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BACK PAIN IN POLISH MILITARY TRANSPORT AIRCRAFTS PILOTS

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SUMMARY: Background: *Back pain is more and more frequently reported by military pilots as a serious problem which requires a quick solution. Back pain impedes body movements. Therefore, it affects precision of flight control and increases pilots' fatigue. Moreover, it requires a high degree of concentration. Analysis of this problem has been a subject of studies carried out in the Polish pilots of the military transport aircraft.* ***Objectives:*** *The study aimed at getting information about the scope of this problem including back pain incidence, localization, severity during flights, and the effect on aircraft control.* ***Material and Methods:*** *The authors performed a questionnaire survey which involved 60 pilots. The questionnaire contained 21 questions concerning pain onset in various segments of the spine or complaints concerning mainly the muscular system and defined as the level of discomfort. Some questions were also related to the development of pain during flight, after its completion and in everyday life.* ***Results:*** *Forty-four respondents reported back pain of various severities. Fourteen pilots reported severe back pain, while thirty pilots reported the sense of discomfort. Twenty-six pilots reported frequent back pain during the flight as well as its persistence - seven pilots. No back pain was reported in 16 pilots.* ***Conclusions:*** *Back pain during the flights affected pilots' activity but not specifically the flight. The most frequent causes of back pain were uncomfortable posture and intensive, long-haul flights. Back pain was diminished by preventive measures, such as physical exercises and rehabilitation*
KEY WORDS: *spine pain, causes, pilots, transport aircrafts*

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Introduction

Back pain is a frequent complaint of pilots of military transport aircraft. In the majority of cases it is an evidence of spine pathologies [4,20]. However, it should more frequently be associated with increased muscular tone, mainly in the lumbar, interscapular or shoulder areas [3,5,8,10,16]. Its severity is associated with the type of aircraft and type of operation.

Considering work conditions of pilots of military transport aircraft, it should be stressed that several complaints are associated with the flights predisposing to back pain development reported by other authors [2,6,10,16,22]. They include: forced sitting posture for a long time, ergonomic features of the pilots' seat, increasing fatigue, and aircraft flight controlling without the autopilot. These complaints may increase during trunk rotation and flexion, bending forward and to left or right side, and control column pulling or pushing, and bending the trunk from either neutral or supported position [8,11]. Back pain is a marked physical and psychological load for the pilots.

Objectives

The objective of the study was to collect information from the pilots of military transport aircraft concerning back pain incidence, localization, and severity during the flight and after its completion. Moreover, the information was supplemented with data concerning principle causes of back pain and its effect on aircraft control.

Material and Methods

The study involved 60 Polish pilots of military transport aircraft. These pilots performed long-haul international and domestic flights in C-295M, Jak-40, and M-28 aircraft. All pilots have had actual multispecialist medical examinations. They were well rested prior to flying. Their task was to fill out a 21-question questionnaire.

Prior to answering the questions, informed consent was received from all of the pilots. This information contained questionnaire contents, ways of answering the questions and comments to each written answer. All pilots could ask detailed questions related to the questionnaire.

The questionnaire contained the following groups of questions:

1. Anthropometrical data and number of flown hours.
2. Back pain occurrence and localization.
3. Determination of the possible causes.
4. The effect of back pain on the pilot's precision of flight control.
5. Use of preventive measures.

Each of the above listed groups contained detailed questions. In the first group, the authors attempted to determine a degree of pilots' overloading with both the number of total and annual flown hours, depending on the aircraft type.

The second group of questions concerned onset of backache and muscular pain. In case of its development, the authors tried to get information about its localization, severity, and persistence during the flight or after its completion.

The third group contained questions concerning an effect of the work in aircraft

cockpit environment and factors, which could cause back pain. Questions concerned an opinion on the comfort of the pilot's seat, most frequent posture assumed by the pilot during the flight and the rate of any body movements.

The fourth group of questions was aimed at gathering information about the factors being responsible for flight control precision when back pain developed. These questions were related to the body status: degree of fatigue, nervous tension development, effect of fatigue on concentration and any effect on their ability of perceiving flight instrument panel readings.

