



THE PREVALENCE AND RISK FACTORS OF OTIC BAROTRAUMA AMONG AIRCREW MEMBERS

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ABSTRACT

Barotrauma is the most prevalent medical problem associated with airplane travel (traveling) and has been a causal factor in the aviation accident. This study aimed to explore the prevalence of otic barotrauma and its risk factors among the aircrew members. This cross sectional study included 267 aircrew members (116 pilots and 151 flight attendants) who presented themselves to the outpatient clinic at “Saudi Airlines Medical Services” for assessment of their fitness before the flight. The participants were selected using a non-probability consecutive sample over the study period from January to September 2018. They were interviewed face to face about their socio-demographic and job characteristics, the risk factors for barotrauma, as well as the symptoms of ear trauma. Otic barotrauma was found in 39% and 14.4 % had repeated barotrauma. Increased odds ratios of barotrauma were detected among Saudis (OR 2.5 (95% CI: 1.4-4.4)) (p=0.002), smokers (OR 1.8 (95% CI: 1.13-3.1)) (p=0.015), pilots (OR 1.8 (95% CI: 1.1-2.9))(p=0.026), those with allergy (OR 2.6 (95% CI: 1.2-5.5))(p=0.012), members working for > 70 hours per month (OR 2.5 (95% CI: 1.5-4.2))(p=0.000), and in females with hormonal disturbance (OR 2.9 (95% CI: 1.2- 6.7)) (p=0.016) or on hormonal therapy (OR 2.6 (95% CI: 1.1- 6.4)) (p=0.028). 39% of aircrew members at Saudi airlines had ear barotrauma and 14.4% had repeated heart attacks. The risk of barotrauma was increased among pilots, Saudis, smokers, those with allergy or hormonal disturbance, or working for >70 hours/month. We recommend to limit smoking on flights, decrease total hours of duties <70 per month (especially for pilots), and to do regular ENT exam for all aircrew members.

KEYWORDS: *aircrew members, avian barotrauma, otic barotrauma, Saudi airlines.*



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INTRODUCTION

Otic Barotrauma is the most common medical complication related to aviation¹. It can be defined as an acute or chronic middle ear traumatic inflammation due to pressure difference between the air in the middle ear and the external atmosphere.² Aircrew members must be able to equilibrate the pressure on both sides of the tympanic membrane; this is possible only with normal Eustachian tubal function. Failure to equalize pressure across the tympanic membrane may result in otic barotrauma.^{3,4} As expected, the maximal time for developing otic trauma is going to be at the descent of the flight or less frequently ascent.² Severe barotrauma cases may end in tympanic membrane perforation and round window membrane rupture² which may result in temporary or even permanent grounding of the aircrew. The most common risk factor for otic barotrauma is Eustachian tube occlusion including flu, upper respiratory tract infections, and allergy.⁴ Common symptoms include: dizziness, general ear discomfort, difficulty hearing, stuffiness or fullness in the ear. If it is very severe or if it takes a long time untreated, other symptoms may occur such as, otalgia, nosebleed, moderate to severe hearing loss.⁵ Given the prevalence of barotrauma and its expected health hazards, there has been a disproportionately few published research that addressed this condition particularly among Saudi aircrew.⁶ Therefore, there is a need to identify potentially modifiable risk factors of disease onset and progression. This study aimed to determine the prevalence of otic barotrauma and its risk factors among the aircrew members.

METHODS

This cross sectional study included 267 aircrew members who presented themselves to the outpatient clinic at "Saudi Airlines Medical Services" for assessment of their fitness before the flight. The participants were selected by using a non-probability consecutive sample over the study period from September 2018 to February 2019.

Researchers performed face to face interview for demographic data, job characteristics, risk factors, and for symptoms of barotrauma. In female participants, hormonal disturbances were also evaluated. Participants included the pilots (the responsible persons for the operation of the aircraft and the commander of the aircraft during flight time without limitation) and other crew members (the persons assigned to perform duty in an aircraft during flight time). Exclusion criteria included those who were currently on treatment for any chronic disease including chronic nasal diseases (e.g, sinonasal polyposis or nasal masses). Ethical approval was received for this study from the ethical committee at Ibn Sina national college for medical studies, Jeddah, Saudi Arabia. Written informed of consent was obtained from all participants before the interview and data were dealt with confidentiality.

STATISTICAL ANALYSIS

Data were collected and coded before being entered into the Statistical Package for Social Sciences version 17 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were carried out for all variables. We used Chi square to find associations between risk factors and ear barotrauma (odds ratio (OR) and 95% confidence interval (95% CI)). A p-value of less than 0.05, was set to be the significance of the results.

