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Original Article

Varicose vein disease in cabin crews and a screening scale

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Abstract

Aim: Varicose vein disease (VVD) and related symptoms are expected to be encountered more frequently in cabin crews. Considering their working environment, standing still for long periods of time and lacking mobility on flights may contribute to VVD. For this reason, our study aimed to determine the rate and the risk factors of VVD in cabin crew members and to develop a screening scale for VVD.
Material and Methods: A questionnaire including 43 questions was applied to the participants, querying their socio-demographic, occupational characteristics, smoking history, family history, and VVD. Eight survey questions were used to establish a VVD Evaluation Scale (VVDES).
Results: A total of 264 civil cabin crews participated in this study. 23.5% of civil aviation cabin crews had VVD. The diagnosis of VVD in the female group was higher than in the male group ($p<0.001$). A family history of varicose veins was crucial for VVD diagnosis and significantly increased the VVD risk in female cabin crew ($p<0.001$). It was determined that the rate of VVD was higher in cabin crews who worked on short flights (4 hours or less). It was shown that VVDES could accurately detect VVD at a rate of 77.4%.
Conclusion: Family history of VVD was a crucial factor in terms of VVD. Multiple short flights have been linked to an increased risk of VVD. A VVDES has been developed in this study and can be used clinically as a screening scale for cabin crews.

Keywords: Venous insufficiency, occupational exposure, aerospace medicine, surveys and questionnaires

INTRODUCTION

Layers of the vascular wall are the Tunica Intima, Tunica Media, and Tunica Externa/adventitia. The presence of elastic fibers in all three layers is one of the fundamental components of vascular resistance [1]. Therefore, it is believed that there is a correlation between high blood pressure, vascular diameters, and fiber density and thickness (Figure 1) [2-5].The Earth puts on 1 G of gravity force on people. Because of this, venous pressure increases significantly in the lower extremities while standing still [6] (Figure 1). Venous valves (VV) and venomuscular pumps (VMP) are the main physiological mechanisms for coping with high blood pressure in the lower part of the body [7]. VV plays an essential role in venous return to the right atrium, and VV regulates blood flow and favors unidirectional and laminar flow [8-10]. Together with VV, each contraction of the skeletal muscles constricts the veins and acts like a biological pump.

In the long term, elevated blood pressure in the lower extremity veins causes *vascular dilatation*, eventually leading to *venous valve insufficiency* (VVI) and stasis. Due to stasis, numerous symptoms can be seen, including aches, edema, skin changes, and ulcers. Venous insufficiency (VI) is a significant health problem that impairs the quality of life and leads to severe complications. VI can appear in many clinical presentations, ranging from telangiectasias to painful ulcers. When non-specific lower extremity symptoms like ache, swelling, skin changes etc. are noticed by a health care provider during physical examination of the patient, venous Doppler ultrasound of the lower extremity is performed to diagnose varicose vein disease (VVD).

CITATION
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Maximum flight duty times can be up to 16 hours per day according to aviation regulations [11]. Cabin crews stand still for long periods of time, and they have limited inflight mobility. These working conditions are thought to produce venous stasis and VVD.

VI disease can start with nonspecific leg ache in cabin crews. Generally, this symptom ceases during off days resting. Therefore, the symptom might be attributed to simple fatigue and can be overlooked. Unnoticed VVD progresses in time and eventually shortens the expected cabin crew profession time. For this reason, recognizing VVD in early stages of the disease is important to protect health of the cabin crews. From this point of view, any means of diagnostic tool can be useful to help cabin crew self-diagnose.

To the authors' best knowledge, the prevalence of VVD in cabin crew is unknown. The aim of this study is to evaluate the prevalence of VVD in cabin crews and to establish a reliable VVD evaluation scale (VVDES) that can be used as a screening test.