The fifth group contained questions concerning back pain prevention: types of physical exercises recommended by the specialists or performed individually.

After questionnaire completion the pilots were interviewed individually and asked about work conditions, rest, suggestions concerning ergonomic adjustments or improvement in other requirements related to the physical and psychological overload during the flight. An emphasis during this interview was on the proper rest conditions and susceptibility to fatigue before the flight.

Results

The largest group of pilots fly aircraft of the M-28 Bryza type. This group included 38 pilots. Similar features of the transport aircraft Jak-40 and Tu-154M types allowed us to combine these aircraft into one group of 8 pilots for analysis. The last group of 14 pilots fly the C-295M aircraft.

Mean values of anthropometrical data with respect to the aircraft flowninclude: age, body weight, height, and BMI (table 1).

Tab. 1. Responders' anthropometrical data with aircraft type taken into consideration (x±SD)

	Total n=60	**C-295M**	**Group Jak-40, Tu-154M**	**M-28**
Age (years)	37,0±6,3	36,4±5,0	38,9±4,7	36,8±7,1
Height (cm)	176,9±6,0	173,7±5,1	180,6±6,9	177,3±5,6
Body weight (kg)	82,8±10,3	80,1±10,2	89,5±10,4	82,3±10,0
BMI	26,4±3,0	26,6±3,5	27,4±2,3	26,2±2,9

Differences in the anthropometrical data mean values were similar for all pilots. An exception was a combined group of pilots flying Jak-40 and Tu-154M, consisting of mainly older, taller, and heavier pilots. BMI in this group reached the lower border of the overweight range.

Analyzing the number of flown hours, it was shown that the highest total number of the flown hours, i.e. 2840±1545 hrs, had the group of the oldest pilots flying the Jak-40 and Tu-154M. In this group, the number of hours flown last year was also the highest. In this group, were two pilots of Tu-154M aircraft and their numbers of total flown hours was 3500 hrs and 3800 hrs, respectively. Number of the flown hours of the remaining pilots of this group was not less than 1000 hours.

Tab. 2. Number of the flown hours in different groups (x±SD)

	Total n=46	**C-295M**	**Group Jak-40, Tu-154M**	**M-28**
Total number of flown hours	1837,2±1334,7	2288,6±1487,9	2480,0±1545,4	1535,6±1162,4
Number of flown hours in the last year	119,7±72,7	172,5±83,3	186,0±87,5	96,6±59,0

Data in table 2 suggest that not all pilots flying each type of aircraft flew a similar number of hours. Marked differences in SD both in the total number of the flown hours and those flown in the last year confirm this fact.

Table 3 shows an incidence and severity of back pain. It was found that 16 out of 60 (27%) pilots did not report any pain. Forty four respondents (73%) reported back pain of different degrees of severity.

Tab. 3. Number and severity of reported back pain (n/%)

	Total n=60	**C-295M**	**Group Jak-40, Tu-154M**	**M-28**
Did pain occur?	44 (73%)	12 (86%)	5 (63%)	27 (71%)
Severe	14 (23%)	1 (7%)	2 (25%)	11 (29%)
Mild of discomfort type	30 (50%)	11 (79%)	3 (38%)	16 (42%)

Two pilots flying the Tu-154M reported severe back pain, which could be associated with the high number of the hours flown. One pilot with 3200 hours reported only periodical back pain during the flights. Pain developed after some hours of flight and persisted during the day after its completion. This could be associated with the overloading of flights and more rapidly increasing fatigue in comparison with other pilots.

The second pilot of this group, with 3100 hours, reported low back pain persisting both during the flight and after its completion. It should be noted that this pilot was markedly overweight (BMI=30,06). Answering the question concerning causes of back pain, this pilot admitted uncomfortable posture also in the seated position, long-haul flights or nervous tension. He was hospitalized and rehabilitated for back pain. Problems subsided after the treatment.

Similarly to that survey, the authors divided back pain into mild but clearly sensed or severe, i.e. 5-10 scores (0 – no pain, 10 – the most severe pain), and mild pain (VAS scores: 1-5). The Visual Analogue Scale (VAS), used in both medicine and psychology, was applied for this purpose (see fig. 1).

