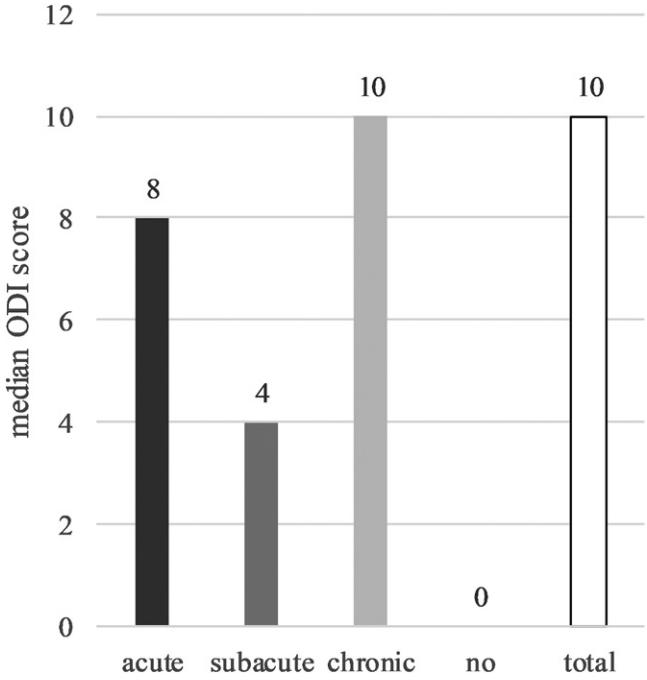

Fig. 3. Median Oswestry Low Back Pain Disability Index score for subgroups and the total population.

prevalence = 13.4%), which shows that the general German population suffers more often from LBP (not statistically tested).

The high point prevalence for total LBP, as a sum of acute, subacute, and chronic LBP, found in this study is supported by the equally surprisingly high point prevalence for acute backache (current LBP) at the time the questionnaire was answered. More than 70% of all subjects (74%, 517/698) had actual backache when answering the questionnaire. This is two to three times higher than the proportion reported in the general German population.[16,21] This finding makes the high point prevalence for total LBP plausible and supports the finding.

Together, the aspects of individual work conditions and socioeconomic background might explain the high point prevalence we found. This assumption is only speculative but calls for further research into possible root causes.

Regression analysis showed that pilots with more than 600 flying hours within the last 12 mo suffered from acute LBP significantly more often. This is in accordance with previous data[23] and suggests a cumulative effect of exposure to stressors on acute back pain. However, it remains unclear under what conditions such episodes of acute LBP after many flying hours will eventually trigger the new phenotype of chronic LBP. All pilots with LBP of any kind evaluated their seat as being "very uncomfortable/extremely uncomfortable" significantly more often than those without back pain. However, it remains unclear for the moment whether uncomfortable pilot seats cause LBP or whether LBP actually just makes pilots more demanding with regards to their seats.

No other investigated item was associated with any type of LBP (marital status, total hours spent flying for work, flight length, percentage of time spent sitting, BMI, age and body height). Some previously found risk factors could not be confirmed (age,[14] sex,[6] body height,[14] high BMI[26]). The reason for this could be the strict health conditions for active airline pilots leading to a healthy worker bias and an uneven sex balance in our sample.

Even though more than 80% of all participating pilots fulfilled the criteria for any kind of LBP, they are still participating in work. To assess this inconsistent situation, in our opinion, different factors must be considered. Highly restrictive health requirements for airline pilots in the European Union[4] eliminate pilots who have severe disabilities. This generates a healthy worker bias and might be reflected by the relatively low median ODI score (acute 8 [Q1: 4; Q3: 12], subacute 4 [Q1: 8; Q3: 22], chronic 10 [Q1: 6; Q3: 18]) even for pilots experiencing nonspecific LBP. However, the affected pilots theoretically met the guideline definitions. Their performance appears to be unimpaired, and they may not have been diagnosed with LBP. Alternatively, pilots intentionally want to avoid being diagnosed with acute/subacute or chronic LBP to keep their required medical certificate for pilots, financial income, and social status. Again, this hypothesis needs to be investigated in the future.