RESULTS

This cross sectional study included 267 aircrew members (116 pilots and 151 flight attendants). After the interview, 104 (39%) was found to have ear barotrauma. Barotrauma symptoms included loss of balance (26 (25%)), ear discomfort (43 (41.3%)), ear pain (59 (56.7%)), vagal ataxia (20 (19.2%)), blocked nose (48 (46.2%)), and hearing loss (7.5%) (Figure 1). Most symptoms were at a stage of flight take off (68.3%) and 14.4 % had repeated barotrauma. Aircrew members used to perform Valsalva maneuver (44.2%); or to use ear medicine (26%) (Figure 2).

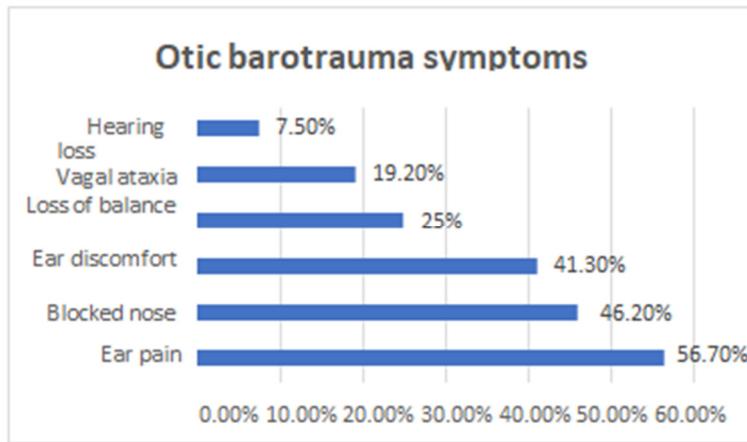


Figure 1
Symptoms of otic barotrauma among flight crew.

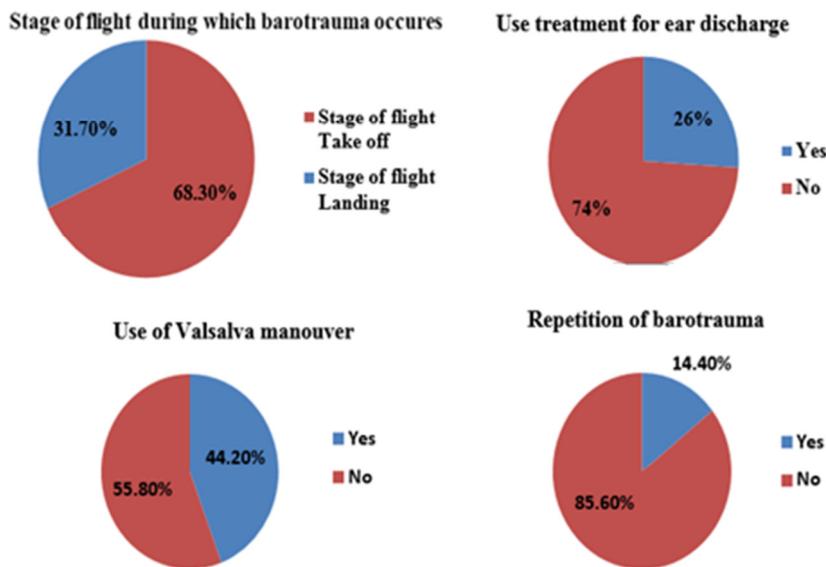


Figure 2
Description of barotrauma by aircrew members.

Members with barotrauma had more ear inflammation ($p=0.002$), drum disease ($p=0.007$), ear discharge ($p=0.003$), history of Eustachian tube surgery ($p=0.000$), and gastro-oesophageal reflux disease ($p=0.000$) (Table 1). Table 2 and 3 show a comparison between members with and without barotrauma. They were age ($p=0.156$) and gender ($p=0.052$) matched with similar marital status ($p=0.431$) and underlying chronic illness ($p=0.413$). There were significant differences in job description as pilots had more odds to develop barotrauma compared to flight attendants (OR 1.8 (95% CI: 1.1-2.9))($p=0.026$). Increased odds of

barotrauma were also seen in Saudis (OR 2.5 (95% CI: 1.4-4.4)) ($p=0.002$), smokers (OR 1.8 (95% CI: 1.13-3.1)) ($p=0.015$), and in those working for more than 70 hours per month (OR 2.5 (95% CI: 1.5-4.2))($p=0.000$), but not if they spent ≥ 10 hours per flight ($p=0.231$). Members with a history of allergy also had increased odds of barotrauma (OR 2.6 (95% CI: 1.2- 5.5))($p=0.012$). Hormones was associated with barotrauma as both hormonal disturbance (OR 2.9 (95% CI: 1.2-6.7)) ($p=0.016$) and hormonal therapy (OR 2.6 (95% CI: 1.1-6.4)) ($p=0.028$) had more odds for barotrauma (Table 3).