Graphic comparison of pain mean VAS scores of severe and mild pain is shown in fig. 1.

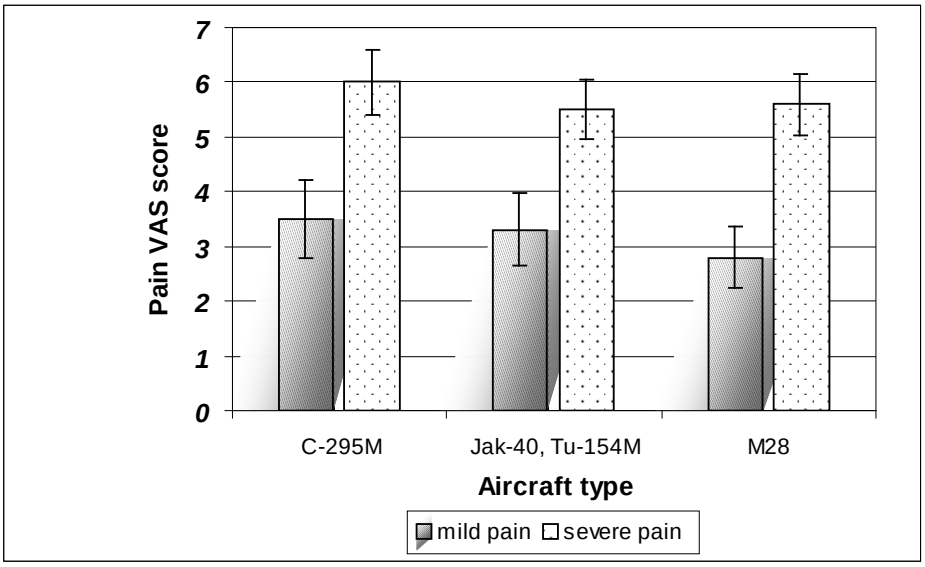

Fig. 1. Pain mean VAS scores with respect to aircraft type (with SD graph).

Based on the data shown in fig. 1, one may conclude that mild and severe pain was noted in each group of pilots. The differences between mild and severe pain and aircraft type were not statistically significant.

Table 4 presents localization of all reported pain complaints. It should be stressed that data in table 4 concern the answers of pilots reporting pain in different body parts. The largest number of pilots (n=41) reported low (lumbar) back pain. The pilots of the military transport aircraft of all types reported such pain.

Tab. 4. Localization of pain in different body parts (n=60)

Pain localization	**Total n=60(%)**	**C-295M**	**Group Jak-40, Tu-154M**	**M-28**
Cervical spine	14 (23%)	3 (21%)	1 (13%)	10(26%)
Thoracic spine	6 (10%)	2 (14%)	(0) (0%)	4 (11%)
Lumbar spine	41 (68%)	11 (79%)	5 (63%)	25 (66%)
Limbs – upper and lower	4 (7%)	2 (14%)	(0) (0%)	2 (5%)

Six pilots reported pain in the interscapular area, 14 pilots in the cervical spine, and four reported pain in the limbs. Some pilots described this pain as localized and constant, other more rarely – as radiating to the interscapular area, and three pilots described pain as transient lower limbs contractions. It should be stressed that data in Table 4 concern the answers of pilots reporting pain in different body parts.

Analyzing pain onset during the flight, pilots of C-295M, Jak-40, and Tu-154M felt pain after about 150, 80, and 90 minutes of flight, respectively. Seven pilots reported that pain persisted after the flight but its duration was individually different - from several minutes to some hours. In two of these cases, mentioned above,

severe pain developed periodically in everyday life. Mild pain, mainly of muscular origin, developed most frequently in the last phase of the flight. No respondent admitted that back pain or muscular pain occurred during every flight.

Work of the military transport aircrafts pilots is associated with nervous tension, but only four pilots emphasized it. It should be stressed that this state is associated with responsibility for safe transporting of men or precious equipment. Therefore, the small number of pilots emphasizing this aspect is rather surprising. Questions concerning an effect of turbulence, aircraft maneuvers during takeoff and single pilots only answered landing. It means that these factors did not cause back pain.

