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ORIGINAL ARTICLE

Low Back Pain and Neck Pain in Paragliding Pilots

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ABSTRACT

BACKGROUND
Paragliding is a popular aerial sport requiring pilots to maintain specific postures and engage in repetitive movements, potentially leading to musculoskeletal issues such as low back pain (LBP) and neck Pain (NP). This study aims to identify the incidence of low back pain and neck pain among paragliding pilots. Additionally, potential risk factors that contribute to these conditions within this population should be identified.

METHODS
An online questionnaire was developed and distributed to a sample of paragliding pilots. The grade of impairment due to LBP was evaluated by the Oswestry Low Back Pain Disability Index (ODI). Similarly, the Neck Disability Index (NDI) was used for NP. Additional questions were focused on potential risk factors

RESULTS
Ninety paragliding pilots participated in the online questionnaire. The average age was 39.36 years, with a mean BMI of 24.85 (SD 4.69). Forty-five participants were Nepali citizens, and the other 45 were foreign nationals. The prevalence of LBP was 68.9 %, and that of NP was 71.10%. NP had a strong statistical association with the type of helmet (P-value <0.005). All the pilots with age less than 30 had NP; similarly, all the female pilots had LBP and NP, and all pilots with a BMI of over 30 had LBP. The mean ODI score was 12.22 (SD 15.78), and the mean NDI score was 9.84 (SD 14.21).

CONCLUSION
Female gender, age less than 30 and type of helmet positively correlate with NP, while BMI and female gender positively correlate with LBP.

KEYWORDS
Low back pain; Neck pain; Paragliding Pilots

INTRODUCTION

Low back pain (LBP) is a growing global health concern and is among the most prevalent conditions in the general population.[1, 2] Paragliding is a popular aerial sport that requires pilots to maintain specific postures and engage in repetitive movements, which could potentially lead to musculoskeletal issues such as low back pain and neck Pain.[3] By identifying the prevalence of low back pain (LBP) and neck pain (NP) and the associated risk factors, the study will contribute to developing strategies to minimise these health issues, thereby enhancing the safety and performance of paragliding pilots. The primary objective of this research is to identify the prevalence and incidence of LBP and NP among paragliding pilots. The study also aims to identify potential risk factors that contribute to these conditions within this population. This study is among the first to explore this area, contributing valuable insights.

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METHODS

Prior to conducting the study, we found that there were around 116 paragliding pilots registered with civil aviation authority, which was taken as the study population size and the final sample size was calculated using Solven's formula, taking a 5% margin of error, which was calculated to be 90. A cross-sectional study design was employed to achieve the research objectives. An online questionnaire was developed and distributed to a sample

of paragliding pilots. The questionnaire included sections on demographic information, paragliding experience, frequency and duration of flights, and specific questions related to the occurrence, frequency, and severity of LBP and NP. The grade of impairment due to LBP was evaluated by the Modified Oswestry Low Back Pain Disability Index (ODI).[4] Based on 10 sections (pain intensity, personal care, lifting, walking, sitting, standing, sleeping, social life, travelling, employment/homemaking), this index assesses the everyday intensity and impairment due to LBP. Similarly, the Neck Disability Index (NDI) was used for NP.[5] This included 10 sections (Pain intensity, personal care, lifting, reading, headache, concentration, work, driving, sleeping, recreation), which assesses the everyday intensity and impairment due to NP. Additional questions were focused on potential risk factors such as pre-existing health conditions, physical fitness levels, equipment used, and ergonomic factors during flights.

The questionnaire was distributed through various online platforms, including paragliding forums, social media groups, and email lists of paragliding clubs and organizations. Participants were asked to complete the questionnaire voluntarily and anonymously. To ensure a high response rate, two follow-up reminders were sent at intervals of 4 weeks. Active Paragliding Pilots aged above 18 years, with at least six months of experience and willingness to participate voluntarily, were included in the study. Individuals with incomplete data, aged less than 18 years, and with recent injuries were excluded from the study.