Table 1
Odds ratio of previous history of ear troubles among flight crew.

	Without barotrauma (n=163)	With barotrauma (n=104)	p-value	Odd's Ratio (CI)
	N (%)	N (%)		
History of ear inflammation				
- No	153 (93.9)	85 (81.7)	0.002*	3.4 (1.5-7.7)*
- Yes	10 (6.1)	19 (18.3)		
History of ear drum disease				
- No	156 (95.7)	90 (86.5)	0.007*	3.5 (1.4-8.9)*
- Yes	7 (4.3)	14 (13.5)		
History of previous ear tube surgery				
- No	153 (93.9)	80 (76.9)	0.000*	4.6 (2.1-10.1)*
- Yes	10 (6.1)	24 (23.1)		
Diminished hearing starting with work				
- No	148 (90.8)	96 (92.3)	0.668	0.8 (0.3-2.0)
- Yes	15 (9.2)	8 (7.7)		
Ear discharge				
- No	157 (96.3)	90 (86.5)	0.003*	4.1 (1.5-10.9)*
- Yes	6 (3.7)	14 (13.5)		

*P value is significant if less than 0.05

Table 2
Odds ratio of risk factors of otic barotrauma among flight crew.

	Without barotrauma N (%)	With barotrauma# N (%)	p-value	Odd's Ratio (CI)
	Job description			
- Pilot	62 (38.0)	54 (51.9)	0.026*	1.8 (1.1-2.9)*
- Flight attendant	101 (62.0)	50 (48.1)		
Age				
- ≤ 30 years	49 (30.1)	40 (38.5)	0.156	0.69 (0.4-1.15)
- >30 years	114 (69.9)	64 (61.5)		
Nationality				
- Saudi	100 (61.3)	83 (79.8)	0.002*	2.5 (1.4-4.4)*
- Non Saudi	63 (38.7)	21 (20.2)		
Gender				
- Male	113 (69.3)	60 (57.7)	0.052	1.7 (0.9-2.8)
- Female	50 (30.7)	44 (42.3)		
Marital status				
- Never married	43 (26.4)	23 (22.1)	0.431	1.3 (0.7-2.3)
- Ever married**	120 (73.6)	81 (77.9)		
Smoking status				
- Non smoker	100 (61.3)	48 (46.2)	0.015*	1.8 (1.13-3.1)*
- Smoker:	63 (38.7)	56 (53.8)		
Flight hours per month				
- ≤ 70 hours	115 (70.6)	51 (49.0)	0.000*	2.5 (1.5-4.2)*
- > 70 hours	48 (29.4)	53 (51.0)		
Flight duration				
- < 10 hours per flight	35 (21.5)	29 (27.9)	0.231	0.7 (0.4-1.2)
- ≥ 10 hours per flight	128 (78.5)	75 (72.1)		
History of allergy including allergic rhinitis				
- No			0.012*	2.6 (1.2-5.5)*
- Yes	150 (92.0)	85 (81.7)		
	13 (8.0)	19 (18.3)		
History of GERD***				
- No	155 (95.1)	84 (80.8)	0.000*	4.7 (1.9-10.9)*
- Yes	8 (4.9)	20 (19.2)		

*P value is significant if less than 0.05, **Ever married include currently married, widow and divorced, ***: Gastro-oesophageal reflux disease # With barotrauma means have any of the following complaints during flight: ear pain, ear discomfort, vagal ataxia, nausea and vomiting, loss of balance and presence of blocked nose without flu., \$ Fisher Exact test was used here., & Include overlapped intake of antihistamines, hormonal therapy, oral hypoglycemic, antihypertensive, medications for renal gravels as no uric.

Table 3

Characteristic of female flight crew with barotrauma compared with those without barotrauma.