When discussing the present results, some study characteristics must be considered. The questionnaire was electronically distributed by the pilots' labor union Vereinigung Cockpit e. V. In reference to the official data, the union has 9500 members in

Table IV. Results of the Logistic Regression Analysis.*

	ACUTE vs. NO LBP		SUBACUTE vs. NO LBP		CHRONIC vs. NO LBP	
	ADJUSTED OR	ADJUSTED *P*-VALUE	ADJUSTED OR	ADJUSTED *P*-VALUE	ADJUSTED OR	ADJUSTED *P*-VALUE
Hours spent flying in last 12 mo						
<600	Reference	0.0343	Not included in the model		Not included in the model	
≥600–< 700	4.000 [1.405; 11.387]					
≥700	2.119 [0.706; 6.357]					
Comfortability of cockpit seat						
Very comfortable or comfortable	ref.	0.0040	ref.	0.0020	ref.	<0.0001
Neither comfortable nor uncomfortable	1.583 [0.542; 4.622]		3.033 [0.338; 27.213]		1.896 [0.930; 3.866]	
Uncomfortable or very uncomfortable	10.480 [2.420; 45.393]		29.250 [2.789; 306.806]		16.010 [5.036; 50.903]	

* Odds ratios (OR) and *P*-values adjusted for other variables remaining in the model after stepwise selection can be the same as univariate OR/*P*-value if only one variable remains in the model after variable selection.
ref. = reference.

Table V. Results of Univariate Logistic Regression Analyses.*

	ACUTE vs. NO LBP		SUBACUTE vs. NO LBP		CHRONIC vs. NO LBP	
	UNIVARIATE OR	UNIVARIATE *P*-VALUE	UNIVARIATE OR	UNIVARIATE *P*-VALUE	UNIVARIATE OR	UNIVARIATE *P*-VALUE
Age (years)		0.1641		0.5825		0.1393
≤29	ref.		ref.		ref.	
30–39	0.471 (0.155; 1.433)		0.667 (0.162; 2.748)		1.552 (0.589; 4.088)	
40–49	0.265 (0.074; 0.943)		0.200 (0.030; 1.351)		1.564 (0.561; 4.362)	
50–59	0.265 (0.065; 1.084)		n. c.		1.173 (0.386; 3.563)	
≥60	0.118 (0.010; 1.359)		n. c.		0.255 (0.052; 1.253)	
Sex*		-		-		-
BMI ($kg \cdot m^{-2}$)		0.2058		0.1502		0.4245
<25	ref.		ref.		ref.	
25–< 30	0.476 (0.210; 1.081)		0.255 (0.064; 1.009)		0.689 (0.376; 1.261)	
≥30	0.625 (0.037; 10.449)		n. c.		1.424 (0.184; 11.053)	
Marital status		0.9838		0.5901		0.1415
In a relationship	ref.		ref.		ref.	
Single	1.011 (0.363; 2.812)		0.634 (0.120; 3.334)		0.545 (0.243; 1.224)	
Total hours spent flying for work		0.1789		0.6258		0.6068
≤5000	ref.		ref.		ref.	
>5000–≤ 10,000	0.498 (0.186; 1.328)		0.929 (0.255; 3.378)		1.694 (0.773; 3.712)	
>10,000–≤ 15,000	0.271 (0.087; 0.848)		0.310 (0.053; 1.793)		1.009 (0.443; 2.296)	
>15,000–≤ 20,000	0.310 (0.074; 1.288)		0.310 (0.031; 3.111)		0.976 (0.354; 2.693)	
>20,000–≤ 25,000	0.464 (0.059; 3.670)		n. c.		0.844 (0.175; 4.063)	
Total hours spent flying in the last 12 mo		0.0823		0.7123		0.1808
<600	ref.		ref.		ref.	
≥600–< 700	2.884 (1.113; 7.474)		1.346 (0.341; 5.317)		1.572 (0.764; 3.234)	
≥700	2.125 (0.780; 5.786)		1.750 (0.460; 6.653)		1.928 (0.923; 4.026)	
Most common flight length		0.0550		0.1987		0.2509
Short haul	ref.		ref.		ref.	
Medium haul	2.571 (0.493; 13.398)		5.333 (0.767; 37.088)		2.860 (0.643; 12.717)	
Long haul	0.429 (0.180; 1.019)		0.667 (0.182; 2.437)		0.700 (0.362; 1.353)	
Varied	0.286 (0.047; 1.737)		0.667 (0.061; 7.230)		0.796 (0.254; 2.496)	
Proportion of time spent sitting during work (%)		0.2794		0.2247		0.0271
≤20	n. c.		n. c.		0.211 (0.022; 1.972)	
>20–≤ 39	n. c.		n. c.		0.158 (0.016; 1.587)	
>40–≤ 60	0.263 (0.022; 3.083)		n. c.		0.395 (0.084; 1.846)	
>60–≤ 80	0.412 (0.181; 0.936)		0.186 (0.047; 0.743)		0.396 (0.212; 0.740)	
>80	ref.		ref.		ref.	
Comfortability of cockpit seat		0.0059		0.0020		<0.0001
Very comfortable or comfortable	ref.		ref.		ref.	
Neither comfortable nor uncomfortable	1.517 (0.547; 4.207)		3.033 (0.338; 27.213)		1.896 (0.930; 3.866)	
Uncomfortable or very uncomfortable	8.530 (2.135; 34.081)		29.250 (2.789; 306.806)		16.010 (5.036; 50.903)	
Height (cm)		0.4366		0.7484		0.0755
<180	ref.		ref.		ref.	
≥180	1.370 (0.620; 3.031)		0.833 (0.273; 2.539)		1.731 (0.945; 3.171)	