QUESTIONNAIRE

The questionnaire had five sections to gather information on socio-demographic data, medical history, career, flying conditions, equipment and characteristics of LBP and NP. Individual data included sex, age, height and weight, and marital status. Regarding the medical history, we asked for the history of operations, infections, and spine tumours. The career and working conditions section included details about the pilot's position, total length and duration of flying, total time spent flying (air time), total time spent flying in the last 12 months, and the most common flying length and flying condition. Further, the questionnaire asked for the type of canopy used, the general comfortability of the harness, the type of helmet and action camera used, and the attitude toward changing the profession or paragliding due to the symptoms of LBP and NP. Questions about the total duration and frequency of Pain, other associated symptoms, and current Pain in the lower back covered the topic of LBP. Similarly, the topic of NP was covered by questions about the total duration and frequency of Pain, other associated symptoms, and current Pain in the neck. All subjects were grouped regarding their pain duration into acute, subacute, chronic, and without LBP or NP, according to the original questions of the national German guidelines.[6] Following the guidelines, LBP or NP for less than six weeks was classified as acute. Persistent LBP or NP for more than six weeks and less than 12 weeks was classified as sub-acute. LBP or NP for more than 12 weeks was classified as chronic. The remaining individuals were considered to have no LBP or NP.

The mean of quantitative data was calculated by adding all the data points and dividing it by the total number of data points. Then, the standard deviation was calculated using the mean. Statistical analysis was done using the Pearson chi-square test with a P-value <0.05, which was considered statistically significant (taking a 95% confidence interval). SPSS software version 26 was used for the statistical analysis.

RESULTS

In total, 90 paragliding pilots participated in the online questionnaire. Our cohort comprised 12 females (13.3%) and 78 men (86.6%). The average age was 39.36 years (SD 11.06), with an average BMI of 24.85 kg/m2 (SD 4.69). The marital status of 90 subjects was 48 were "married", whereas 29 were single (32.2%), and 13 preferred not to disclose. Forty-five participants were Nepali citizens, and the other 45 were foreign nationals, including India, Bangladesh, British, Israel, France, Germany, Netherlands, Romania, Slovenia, United Kingdom. The mean modified ODI score was 12.22 (SD = ±15.78), and the mean NDI score was 9.84 (SD = ±14.21). (Table 1) 37.78% of respondents were professionally involved in paragliding activity either as pilots or instructors, while others had various primary occupations, e.g. engineers, military, teacher, businessman, musician, and students. 22.44 % of pilots were smoking at the time of the survey.

Table 1 Demographic distribution of pilots according to different variables

Total Respondent	**90**		**100%**
Age of respondent	Mean	39.36	
	Std. Deviation	11.07	
Gender	Male	78	86.6
	Female	12	13.3
Age group	<30	18	20.0
	30-39	34	37.7
	40-49	24	26.6
	50-59	6	6.66
	>60	8	8.88
Nationality	Nepali	45	50.0
	Foreigner	45	50.0
Marital Status	Single	29	32.22
	Married	48	53.33
	Prefer not to disclose	13	14.44
Neck Disability Index (NDI)	Mean	9.84	
	Std. Deviation	14.21	
Modified Oswestry Low Back Pain Disability Index (ODI)	Mean	12.22	
	Std. Deviation	15.78	
BMI	Mean	24.85	
	Std. Deviation	4.69	

Occupation	Professional paraglider	34	37.78
	Other	52	57.78
Smoking	Yes	22	24.44
	No	68	75.56
History of any surgery, infection, or tumours of the back/Spine:	Yes	24	26.67
	No	66	73.33
Position	Trainee Pilot	20	22.22
	Professional Solo Pilot	28	31.11
	Tandem Pilot	33	36.67
	Other	9	10.00
Since how long have you been flying (yrs)	<5	30	33.33
	5-10	12	13.33
	10-15	25	27.78
	15-20	14	15.56
	>20	9	10.00
Air time (Total hours spent flying)	<500	38	42.22
	500-1000	12	13.33
	1000-5000	27	30.00
	>5000	13	14.44
Air time in the last 12 months	<100	45	50.00
	100-200	32	35.56
	>200	13	14.44
Most common flight length (minutes)	<30	38	42.22
	30-60	24	26.67
	60-120	14	15.56
	>120	14	15.56
Frequent Flying Condition	Turbulent	48	53.33
	Calm	42	46.67
Types of paragliding	Solo Flight	30	33.33
	Commercial Tandem Flight	28	31.11
	Cross Country	28	31.11
	Occasional Flight	4	4.44
Types of glide using	EN type A	22	24.44
	EN type B	36	40.00
	EN type C	6	6.67
	EN type D	12	13.33
	Other	14	15.56

