

THE RELATIONSHIP BETWEEN FLIGHT HOURS, AGE, AND BODY MASS INDEX AND THE OCCURRENCE OF LOW BACK PAIN AMONG COMMERCIAL FIXED-WING PILOTS IN INDONESIA DURING THE COVID-19 PANDEMIC

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Abstract

Low back pain (LBP) is a common musculoskeletal complaint among workers, including commercial airline pilots. The aviation work environment is characterized by prolonged static sitting, whole-body vibration, mild hypoxia, low cabin humidity, and individual factors such as age and body mass index (BMI), all of which may contribute to the development of LBP. This study aimed to determine the prevalence of LBP and to analyze the association between total flight hours, age, and BMI with the occurrence of LBP among commercial fixed-wing pilots in Indonesia. An analytic observational study with a cross-sectional design was conducted at the Indonesian Civil Aviation Medical Center. The study population consisted of commercial fixed-wing pilots flying pressurized aircraft who underwent routine medical examinations (MEDEX). A total of 410 pilots met the inclusion criteria and were analyzed. Data were collected using structured questionnaires and medical records, including demographic characteristics, total flight hours, BMI, and LBP assessed using the Oswestry Disability Index (ODI). Data analysis included univariate, bivariate (Chi-square test), and multivariate logistic regression analyses. The prevalence of LBP among commercial fixed-wing pilots in Indonesia was 5.85%. No significant association was found between total flight hours, age, or BMI and the occurrence of LBP ($p > 0.05$). However, female pilots showed a significantly higher risk of LBP compared to male pilots (OR = 6.85; 95% CI: 1.47–31.81; $p = 0.01$). The prevalence of LBP among commercial fixed-wing pilots in Indonesia was relatively low. Total flight hours, age, and BMI were not significantly associated with LBP, whereas sex was the most influential factor. These findings highlight the importance of gender-sensitive ergonomic and occupational health strategies in the prevention of LBP among commercial pilots.

Keywords: low back pain, commercial pilots, flight hours, body mass index, occupational health

INTRODUCTION

Low back pain (LBP) is one of the most prevalent musculoskeletal disorders worldwide and a leading cause of disability and reduced work productivity. It is estimated that 60–90% of individuals will experience LBP at least once in their lifetime, with a substantial proportion developing chronic symptoms that impair functional capacity and quality of life. In occupational health, LBP is of particular concern because it is closely associated with work-related physical demands, posture, and environmental exposures.

Commercial airline pilots represent a unique occupational group with specific risk factors for LBP. Their work involves prolonged static sitting with limited mobility, exposure to whole-body vibration, reduced cabin pressure resulting in mild hypoxia, low cabin humidity, and exposure to cosmic radiation. These factors may induce degenerative changes in the lumbar spine, particularly in the intervertebral discs, thereby increasing the risk of LBP. In addition to occupational exposures, individual factors such as age and body mass index (BMI) may further increase mechanical loading on the lumbar spine and accelerate degenerative processes.

Several international studies have reported a high prevalence of LBP among civil aviation pilots, ranging from 40% to more than 80%, particularly for chronic LBP. LBP among pilots not only affects individual health and comfort but may also impair work performance, slow reaction times, and increase the risk of sudden incapacitation, potentially compromising flight safety. Therefore, LBP in pilots represents an important occupational health and aviation safety issue.

In Indonesia, research on musculoskeletal disorders among aircrew remains limited and has primarily focused on cabin crew. Data specifically addressing the prevalence and risk factors of LBP among commercial fixed-wing pilots are scarce. Differences in operational characteristics, flight duration, flight frequency, and flight hour regulations may result in a distinct risk profile compared to pilots in other countries. Consequently, this study aimed to determine the prevalence of LBP and to analyze the relationship between total flight hours, age, and BMI and the occurrence of LBP among commercial fixed-wing pilots in Indonesia.

LITERATURE REVIEW

Low back pain (LBP) is pain or discomfort in the lower back region and is commonly classified as acute, subacute, or chronic based on duration. Most LBP cases are non-specific, with no identifiable pathological cause. Globally, LBP is a leading cause of disability, particularly among working-age populations, and results from a multifactorial interaction of individual, biomechanical, and occupational factors.

Age and body mass index (BMI) are important individual risk factors for LBP. Increasing age is associated with degenerative changes in the spine, while higher BMI increases mechanical loading on the lumbar spine, potentially accelerating disc degeneration. Although many studies report a positive association between elevated BMI and LBP, findings remain inconsistent across different populations.