Figure 2 presents selected causes of pain during the flight in with respect to particular aircraft types.

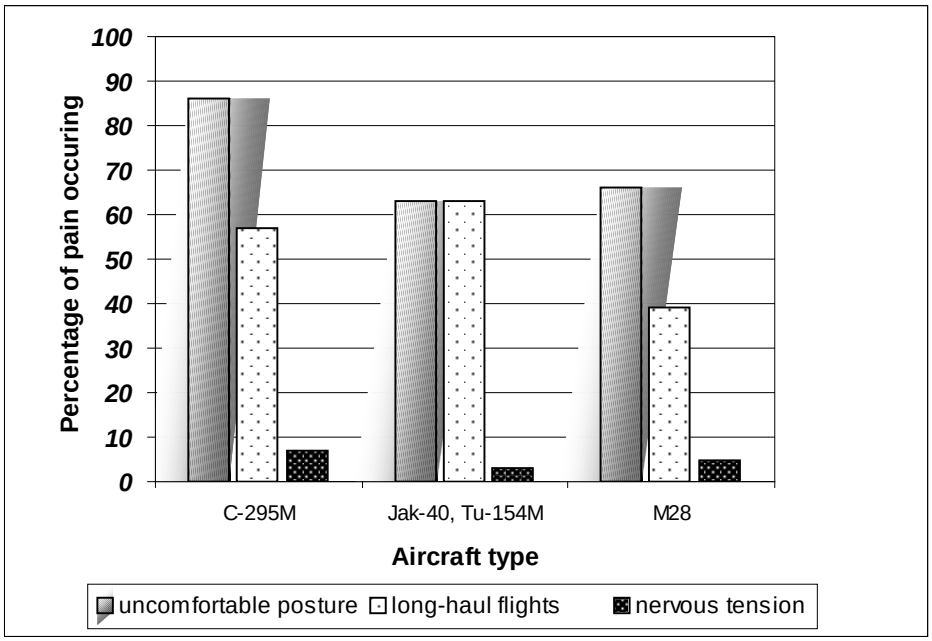

Fig. 2. Selected causes of pain during the flight with respect to aircraft type.

Questions related to an effect of pain on aircraft control were considered important. Twenty six pilots answered that increasing back pain during the flight may somehow impede precision of aircraft control because of limited body movements leading to an increase in pain severity. It is associated with decreased concentration and less precise perception of the flight instrument panel readings.

Pain did not result in flight discontinuation. It has already been mentioned that pain could become more severe during body movements. Therefore, respondents were asked whether body rotation, trunk bending sideways, or head movements intensified back pain during the flight. Not all pilots answered this question. Eight admitted that trunk rotations intensified back pain, while three pilots reported head movements caused back pain. Thirty-six (60%) pilots answered that they feel pain at rest. This results seems justified as body movements may intensify pre-existing pain.

One survey element concerned determination of back pain prevention by the aid of general physical exercises. Only 23 pilots (38%) undertook preventive means 20 of these 23 pilots reported pain development during the flight. One could, therefore, assume that the remaining three pilots practiced physical exercises, even if they did not suffer from pain. Moreover, it should be stressed that nine pilots of this group reported severe back pain and eleven reported mild pain of muscular origin.

As far as the types of physical exercise are concerned, 85% of pilots reported regular practicing of stretching and relaxing paravertebral muscle exercises both before and after the flight. These exercises included head movements from one side to another, trunk rotations, bending forward and extensions backward. The mean duration of exercises was about 5 minutes before the flight and 5 minutes after leaving the cockpit.

Percent values of pain and frequency of the above mentioned physical exercises are shown in fig. 3. The level of preventive measures undertaken by the pilots should be stressed as it indicates that nearly one-half of the pilots reporting back pain are aware of this problem.