Comfortability of Harness seat	Very comfortable	32	35.56
	Comfortable	54	60.00
	Neither comfortable nor uncomfortable	4	4.44
Types of helmet	Open face helmet	72	80.00
	Full face helmet	6	6.67
	Lightweight helmet	12	13.33
How you carry your action camera (e.g. GoPro) during the flight	I do not carry a camera.	27	30.00
	Helmet Mount	16	17.78
	Selfie Stick	42	46.67
	Foot Mount	5	5.56
Thinking of Job Change or Stop paragliding due to Low Back Pain	Often	4	4.44
	Occasionally	6	6.67
	Rarely	11	12.22
	Never	69	76.67
Have you experienced any of these symptoms along with Low back pain	The tingling sensation in the leg	9	10.00
	Numbness of leg	8	8.89
	Radiating Pain in the leg	6	6.67
	No	67	74.44
Have you experienced any of these symptoms along with Neck pain	Shoulder pain	27	30.00
	The tingling sensation in the upper limb	9	10.00
	Radiating Pain in the upper limb	2	2.22
	No	52	57.78
Are you exercising regularly, e.g., physiotherapy, stretching, pilates, or yoga?	Yes	55	61.11
	No	35	38.89
Did you seek medical help?	Yes	31	34.44
	No	28	31.11
	No response	31	34.44

How do you manage Low back pain or neck pain?	I never had Low back pain or neck pain	9	10.00
	I go to a Medical Doctor	4	4.44
	I go to physiotherapist / chiropractor	10	11.11
	I do stretching by myself	47	52.22
	I neglect and let it subside itself	16	17.78
	No response	4	4.44
Have you ever had a significant accident related to paragliding (Back injury/ neck injury/ fractures/ sprain, etc.)	Yes	23	25.56
	No	63	70.00
	No response	4	4.44

Table 2: Distribution of variables according to acute, subacute and chronic low back pain and neck pain

Variables		**LBP**			**No LBP**	**NP**			**No NP**
		Acute	**Sub-acute**	**Chronic**		**Acute**	**Sub-acute**	**Chronic**	
	Absolute No.	24	20	14	32	32	16	16	26
Age	<30	10	2	2	4	14	0	4	0
	30-39	8	10	4	12	8	8	4	14
	40-49	4	6	2	6	6	6	6	6
	50-59	2	0	0	4	2	0	0	4
	>60	0	4	2	2	2	2	2	2
Sex	Male	18	20	12	28	26	14	12	26
	Female	6	2	4	0	6	2	4	0
BMI	>25	14	10	10	13	18	8	8	13
	25-30	6	10	4	15	10	6	6	13
	>30	4	2	2	0	4	2	2	0
Marital Status	Single	10	5	6	8	14	3	8	4
	Married	12	15	8	13	16	11	6	15
	Prefer not to disclose	2	2	2	7	2	2	2	7
Position	Trainee Pilot	4	0	6	10	6	0	4	10
	Professional Solo Pilot	12	6	4	6	12	6	4	6
	Tandem Pilot	8	11	4	10	14	5	6	8
	Other	0	5	2	2	0	5	2	2

Since how long have you been flying (years)	<5	12	4	4	12	16	2	2	10
	5-10	6	6	4	0	2	6	4	0
	10-15	12	3	6	10	6	3	8	8
	15-20	2	4	2	4	4	2	2	6
	>20	32	5	0	2	4	3	0	2
Air time (Total hours spent flying)	<500	10	6	10	12	12	6	10	10
	500-1000	4	4	0	4	8	0	0	4
	1000-5000	8	7	4	8	10	5	4	8
	>5000	2	5	2	4	2	5	2	4
Air time in the last 12 months	<100	12	10	12	11	16	8	10	11
	100-200	8	9	2	13	12	5	4	11
	>200	4	3	2	4	4	3	2	4
The most common flight length	<30	12	7	6	13	18	3	6	11
	30-60	2	11	4	7	4	9	4	7
	60-120	2	4	4	4	2	4	4	4
	>120	8	0	2	4	8	0	2	4
Frequent flying condition	Calm	16	6	14	12	18	6	14	10
	Turbulent	8	16	2	16	14	10	2	16
Types of paragliding	Solo Flight	8	4	6	12	10	4	6	10
	Commercial Tandem Flight	6	12	2	8	10	8	2	8
	Cross Country	8	6	6	8	10	4	6	8
	Occasional Flight	2	0	2	0	2	0	2	0
Types of glide using	EN type A	6	2	6	8	6	2	4	10
	EN type B	4	14	4	14	8	12	6	10
	EN type C	2	0	2	2	2	0	2	2
	EN type D	2	4	4	2	4	2	4	2
	Other	10	2	0	2	12	0	0	2