Commercial pilots face unique occupational risks for LBP due to prolonged sitting, limited movement, and cockpit ergonomics during flight operations. Exposure to whole-body vibration and cumulative aviation-related stressors may further contribute to spinal degeneration. Total flight hours reflect cumulative exposure to these risk factors and have been suggested as a determinant of musculoskeletal disorders, including LBP, although reported associations vary.

Research on LBP among commercial fixed-wing pilots in Indonesia is limited. Differences in flight operations, regulations, and demographic characteristics highlight the need for country-specific studies. This study aims to examine the relationship between flight hours, age, BMI, and the occurrence of LBP among commercial fixed-wing pilots in Indonesia.

METHODS

Study Design and Setting

This study was an analytic observational study with a cross-sectional design. The research was conducted at the Indonesian Civil Aviation Medical Center during routine aeromedical examinations (Medical Examination for Pilots/MEDEX). The study evaluated the relationship between total flight hours, age, and body mass index (BMI) and the occurrence of low back pain (LBP) among commercial fixed-wing pilots in Indonesia.

Study Population and Sample

The study population consisted of commercial civil pilots operating fixed-wing, pressurized aircraft in Indonesia. Eligible participants were pilots who underwent routine aeromedical examinations during the study period.

Inclusion criteria were:

1. Active commercial fixed-wing pilots operating pressurized aircraft
2. Undergoing routine aeromedical examination (MEDEX)
3. Willing to participate in the study

Exclusion criteria were:

1. History of spinal surgery
2. Diagnosed spinal deformities or neurological disorders affecting the spine
3. Incomplete questionnaire or medical record data

A total of 410 pilots met the inclusion criteria and were included in the final analysis.

Variables and Measurements

The dependent variable was the occurrence of low back pain, assessed using the Oswestry Disability Index (ODI). An ODI score greater than 20% was used to indicate functionally significant low back pain.

The independent variables included:

1. Total flight hours, obtained from official flight log records and categorized based on cumulative exposure
2. Age, recorded in years and analyzed as a categorical variable
3. Body mass index (BMI), calculated as weight in kilograms divided by height in meters squared (kg/m^2) and classified according to World Health Organization criteria

Additional variables included sex and history of spinal trauma, which were considered potential confounders.

Data Collection

Data were collected using structured self-administered questionnaires and verified through medical records during the aeromedical examination. Information obtained included

demographic characteristics, flight experience, anthropometric measurements, and musculoskeletal complaints.

The Oswestry Disability Index questionnaire used in this study has been widely validated and is considered a reliable instrument for assessing disability related to low back pain.

Statistical Analysis

Data analysis was performed using statistical software. Descriptive (univariate) analysis was conducted to summarize demographic characteristics and study variables. Bivariate analysis using the Chi-square test was applied to evaluate the association between independent variables and the occurrence of low back pain.

Variables with p -values < 0.25 in bivariate analysis were included in the multivariate analysis. Multivariate logistic regression was used to identify factors independently associated with low back pain, with results presented as odds ratios (ORs) and 95% confidence intervals (CIs). A p -value < 0.05 was considered statistically significant.

Ethical Considerations

This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the appropriate institutional ethics committee. All participants provided informed consent prior to participation, and confidentiality of personal data was strictly maintained.

RESULT AND DISCUSSION

Result

A total of 410 commercial fixed-wing pilots met the inclusion criteria and were included in the analysis. All participants operated pressurized aircraft and underwent routine aeromedical examinations (MEDEX). The majority were male (96.1%), with a mean age of 34.25 years. More than half of the participants were classified as overweight or obese based on BMI (84.15%), and the mean total flight time was 6,253 hours.

The prevalence of LBP assessed using the Oswestry Disability Index (ODI) with a disability threshold greater than 20% was 5.85% (24 out of 410 pilots). Most pilots did not report functionally significant LBP.

Bivariate analysis demonstrated no significant association between age and LBP ($p = 0.619$), total flight hours and LBP ($p = 0.834$), or BMI and LBP ($p = 1.000$). However, sex was significantly associated with LBP, with female pilots showing a higher risk compared to male pilots (OR = 4.10; 95% CI: 1.08–15.50).