* Univariate logistic regression with sex as a predictor was not possible due to the lack of women in our sample with no LBP (see Table I).
n. c., not computable; LBP, low back pain; OR, odds ratio; ref., reference.

all Germany-based airlines. However, the exact number of active-duty pilots and the percentage of those who actually received and read the invitation to participate in our study is unknown. In relation to the official membership statistics, we generated a response rate of 8.2%, but it is conceivable that we actually scored substantially higher among active pilots. We consider it to be an advantage that the pilots who participated were from various airlines rather than a single airline, especially with regard to generating descriptive data that are supposed to depict the entire population of airline pilots. Despite these positive assumptions, a selection bias cannot be ruled out. Healthy subjects participate more often in surveys on health topics in general.[25] Due to the nature of the survey no information on nonresponders is available or can be analyzed. Additionally, as mentioned above, the healthy worker bias might be very strong in commercial airline pilots due to the European regulations.[4] Therefore, the point prevalences identified in this study might be lower than the actual values, and factors influencing LBP could have been missed during the regression analysis.

The evaluation by our online questionnaire showed a surprisingly high point prevalence for total LBP (93.2%) in German commercial airline pilots. This agrees with an equally high point prevalence of current LBP (74.1%). The total LBP prevalence was 8.2% for acute pain, 2.4% for subacute pain and 82.7% for chronic LBP. All pilots affected by LBP had a

significantly higher ODI score compared to nonaffected pilots. Furthermore, German airline pilots suffer more often from current LBP than the general German population and Norwegian commercial airline pilots. A total flying time in the last 12 mo of more than 600 h was associated with acute LBP. Pilots with LBP of any kind evaluated their pilot seat as being "uncomfortable" or "very uncomfortable" more often than those with no LBP. Whether or not there is a causal relation, i.e., the uncomfortable seat causes LBP or LBP makes the seat uncomfortable, remains uncertain.

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