Comfortability of Harness seat:	Very fortable	12	4	6	10	16	4	6	6
	Comfortable	10	18	8	18	14	12	8	20
	Neither comfortable nor uncomfortable	2	0	2	0	2	0	2	0
	Uncomfortable	0	0	0	0	0	0	0	0
	Very uncomfortable	0	0	0	0	0	0	0	0
Types of helmet	Open face helmet	N/A				24	16	14	18
	Full face helmet					0	0	0	6
	Lightweight helmet					8	0	2	2
How you carry your action camera	I do not carry a camera.	N/A				8	2	10	7
	Helmet Mount					6	4	0	6
	Chest Mount					0	0	0	0
	Harness Mount					0	0	0	0
	Selfie Stick					16	7	6	13
	Foot Mount					2	3	0	0
	wingtip or riser Mount					0	0	0	0
ODI	0-20	18	18	8	28	N/A			
	20-40	4	4	6	0				
	>40	2	0	2	0				
NDI	0-20	N/A				24	14	12	26
	20-40					4	2	4	0
	>40					4	0	0	0

Only 11% of the pilots often or occasionally thought of job change of stop paragliding due to LBP. 25% of pilots with low back pain experienced associated symptoms like radiating pain, numbness or tingling sensation.

Around 42% of pilots with neck pain experienced associated symptoms like radiating pain, numbness or tingling sensation of upper limb or shoulder pain. 61% pilots are doing regular exercises

Table 3: Correlation of variables with LBP and NP

Variables	Categories	LBP (%)	χ2, p-value	NP(%)	χ2,p-value
Duration	Total	68.90		71.10	
	Acute	26.67		35.56	
	Subacute	24.44		17.78	
	Chronic	17.78		17.78	
Age group	<30	77.78	5.04, 0.28	100	14.22, 0.01
	30-39	64.70		58.82	
	40-49	75.00		75.00	
	50-59	33.33		33.33	
	>60	75.00		75.00	
Gender	Male	64.10	6.25, 0.01	66.67	5.63, 0.02
	Female	100		100	
BMI range	<25	72.34	6.13, 0.05	72.34	4.45, 0.11
	25-30	57.14		62.86	
	>30	100		100	
Position	Trainee Pilot	50	4.90, 0.18	50	5.64, 0.13
	Professional Solo Pilot	78.57		78.57	
	Tandem Pilot	69.70		75.76	
	Other	77.78		77.78	
Since how long have you been flying (years)	<5	60.00	0.06, 0.10	66.67	6.81, 0.15
	5-10	100		100	
	10-15	60.00		68	
	15-20	71.43		57.14	
	>20	77.78		77.78	
Air time (Total hours spent flying)	<500	68.42	0.06, 0.10	73.68	0.27, 0.97
	500-1000	66.67		66.67	
	1000-5000	70.37		70.37	
	>5000	69.23		69.23	
Air time in the last 12 months	<100	75.56	2.29, 0.32	75.56	0.92, 0.63
	100-200	59.38		65.63	
	>200	69.23		69.23	
Most common flight length (minutes)	<30	65.79	0.30, 0.96	71.05	0.00, 0.10
	30-60	70.83		70.83	
	60-120	71.43		71.43	
	>120	71.43		71.43	
Frequent Flying Condition	Turbulent	75.00	1.80, 0.18	79.17	3.25, 0.07
	Calm	61.90		61.90	
Types of paragliding	Solo Flight	60.00	3.08, 0.38	66.67	1.91, 0.59
	Commercial Tandem Flight	71.43		71.43	
	Cross Country	71.43		71.43	
	Occasional Flight	100		100	
Types of glide using	EN type A	54.55	5.23, 0.26	54.55	5.34, 0.25
	EN type B	66.67		72.22	
	EN type C	66.67		66.67	
	EN type D	83.33		83.33	
	Other	85.71		85.71	
Comfortability of Harness seat	Very comfortable	68.75	1.93, 0.38	81.25	4.97, 0.08
	Comfortable	66.67		62.96	
	Neither comfortable nor uncomfortable	100		100	
Types of helmet	Open-face helmet	n/a		75.00	16.17, 0.00
	Full face helmet			0.00	
	Lightweight helmet			83.33	
How you carry your action camera (e.g. GoPro) during the flight	I don't carry the camera.	n/a		74.07	2.81, 0.42
	Helmet Mount			62.50	
	Selfie Stick			69.05	
	Foot Mount			100	