Multivariate logistic regression analysis confirmed that female sex was the strongest factor associated with LBP (OR = 6.85; 95% CI: 1.47–31.81; $p = 0.01$), while age, total flight hours, BMI, and history of trauma were not significantly associated with LBP.

Discussion

This study demonstrated a relatively low prevalence of LBP (5.85%) among commercial fixed-wing pilots in Indonesia. This prevalence is considerably lower than that reported in many international studies, which have documented LBP prevalence rates ranging from 40% to over 80%. This discrepancy may be attributed to differences in LBP assessment methods, diagnostic criteria, and population characteristics. The use of the Oswestry Disability Index with a functional disability threshold in this study likely identified only clinically meaningful cases of LBP.

The absence of a significant association between total flight hours and LBP contrasts with biomechanical theories suggesting that prolonged static sitting and cumulative flight exposure increase musculoskeletal risk. However, similar findings have been reported in studies indicating that the relationship between flight hours and LBP is not consistently significant. Possible explanations include physiological adaptation, improved cockpit seat ergonomics, strict flight hour regulations, and adequate work-rest schedules in commercial aviation.

Age was not significantly associated with LBP in this study. Most participants were relatively young, and clinically significant degenerative spinal changes may not yet have developed. Furthermore, pilots undergo rigorous medical screening, which may exclude individuals with severe musculoskeletal disorders from active flying duties.

BMI was also not significantly associated with LBP, despite the high prevalence of overweight and obesity among participants. High physical fitness requirements and regular aeromedical assessments may mitigate the biomechanical effects of increased body weight on the lumbar spine.

The most notable finding was the strong association between female sex and LBP. Female pilots had a significantly higher risk of LBP compared to male pilots. This finding is consistent with previous studies suggesting that women are more susceptible to musculoskeletal disorders due to differences in anatomy, muscle composition, hormonal factors, and ergonomics. Cockpit design based primarily on male anthropometry may result in suboptimal posture and increased lumbar strain among female pilots.

Overall, these findings suggest that individual factors—particularly sex—may play a more prominent role in LBP occurrence than occupational exposure factors such as total flight hours. This highlights the importance of gender-sensitive ergonomic design and targeted occupational health interventions for female pilots.

CONCLUSION

The prevalence of low back pain among commercial fixed-wing pilots in Indonesia was relatively low. Total flight hours, age, and body mass index were not significantly associated with the occurrence of low back pain, whereas female sex was identified as the most influential factor. These findings emphasize the need for gender-specific ergonomic considerations and targeted musculoskeletal prevention strategies to support pilot health and aviation safety.

The lack of significant associations between low back pain and total flight hours, age, and body mass index may be partly explained by contextual factors during the study period. Data

collection was conducted during the COVID-19 pandemic, a time when flight operations were substantially reduced, resulting in decreased cumulative exposure to occupational risk factors. In addition, pilots undergoing routine aeromedical examinations may have received timely medical treatment and rehabilitation for musculoskeletal complaints, potentially leading to symptom resolution at the time of assessment. These factors may have contributed to the relatively low prevalence of functionally significant low back pain observed in this study.

Future studies with longitudinal designs conducted under normal flight operation conditions are warranted to further clarify the long-term effects of cumulative flight exposure and individual risk factors on the development of low back pain among commercial pilots.