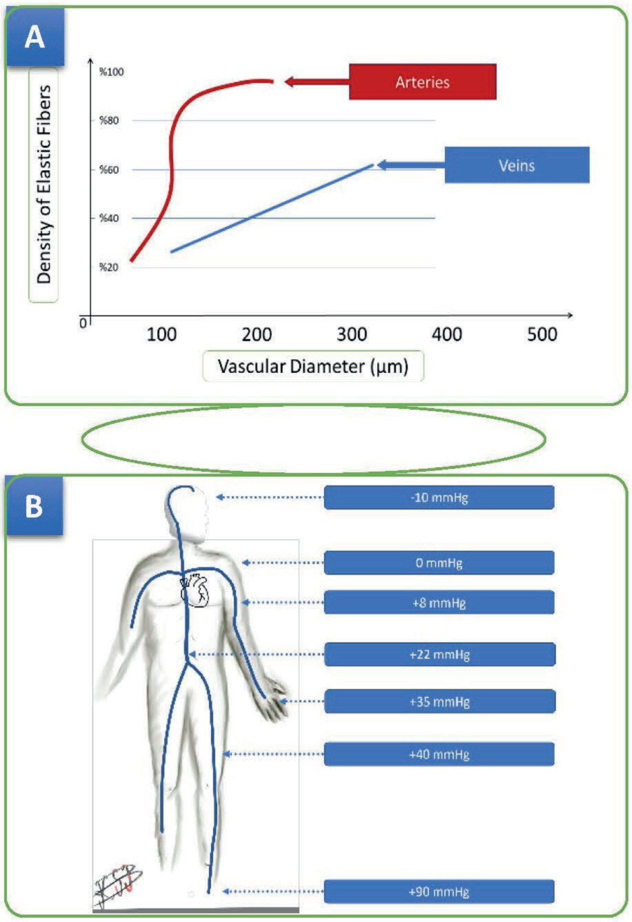

Figure 1. A. The relationship of elastic fiber density with the vascular diameter [1-4], **B.** Pressures of the venous system in a person with a standing still [6,7]

MATERIAL AND METHODS

Type of Research

The study was designed as a single-centered and cross-sectional survey and conducted by the Department of Aerospace Medicine, Gülhane Faculty of Medicine, University of Health Sciences.

Inclusion/Exclusion Criteria for Research

Cabin crews aged between 18 and 65 years old and actively performing flight duties were included in this study.

Cabin crews who did not consent were not allowed to participate in this study.

Determination of Sample Size

To the authors' best knowledge, the prevalence of VVD in cabin crew was unknown, and sample size calculation was based on the CEAP-C2 disease prevalence (20%) in the general population [12,13]. Based on 2021 records of The Turkish Cabin Crews Association, the number of active cabin crews was 12402. With 95% reliability (a=0.05 error) and to achieve the desired 5% degree of precision (d=0.05), the number of study participants should be 240. As a safety margin, 10% times more cases were included, and the final study sample size was determined as 264 participants.

Data Source of the Research and Scale Development Process

A questionnaire was applied to the preliminary study group which consisted of 20 aerospace medicine residents, for pre-evaluation (pre-test). The questionnaire was rearranged based on the responses and received feedback. The online questionnaire could be completed in eight minutes (Table 1).

Research Ethics and Permissions

The Health Sciences University Gülhane Scientific Research Ethics Committee approved the study (2022/133). All participants were informed about the study and consent was obtained.

Research Data Editing and Data Analysis

The data were compiled in the Microsoft Excel program, and statistical analysis was performed with the IBM SPSS program. In our study, with the hypothesis "H1: Cabin crew experience venous insufficiency more frequently compared to the normal population," various statistical methods were used to test the hypotheses. The Kolmogorov-Smirnov test was used to evaluate the distribution of variables. Between the two groups, analysis of non-parametric variables was evaluated by the Mann-Whitney U test, while categorical variables were analyzed by the Chi-Square test, and Spearman Correlation tests were used to assess the relationships between variables. To develop a valid and reliable VVDES, KMO-Bartlett's Sphericity Tests, Cronbach's

Alpha Test, Exploratory and Confirmatory Factor Analyses were performed in accordance with the scale preparation procedure. ROC analysis was performed to find a threshold value for the developed VVDES. The p values of 0.05 or lower were considered statistically significant.

Study Power

After the pilot study data collection, the groups' standard deviations were determined, and effect sizes were calculated. With type-1 error value of 0.05, the study's statistical power was calculated as 93.5%.