e.g. Physiotherapy, stretching, pilates or yoga etc in their daily life. In total only 5% of pilot seek help of medical doctor for their NP or LBP rest, 65% of pilots do self remedy or stretching or ignore it. We also evaluated the incidence or pattern of paragliding related other injury in the pilots. We found that 70% pilots had no accidents related to paragliding. (Table 1)

DISCUSSION

Despite the plausible risk factors, there is a paucity of research specifically examining LBP and NP in paragliding pilots. This study is essential to provide empirical data on the prevalence and incidence of these conditions in this population. Understanding the extent of the problem and identifying specific risk factors will inform the development of ergonomic guidelines, training programs, and preventive measures tailored to paragliding pilots. One population that is exposed to similar individual risk factors is commercial airline pilots.[7] This is reflected in a 12-mo prevalence of LBP of at least 40%, as described in recent studies.[8]

Paragliding is an adventurous sport that involves flying lightweight, free-flying, foot-launched gliders.[9] It has gained popularity worldwide due to the thrill and freedom it offers. However, like many sports, paragliding is not without its risks. Among these, musculoskeletal issues such as LBP and NP have been reported by pilots. Understanding the prevalence, incidence, and risk factors associated with these conditions is crucial for developing preventive measures and ensuring the well-being of pilots.

LBP and NP are common musculoskeletal complaints in the general population, with significant impacts on quality of life and occupational performance.[10] For paragliding pilots, the nature of the sport involves prolonged periods of sitting in harnesses, repetitive movements, and exposure to vibrations and forces during takeoff, flight, and landing. These factors may predispose pilots to developing LBP and NP. Nilsson et al. have reported that among the 658 skydivers they had surveyed, 25% of them had reported that they had had neck pain during or after the parachute had been opening.[11] Bar-Dayan et al. have reported that out of the 74 parachute instructors they had studied, 10.9% of them had had moderate, and 5.5% of them had had severe degenerative disease of the lumbar spine.[12] In our study we had similar finding with ODI score and NDI score of more than 20 in 18 pilots and 14 pilots simultaneously with 4 pilots in each group with ODI and NDI score more than 40.

Understanding the prevalence and incidence of LBP and NP among paragliding pilots, along with identifying potential risk factors, is essential for developing targeted preventive strategies. These strategies may include ergonomic improvements in harness design, strength and conditioning programs for pilots, and education on proper posture and body mechanics during flight. Further research is needed to explore these risk factors in more detail and to develop evidence-based interventions to reduce the burden of LBP and NP in this population.

Several factors may contribute to the high prevalence and incidence of LBP and NP among paragliding pilots:

1. Prolonged Sitting in Harnesses: Paragliding requires pilots to sit in harnesses for extended periods, which can place stress on the lumbar and cervical spine. Poorly adjusted harnesses or improper sitting postures can exacerbate this stress, leading to pain and discomfort.[13]
2. Repetitive Movements and Vibrations: Pilots often perform repetitive movements during flight, such as adjusting controls and shifting body weight. Additionally, they are exposed to vibrations from the wind and turbulence, which can contribute to musculoskeletal strain.[14]
3. Physical Fitness and Conditioning: A lack of core strength and overall physical fitness can increase the risk of developing LBP and NP.[15]
4. Equipment Design and Fit: The design and fit of the harness and other equipment can significantly impact spinal alignment and comfort. Poorly fitting equipment can exacerbate postural strain and increase the risk of pain.[13]
5. Previous Injuries: Pilots with a history of spinal injuries or chronic musculoskeletal conditions are at higher risk of experiencing LBP and NP. Previous trauma can weaken the spinal structures and increase vulnerability to pain.
6. Age and Experience: Age and flying experience can also play a role. Older pilots and those with many years of flying experience may have accumulated musculoskeletal wear and tear, increasing their risk of pain.