	Without barotrauma N (%)	With barotrauma N (%)	P-Value	Odd's Ratio (CI)
Menstrual regularity				
- Irregular	4 (86.0)	37 (84.1)		
- Regular	7 (14.0)	7 (15.9)	0.795	1.2 (0.4-3.6)
Presence of gynecological problem				
- No	42 (84.0)	43 (72.7)	0.183	1.9 (0.7-5.4)
- Yes	8 (16.0)	12 (27.3)		
Presence of hormonal disturbance				
- No	37 (74.0)	22 (50.0)	0.016*	2.9 (1.2-6.7)*
- Yes	13 (26.0)	22 (50.0)		
Intake of hormonal medications including hormonal contraceptives				
- No	38 (76.0)	24 (54.5)	0.028*	2.6 (1.1-6.4)*
- Yes	12 (24.0)	20 (45.5)		

*P value is significant if less than 0.05

DISCUSSION

In this study, a substantial number of flight crew members had otic barotrauma (39%) with repeated attacks in 14.4 %. The increased risk was seen among pilots, Saudis, smokers, those who suffered ear troubles before, allergy, hormonal disturbance, or working for >70 hours/month. At present, barotraumata still happen despite new cabin technologies. In fact, most pilots had suffered at least one attack of otic barotrauma.⁷ Modern airline cabins have very dry air^{8,9} with a relative humidity far below the relative comfortable humidity between 40 to 70%.^{10,11} The prolonged exposure to low humidity might lead to dry throat, eyes, and nasal mucosa.^{10,13} This was found when researchers compared barotrauma among pilots to another study done 10 years back using the same questionnaire. They found that barotraumata had increased from 37.4 to 55.5% with a significant increase in the number of pilots using decongestant drugs from 43.3 to 59.5%.¹³ Our crew members with barotrauma had more frequent ear inflammation, drum disease, ear discharge, eustachian tube surgery and gastro-oesophageal reflux disease compared to those without barotrauma. Similarly, another study found a significant association between the previous history of ear, nose and throat (ENT) diseases and delayed ear pain in barotrauma patients.¹⁴ These results were also in concordance with common risk factors for eustachian tube occlusion; the main pathophysiology of otic barotrauma.⁴ Similarly,

their symptoms were matched with known common symptoms of barotrauma.⁶ Interestingly, hearing loss was equal in those with (7.7%) and without barotrauma (9.2%). Barotrauma can lead to hearing loss among pilots ranging from 8 % up to 17%.¹⁵ Our crew's main barotrauma symptoms were ear pain and discomfort which usually heightened at the stage of flight take off (68.3%). Many of our flight crew performed Valsalva maneuver (44.2%) or used decongestant medicine for their ear symptoms. Valsalva and or ear decongestant are well known ways to prevent middle ear symptoms while flying.⁶ In this study, smoking increased the odds of barotrauma. Previous studies on the impact of smoking on barotrauma were inconsistent. Smoking may be considered as a factor increasing hearing loss among pilots with barotrauma but not a primary cause.^{16,17} Results showed increased odds of barotrauma among crew members working for more than 70 hours monthly. Other studies^{16,18,19} found similar associations. Recently, one study found that increased flight hours at or more than 66 hours per month was associated with decreased work ability.¹⁸ Another study reported a significant correlation between total flight hours and hearing loss among pilots.¹⁶ A major advantage of our study was its relatively large number of male and female flight crew workers in Saudi airlines. We detected a hormonal association with barotrauma among female members. To the best of our knowledge, there are no studies reporting a similar association. The only reported association was the effectiveness of topical estrogen in the healing of a

chronic tympanic membrane perforation.²⁰ Therefore, hormonal disturbance might interfere with the healing of otic barotrauma. However, further studies are also needed to address such an association to help women working on flights during their periods of hormonal changes. The main limitation of the present study was its cross-sectional design that limited identifying the causal relationship or the time-course of risk factors and barotrauma. The second limitation was using questionnaires to examine the crew's response which can create a recall bias. Moreover, we did not perform an ENT examination to grade the severity of otic barotrauma. Finally, we selected currently employed flight crew with possible healthy worker selection bias (healthier workers are more likely to be selected for the workforce) and survivor bias (workers with severe symptoms might have left workplace because of the occupational hazard).

CONCLUSION

We conclude that otic barotrauma is common among flight crew with possible repeated attacks resulting in chronic ear diseases. The increased risk is seen among Saudis, pilots, smokers, those with allergy or hormonal disturbance, or working for

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>70 hours/month. Therefore, we recommend decreased working hours and/or increased rest time between work periods, given the volume of the flight crew's duties. We also recommend non-smoking among crew or at least limited smoking in flights. Regular ENT exam for all flight crew members should be properly scheduled especially for the high risk members. Finally, further studies are needed to address the association between hormonal disturbances and otic barotrauma among women working in flights.

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AUTHOR CONTRIBUTION STATEMENT

All authors shared work in proposal writing, data collecting, data entry, analysis of the data and manuscript writing.

CONFLICT OF INTEREST

Conflict of interest declared none.

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