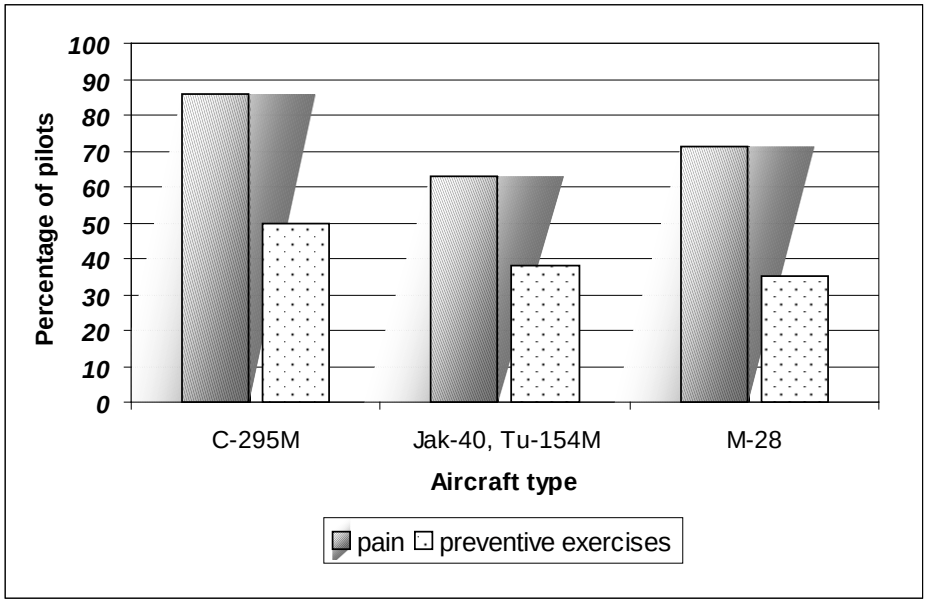

Fig. 3. Practice of the preventive exercises versus reported pain, with respect to aircraft types.

Analyzing rehabilitation, it was found that six pilots underwent physiotherapy, whereas three pilots used prescribed medicines, which effectively diminished the pain. It should be stressed that these pilots complained of severe pain, radiating to both the cervical and lumbar spine.

During individual interviews it was noted that refusal to fly was principally due to general malaise, fatigue or infection.

Discussion

This questionnaire survey aimed at gathering information on back pain and its causes and effect on pilots' performance. Similar results have been reported also by other authors who determined the scale of such complaints in pilots of different nations. Froom et al. [8] have shown that a high percentage of the Israeli pilots of military transport aircraft complained of low back pain. The authors suggested that one of the causes was a post-traumatic spine lesion. Similarly, Burmeister and Thoma [3] attempted to gather information about backache from pilots flying Plaggio 149 and Dornier 28 aircraft. The majority of the pilots complained of backache.

Porter and Simpson [18] tried to gather information about musculoskeletal pain in 174 British and Irish pilots. They found that 53% reported pain and discomfort in the lumbar area. Similar reports of pain in aircrew of the transport aircraft were also documented by Fitzgerald and Crotty [6]. The authors observed that the incidence of backache was twice as high as in other crew members. This difference depended on the age of responders. Mainly older pilots(over 45 years of age) suffered backache. In our survey, we also found that back pain occurred most frequently in the group of the older, taller and heavier pilots.

Analyzing the results quoted by other authors, it may be assumed that prevalence of severe backache reached about 40%. Mild muscular pain of the shoulders and back, reported by 60% to 80% of the pilots, included a sensation of discomfort in these areas [14,16]. In our survey, 44% of pilots suffering from severe backache reported that pain was gradually increasing. Initially it was mild, next – medium, and finally severe and troubling. This type of back pain could be associated with the number of flown hours. It should be stressed that pilots did not discontinue the flight, despite severe back pain.

Results of our survey and information provided by the pilots during the individual interviews indicated that in addition to already mentioned factors back pain affects concentration and increases nervous tension; changes in the muscular tone impeded relaxation, sporadically developed somnolence, and resulted in the lack of effective flight control.