Table 1. Survey questions used in the study

1.	**Consent form**		**Smoking assessment section**
	General information section	**20.**	Have you ever smoked (A=Active Smoker), (E=Ex-smoker), (N=No)
2.	Year of birth	**21.**	Average number of cigarettes consumed per day (For A and E)
3.	Height (cm)	**22.**	Total amount of cigarettes consumed in years (For A and E)
4.	Weight (kg)	**23.**	How many years have you not smoked? (For E)
5.	Email	**24.**	Fagerström Nicotine Dependence Scale (For A) (6 questions)
6.	Gender		**Venous insufficiency quenstionnaire section**
7.	Have you ever given birth?	**30.**	Do you have any signs in your legs?
8.	How many births have you had?	**31.**	Which sign or symptoms do you have in your legs?
9.	Do you take hormone medications (anti-pregnancy, birth control, etc.)?	**32.**	Is there anyone diagnosed with varicose veins in the family elders?
	Flight information section	**33.**	Which of the grandparents has a diagnosis of varicose veins?
10.	Total working time as a civil aviation cabin crew (years)	**34.**	When you evaluate your daily life outside of your flight duties, do you usually spend your days sitting or standing still?
11.	Taking a break from working life during your working time	**35.**	Some connective tissue diseases can further prepare the ground for the formation of varicose veins. Do you have such diseases that you know? (Ex: Lupus Syndrome, Scleroderma, Polymyositis, Ehlers-Danlos Syndrome, Marfan Syndrome, Loeys-Diets Syndrome, Familial Thoracic Aortic Aneurysm and Dissection Syndrome, Sjogren's Syndrome… etc.)
12.	Reason for the break (H=Illness, G=Pregnancy, E=Education, D=Other)	**36.**	Which connective tissue disease do you have?
13.	Break time (1,2,3,…,60,61+) (month)	**37.**	Do complaints on your legs increase in high humidity or hot places?
14.	Is the break within the last year or does it cover the last year?	**38.**	Do you have capillary dilations in your legs for a long time, consisting of superficial thin veins?
15.	Please select the range of your total flight time:	**39.**	Do you usually wear high heels? (Over 7cm)
16.	How many hours is the total flight time?	**40.**	Do you have varicose veins diagnosed by a medical doctor?
17.	How many hours is the total flight time in the last year?	**41.**	When were you diagnosed? (only year)
18.	Flight type (in usual flights)	**42.**	Do you exercise at least twice a week, especially those that work your leg muscles? (It should be answered by considering the exercise in which the muscle groups below the knee and above the knee, primarily the calf is worked.)
19.	How many hours does an average flight usually cover, such as standing still or low movement, etc.?	**43.**	Is there at least 30 minutes of brisk walking a day?

RESULTS

The 43-question survey was conducted among two hundred sixty-six cabin crews, but two of them declined to participate. Thus, two hundred sixty-four cabin crews completed the study questionnaire. The study questionnaire was designed to prevent missing or erroneous data. For this reason, no individuals were excluded from the study due to missing or conflicting data, and two hundred sixty-four participants' data were analyzed after the questionnaire application period.

The difference in the demographic characteristics of the participants was statistically significant between genders (Table 2).

In our study, sixty-two (23.5%) of the participants (4 males and 58 females) had VVD. The prevalence of VVD was higher in females, and the gender difference was statistically significant (Table 3A).

It was shown that the rate of VVD was higher in the female group who gave birth (Fisher's Exact Test p=0.086; Given Birth Yes: 36.8%, No: 25.9%). The diagnosis of VVD was investigated in females who were taking hormone replacement therapy (HRT) (Fisher's Exact Test p=0.56; HRT Yes: 28.0%, No: 29.1%) and who were wearing high-heeled shoes (7cm or higher) (Fisher's Exact Test p= 0.12; High-Heeled Shoes Yes: 18.8%, No: 31.0%), but no statistical significance was found.

Participants were divided into groups based on their median age and gender. Thirty-three years of age and older group had a significantly higher VVD rate in females (Table 3B).

VVD was more common in participants with a positive family history of VVD in both genders, and the difference was statistically significant in female group (Table 3C).

In terms of smoking, it was found that 25% of males (N=16) had never smoked, 34.4% (N=22) of the males had quit, and 40.6% (N=26) of them were actively smoking. While rates among females were respectively 47.5% (N=95), 19.5% (N=39), and 33% (N=66), no statistical significance was revealed between smoking history and VVD (Chi-Square: Female; p=0.70, Male; p=0.48). Additionally, the amount of smoking (package per year: PPY) was higher in males with VVD. However, there was no statistical significance between the amount of smoking and the diagnosis of VVD in both genders (Table 4A).