REFERENCES

- Hartvigsen, J. et al. What low back pain is and why we need to pay attention. *Lancet* 391, 2356–2367 (2018).
- Rodriguez, H. A. F. & Mayorga, V. A. O. Characterization of Low Back Pain in Pilots and Maintenance Technicians on a Commercial Airline. *Aerosp. Med. Hum. Perform.* 87, 795–799 (2016).
- Steffens D, Maher CG, Pereira LS, Stevens ML, Oliveira VC, Chapple M, Teixeira-Salmela LF, Hancock MJ. Prevention of Low Back Pain: A Systematic Review and Meta-analysis. *JAMA Intern Med.* 2016 Feb;176(2):199-208.
- Rik, L., De Beeck, O. & Hermans, V. Research on work-related low back disorders. (2000). Gaydos, S. J. Low back pain: Considerations for rotary-wing aircrew. *Aviat. Sp. Environ. Med.* 83, 879–889 (2012).
- Çınar-Medeni, Ö., Güzel, N. A. & Erdogan, M. The predictors of low back pain in helicopter pilots. *Gazi Med. J.* 26, 15–18 (2015).
- Baron, R. et al. Neuropathic low back pain in clinical practice. *Eur. J. Pain (United Kingdom)* 20, 861–873 (2016).
- Allegri, M. et al. Mechanisms of low back pain: A guide for diagnosis and therapy [version 1; referees: 3 approved]. *F1000Research* 5, 1–11 (2016).
- Khripanandit, I., Tapan, H., Firdos, M. & Basuki, B. Flight time, number of sectors and risk of low back pain among short and medium haul commercial female flight attendants in Indonesia. *Heal. Sci. J. Indones.* 7, 64–68 (2016).
- Peraturan Direktur Jenderal Perhubungan Udara Nomor KP 238 Tahun 2018 Tentang Petunjuk Teknis Peraturan Keselamatan Penerbangan Sipil Bagian 67-02 Tentang Pedoman Penilaian Kesehatan Penerbangan. (2018). *Manual of Civil Aviation Medicine.* (International Civil Aviation Organization, 2012).
- Lee, H., Wilbur, J. & Conrad, K. M. Work-Related Musculoskeletal Symptoms Reported by Female Flight Attendants on Long-Haul Flights. 77, 1283–1287 (2006). Taneja, N. Spinal disabilities in military and civil aviators. *Spine (Phila. Pa. 1976)*. 33, 2749–2753 (2008).
- Haugli L, Skogstad A, Hellesoy OH. Health, sleep, and mood perceptions reported by airline crews flying short and long hauls. *Aviat Space Environ Med* 1994; 65: 27–34. Peter A. Simpson & J. Mark Porter (2003) Flight-Related Musculoskeletal Pain and Discomfort in General Aviation Pilots From the United Kingdom and Ireland, *The International Journal of Aviation Psychology*, 13:3, 301-318
- Prombumroong, J., Janwantanakul, P., & Pensri, P. (2011). Prevalence of and Biopsychosocial Factors Associated with Low Back Pain in Commercial Airline Pilots. *Aviation, Space, and Environmental Medicine*, 82(9), 879–884.
- Fajardo Rodriguez, H. A., & Ortiz Mayorga, V. A. (2016). Characterization of Low Back

- Pain in Pilots and Maintenance Technicians on a Commercial Airline. *Aerospace Medicine and Human Performance*, 87(9), 795–799
- Albermann M, Lehmann M, Eiche C, Schmidt J, Prottengeier J. Low Back Pain in Commercial Airline Pilots. *Aerosp Med Hum Perform*. 2020 Dec 1;91(12):940-947 Peraturan Menteri Perhubungan nomor 28 Tahun 2013 Tentang Peraturan Keselamatan Penerbangan Sipil Bagian 121 (mengacu pada Civil Aviation Safety Regulation Part 121) Tentang Persyaratan-Persyaratan Sertifikasi Dan Operasi Bagi Perusahaan Angkutan Udara Yang Melakukan Penerbangan Dalam Negeri, Internasional Dan Angkutan Udara Niaga Tidak Berjadwal (2013)
- Snell, Richard S. ; Sugiharto, Liliana ; Ardy Suwahjo ; Yohanes Antoni Liestyawan. *Anatomi Klinis Berdasarkan Sistem / Richard S. Snell; Alih Bahasa, Liliana Sugiharto; Editor, Ardy Suwahjo; Yohanes Antoni Liestyawan. .2012*
- Keith L Moore; Arthur F Dalley, II; A M R Agur. *Clinically oriented anatomy 7th Edition. Philadelphia : Wolters Kluwer Health/Lippincott Williams & Wilkins, [2014]* Biyani A, Andersson G. Low Back Pain: Pathophysiology and Management. *Journal of the American Academy of Orthopaedic Surgeons*. 2004;12(2):106-115.
- Vismara L., Menegoni F., Fabio Zaina F., Galli M., Negrini S., Capodaglio P., 2010. Effect of obesity and low back pain on spinal mobility: a cross sectional study in women. <http://www.jneuroengrehab.com/content/7/1/3>
- Purnamasari H., 2010. Overweight Sebagai Faktor Risiko Low Back Pain Pada Pasien PoliSaraf Prof. Dr. Margono Soekarjo Purwokerto, *Mandala of Health 4: 26-32*. Rathjen, T. et al. *Fundamentals of Aerospace Medicine 4th Edition. Fundamentals of Aerospace Medicine (2008).*
- Gradwell, D. *Ernsting's Aviation and Space Medicine 5E. Ernsting's Aviation and Space Medicine 5E (2016).*
- Nesthus, T. E., Rush, L. L. & Wreggit, S. S. Effects of mild hypoxia on pilot performances at general aviation altitudes. (1997).
- Ma, K. et al. Mechanisms of endogenous repair failure during intervertebral disc degeneration. *Osteoarthr. Cartil.* 27, 41–48 (2019).
- Hiyama, A. et al. Hypoxia activates the notch signaling pathway in cells of the intervertebral disc: Implications in degenerative disc disease. *Arthritis Rheum.*63, 1355–1364 (2011).
- Samartzis, D., Cheung, K. M. C. & Orth, F. Ionizing radiation exposure and the development of intervertebral disc degeneration in humans : myth or reality. *Spine J.* 11, 979–982 (2011).
- Thibeault, C. & Evans, A. D. AsMA medical guidelines for air travel: Stresses of flight. *Aerosp. Med. Hum. Perform.* 86, 486–487 (2015).
- Reinhart, R. O. *Basic flight Physiology. Mc Graw Hill (2008).*
- Inoue, N. & Orias, A. A. E. Biomechanic of Intervertebral Disc Degeneration. *Orthop. Clin. North Am.* 42, 487–499 (2012).
- Smith, L. J., Nerurkar, N. L., Choi, K. S., Harfe, B. D. & Elliott, D. M. Degeneration and regeneration of the intervertebral disc: Lessons from development. *DMM Dis. Model. Mech.* 4, 31–41 (2011).
- BALLANTYNE, J., FISHMAN, S., & RATHMELL, J. P. *Bonica's management of pain. Fifth Edition. Philadelphia : Wolters Kluwer Health, [2019]*
- Hall A, Maher C, Latimer J, Ferreira M, Costa L. The patient-specific functional scale is more responsive than the Roland Morris disability questionnaire when activity limitation is low. *European Spine Journal*. 2010;20(1):79-86.
- Nambi, S. G. (2013). Reliability, validity, sensitivity and specificity of Gujarati version of the Roland-Morris Disability Questionnaire. *Journal of Back and Musculoskeletal*