All cases of severe back pain, most frequently reported by the pilots, concerned the lumbar spine [18,19]. Causes of these complaints are often complex. In the world literature, several authors relate back pain with pilots' seats construction. Mandal [14] is sure that the main cause of back pain is ergonomically improper construction of pilots' seats. Other authors suggest that one of the causes is the lack of lumbar spine support. Graham-Cumming [9] has showed that support of this segment of the spine eliminated back pain in 78% of pilots, being ineffective in 22%.

One of our survey issues was pain onset. We found that pilots will start to feel pain at different times, depending on which aircraft they are flying. The time range of pain onset was 90 to 150 minutes on the average. Philippa et al. [17] performed a questionnaire survey in 74 transport aviation pilots during short-haul transport operations. These authors found that back pain develops before take off, during the flight, and after landing in 17%, 75%, and 8% of the pilots, respectively. In another study [16] the same authors examining 32 pilots executing long-haul flights and crossing time zones found increasing fatigue accompanied by back pain in 11%, 83%, and 8% of the pilots, respectively. Williams et al. [21] investigated an

effect of lordosis change on the pilots' work comfort. They indicated that the use of inappropriate shock-absorbing materials to mould pilots' seats is a main cause of back pain in sitting posture. It is responsible for a decrease in lordosis and pressure on the front parts of vertebral bodies and intervertebral discs resulting in back pain during long-haul flights.

We have also investigated pilots' posture during the flight. The largest group of responders (72%) admitted that uncomfortable sitting posture for a long time was a cause of back pain. Our questionnaire survey indicated that pilots not always have back support during the flight and when back pain appeared they have then assumed a comfortable working sitting posture. The amount of time sitting in a such a position was individually different. It should be stressed that body movements, when back pain developed, might intensify the pain. We could not determine precisely the time of sitting in working or supported posture.

In the pilots' opinion, change of posture during the flight resulted from increasing fatigue due to the long-haul flights. Posture changing improved well-being. Based on the results of studies, we found that precise body clinging to the seat's backrest diminishes or eliminates back pain. One may suppose that the problems with spine curvatures clinging to the pilots' seat may be associated with some pilots' overweight (according to BMI value) condition. This we showed in our studies.

Out of other back pain causes, 53% of the respondents indicated long-haul flights, led to an intensification of both physical and psychological fatigue. Bourgeois-Bougrine et al. [6] performed survey studies of 739 transport pilots during short and long-haul flights. The authors clarify what acute fatigue means to pilots as causal factors in the investigation of accidents and incidents. It is self-evident, that back pain could appear during fatigue and influence flight precision. Other authors [1,2,7,11,13,18,19,20] also investigated this problem. They found that fatigue has a negative effect on human performance and depends on different factors.

Therefore, fatigue can accompany short-haul flights and be more pronounced due to frequent take offs and landings. During long-haul flights pilots have more time for preparation. These authors also admit that pilot physical load during flights in high altitudes is lower despite decreased air pressure in the cockpit. There are other factors responsible for pilots' fatigue, i.e. changes of time zones and circadian cycles, which sometimes produce sleep and rest disorders [21]. Moreover, an extra load is due to the flights in difficult atmospheric conditions and increased nervous tension always present during take offs and landings.

We have showed that back and muscular pain in the pilots of military transport aircraft may limit their ability to fly. One may suspect that frequent back pain episodes of different severity may lead to the development of both acute and chronic diseases of the spine. An early diagnosis of skeletal system pathologies enables one to introduce preventive measures. Various forms of physical exercises practiced by the pilots are an individual choice and are not practiced by the entire pilots population. Therefore, directed prophylaxis in the form of both physical training and treatment is recommended.

Conclusions

1. The majority of interviewed pilots admitted that back pain during the long-haul flights impede the full range of body movements, compromise a comfortable sitting posture and diminish their ability to concentrate on their flying.
2. A high percentage of pilots of military transport aircraft reporting back pain require detailed clinical diagnostic examinations and an early rehabilitation, if some pathologies are found.
3. A specifically designed, uniform training program for all pilots of military transport aircraft is recommended. Such a program should include a set of physical exercises before take off and after landing and programs of prophylactic general fitness training.

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