The effects of occupational factors like Total *Flight Time (TFT), Working Life Span (WLS), Break in WLS (BWLS)* on VVD were also examined in this study. No statistically significant difference was found between genders (Table 4B).

Participants were classified according to flight times. VVD was more common in cabin crews who worked in short flights in both genders (Table 5).

Doing regular leg exercises (LE) and walking fast (WF) for 30 minutes at least twice per week were accepted as Protective Measures (PM) for VVD. Therefore, two questions relevant to VVD-PM were asked to the participants. 54.7% of males (N=35) and 57% (N=114) of females declared that they were doing LE, and 59.4% of males (N=38) and 63.5% of females (N=127) answered "yes" to the WF question. VVD rates were lower in the female group who were doing the PM. In the LE group, the VVD rate was 46.6% (N=27) in females and 25% (N=1) in males. In the WF group, the VVD rate was 39.7% (N=23) in females and 25% (N=1) in males. Although PM helped decrease the VVD rate, differences were not statistically significant (Fisher's Exact Test, LE, WF; Male: p=0.38, p=0.46; Female: p=0.31, p=0.33).

Validity and Reliability Analyses of the Scale

Eight VVD symptoms with the highest internal consistency were selected for the Varicose Vein Disease Evaluation Scale (VVDES) and included in the validity and reliability analysis. VVDES questions were graded as 1 (Yes) or 0 (No), and test scores ranged from 0 to 8.

In terms of inclusivity and internal consistency, reliability tests were conducted. Kaiser-Meyer-Olkin (KMO) test result was 0.734, and Bartlett's Test of Sphericity was calculated as <0.001. Therefore, the sample was sufficient, and a significant correlation existed and supported the exploratory factor analysis. Varimax Rotation (3 iterations) and Kaiser Normalization revealed that these eight questions were grouped into two categories and explained 50% of the overall variation. F1 questions (factor 1) were "Pain," "Edema," "Burning," and "Increasing Symptoms with Environmental Temperature Increment"; F2 questions (factor 2) were "Itching," "Night Cramps," "Erythema," and "Pins and Needles."

Our eight-item scale has a Cronbach's Alpha value (reliability coefficient) of 0.705, and the established VVDES is reliable. Confirmatory factor analysis revealed and verified the scale's two-dimensional factor structure (Figure 2). The degree of freedom (x2: 14.738/df:18) was 0.819. The expected and observed models coexist because the p-value was insignificant (p=0.680). A remarkable comparative fit index (CFI) value of 0.95 indicated that the model fitted precisely (Figure 2).

ROC analysis showed that the cut-off value of VVDES was 2 for all participants. The area under the ROC curve was significant (AUC=0.620; p=0.05) for all subjects whose VVDES scores were 2 or higher. The sensitivity of VVDES was calculated as 77.42%, and the specificity was 46.53%.

When we grouped the participants according to gender, the mean VVDES score of males was 1.50±1.87, while females received a score of 2.53±1.92 and the difference between genders was statistically significant (Mann-Whitney U; p<0.001).

Table 2. Demographic characteristics by gender

		Weight (kg)	Height (cm)	Age (year)	BMI
Male	**N**	64	64	64	64
	M±SD	80.09 (±8.03)	179.86 (±4.95)	35.09 (±5.14)	24.73 (±1.88)
Female	**N**	200	200	200	200
	M±SD	58.60 (±6.54)	167.01 (±4.38)	33.60 (±4.94)	21.00 (±2.16)
Mann-Whitney U	**p**	**.000**	**.000**	**.031**	**.000**

N: number of participants, M: mean, SD: standard deviation, BMI: body mass index

Table 3. Distribution of VVD by gender and relationship with age groups and family history

A) Distribution of VVD by gender

		VVD		p*
		None	Yes	
Male	**N**	60	4	**<0.001**
	%	93.8	6.3	
Female	**N**	142	58	
	%	71.0	29.0	

B) Rate of VVD by genders and age groups

	Age**, ***		VVD		p*
			None	Yes	
Male	**<35**	**N**	30	2	0.69
		%	93.8	6.3	
	35+	**N**	30	2	
		%	93.8	6.3	
Female	**<33**	**N**	72	21	**0.04**
		%	77.4	22.6	
	33+	**N**	70	37	
		%	65.4	34.6	