Rehabilitation, 26(2), 149–153.

- Monticone, M., Baiardi, P., Vanti, C., Ferrari, S., Pillastrini, P., Mugnai, R., & Foti, C. (2011). Responsiveness of the Oswestry Disability Index and the Roland Morris Disability Questionnaire in Italian subjects with sub-acute and chronic low back pain. *European Spine Journal*, 21(1), 122–129
- Childs, J. D., Piva, S. R., & Fritz, J. M. (2005). Responsiveness of the Numeric Pain Rating Scale in Patients with Low Back Pain. *Spine*, 30(11), 1331–1334.
- Krebs, E. E., Carey, T. S., & Weinberger, M. (2007). Accuracy of the Pain Numeric Rating Scale as a Screening Test in Primary Care. *Journal of General Internal Medicine*, 22(10), 1453–1458.
- Chiarotto, A., Vanti, C., Cedraschi, C., Ferrari, S., de Lima e Sà Resende, F., Ostelo, R. W., & Pillastrini, P. (2016). Responsiveness and Minimal Important Change of the Pain Self-Efficacy Questionnaire and Short Forms in Patients With Chronic Low Back Pain. *The Journal of Pain*, 17(6), 707–718.
- Fairbank, J. C. T., & Pynsent, P. B. (2000). The Oswestry Disability Index. *Spine*, 25(22), 2940–2953. doi:10.1097/00007632-200011150-00017
- Chairani, A. Validity and Reliability Test of The Nordic Musculoskeletal Questionnaire with Formal and Informal Sector Workers. *The 7th International Conference on Public Health*. Solo. 2020
- Panduan Praktik Klinis Neurologi. Perhimpunan Dokter Spesialis Saraf Indonesia. 2016 Foster, Anema J, Cherkin D, Chou R, Cohen S, Gross D et al. Prevention and treatment of low back pain: evidence, challenges, and promising directions. *The Lancet*. 2018;391(10137):2368-2383.
- Kurniawan, G. P. D. Mckenzie Exercise dalam Penurunan Disabilitas Pasien Non-Specific Low Back Pain. *Jurnal Kesehatan* Vol. 10 No. 1, Mei 2019