The study is expected to provide valuable insights into the prevalence and incidence of LBP and NP among paragliding pilots. It will also identify key risk factors that contribute to these conditions. This information can be used to develop targeted interventions, such as ergonomic modifications, training programs, and preventive measures, to reduce the incidence of pain and improve the overall well-being of paragliding pilots.

Investigating LBP and NP in paragliding pilots is crucial for enhancing the safety and well-being of individuals engaged in this sport. By identifying the prevalence and incidence of these conditions and pinpointing potential risk factors, this study aims to contribute to the body of knowledge necessary for improving health outcomes and preventing chronic pain among paragliding pilots.

This research has the potential to lead to practical recommendations that can be integrated into training and equipment design, ultimately fostering a healthier and more sustainable paragliding community. However, limited sample size and online evaluation of pilots are two major limitations of this study.

CONCLUSION

Female gender, age less than 30 and type of helmet used during paragliding have positive correlation with NP while BMI and female gender have positive correlation with LBP in paragliding pilots. This research will fill a critical gap in the existing literature and provide a foundation for future studies and interventions aimed at preventing occupational disease related to musculoskeletal health thereby decreasing ergonomic risks in paragliding pilots

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REFERENCES

1. Lidgren L. The bone and joint decade 2000-2010. Bull World Health Organ. 2003; 81:629

2. Koes BW, van Tulder MW, Thomas S. Diagnosis and treatment of low back pain. BMJ. 2006; 332(7555):1430-1434 https://doi.org/10.1136/bmj.332.7555.1430

3. Oksa J, Hämäläinen O, Rissanen S, Salminen M, Kuronen P. Muscle fatigue caused by repeated aerial combat maneuvering exercises. Aviat Space Environ Med. 1999 Jun;70(6):556-60.

4. Fairbank JC, Pynsent PB. The Oswestry Disability Index. Spine. 2000; 25(22):2940-2952 https://doi.org/10.1097/00007632-200011150-00017

5. Vernon, H., Mior, S. The Neck Disability Index: A study of reliability and validity. Journal of Manipulative and Physiological Therapeutics 1991; 14(7): 409-415

6. Bundesärztekammer (BÄK). Kassenärztliche Bundesvereinigung (KBV), Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften (AWMF). National guidelines on nonspecific low back pain (Nationale VersorgungsLeitlinie Nicht-spezifischer Kreuzschmerz - Langfassung, 2. Auflage. Version 1). 2017.

7. 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. https://doi.org/10.3357/AMHP.5656.2020

8. 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

9. Whittall, Noel (2002), Paragliding: The Complete Guide, Airlife Pub, ISBN 1-84037-016-5

10. GBD 2021 Low Back Pain Collaborators. Global, regional, and national burden of low back pain, 1990-2020, its attributable risk factors, and projections to 2050: a systematic analysis of the Global Burden of Disease Study 2021. Lancet Rheumatol 2023: 5: e316-29.

11. Nilsson J, Fridén C, Burén V, Westman A, Lindholm P, Ang BO. Musculoskeletal pain and related risks in sky divers: A population-based survey. Aviat Space Environ Med. 2013;84(10):1034-40, https://doi.org/10.3357/ASEM.3570.2013

12. Bar-Dayan Y, Weisbort M, Bar-Dayan Y, Velan GJ, Rav id M, Hendel D, et al. Degenerative disease in lumbar spine of military parachuting instructors. J R Army Med Corps. 2003;149(4):260-4, https://doi.org/10.1136/jramc-149-04-03

13. Sepehr P, Mousa Jabbari MJ, Naeini HS, Abadi ASS, Ziaei M, Zare A et al. Design and psychometric analysis of the safety harness usability and comfort assessment tool (SH UCAT), Heliyon, Volume 9, Issue 2, 2023, e13524, ISSN 2405-8440, https://doi.org/10.1016/j.heliyon.2023.e13524

14. Lis AM, Black KM, Korn H, Nordin M. Association between sitting and occupational LBP. Eur Spine J. 2007 Feb;16(2):283-98. https://doi.org/10.1007/s00586-006-0143-7

15. Gordon R, Bloxham S. A Systematic Review of the Effects of Exercise and Physical Activity on Non-Specific Chronic Low Back Pain. Healthcare (Basel). 2016 Apr 25;4(2):22. https://doi.org/10.3390/healthcare4020022