C) The relationship between VVD and family history by gender

	Family history VV		VVD		p*
			None	Yes	
Male	**None**	**N**	42	1	0.063
		%	70.0	25.0	
	Yes	**N**	18	3	
		%	30.0	75.0	
Female	**None**	**N**	91	21	**<0.001**
		%	64.1	36.2	
	Yes	**N**	51	37	
		%	35.9	63.8	

N: number of participants, VVD: varicose vein disease; *Chi-Square Test, ** Median age of male: 35, *** Median age of female: 33

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Table 4. Relationship of VVD, smoking, and occupational parameters by gender

A) The relationship between VVD and smoking by gender

	VVD	N	Smoking (package/year)					*p**
			M±SD	Median	IQR	CI Upper	CI Lower	
Male	No	60	5.40±6	4.13	8.76	6.97	3.87	0.12
	Yes	4	10.37±7.10	10.25	13.75	21.68	-0.93	
Female	No	142	2.73±4.50	0.23	3.81	3.47	2.00	0.58
	Yes	58	2.10±3.31	0.25	4.14	2.98	1.23	

B) The relationship between occupational parameters and VVD

	VVD			WLS (years)	Break in WLS (month)	Total flight time (hours)
Male	No	N		60	60	60
		M±SD		9.62±5.22	1.50±4.4	12646.43±17755.7
		Median		9.00	0.00	8000
		IQR		6	1	7324
		CI	Upper	10.96	2.64	17233.22
			Lower	8.27	0.36	8059.64
	Yes	N		4	4	4
		M±SD		9.50±3.31	1.00±2	9500.00±3894.4
		Median		9.00	0.00	9750
		IQR		6	3	7250
		CI	Upper	14.78	4.18	15696.92
			Lower	4.22	-2.18	3303.08
		*p**		0.88	0.64	0.97
Female	No	N		142	142	142
		M±SD		8.76±5.19	5.17±9.21	10256.02±13969.9
		Median		8.00	0.00	6000
		IQR		8	8	9500
		CI	Upper	9.62	6.70	12573.63
			Lower	7.90	3.64	7938.40
	Yes	N		58	58	58
		M±SD		9.38±5.40	8.02±12.7	11944.98±17282.9
		Median		8.05.	0.00	7280
		IQR		8	12	8125
		CI	Upper	10.80	11.36	16489.28
			Lower	7.96	4.68	7400.69
		*p**		0.46	0.75	0.31

N:Number of participants, M:Mean, SD:Standard Deviation, VVD:Varicose Vein Disease, WLS:Working Life Span, CI:Confidence Interval, IQR:Interquartile Range, *Mann-Whitney U Test

Table 5. The relationship between VVD and average flight length

	Average flight length		VVD		p*
			No	Yes	
Male	Less than 4 hours	N	6	1	0.38
		%	85.7	14.3	
	4 hours and more	N	54	3	
		%	94.7	5.3	
Female	Less than 4 hours	N	13	10	0.08
		%	56.5	43.5	
	4 hours and more	N	129	48	
		%	72.9	27.1	

N: number of participants, VVD: varicose vein disease; *Fisher's Exact Test

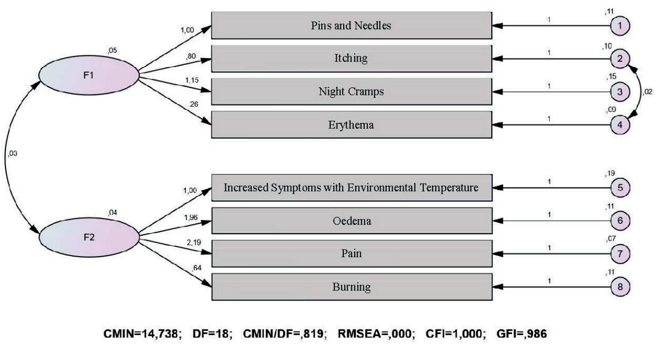

Figure 2. The exploratory factor analysis of Varicose Vein Disease Evaluation Scale

DISCUSSION

In this study, lower extremity VVD was investigated in cabin crews. As in our hypothesis, VVD rate in cabin crew members was found to be higher than normal population prevalence in our study. Family history of VVD was found to be a predisposing factor for VVD and short haul flight duties might be closely related to VVD.

It was reported that 13.9% of VVD are observed in patients aged between 25 and 34 years [13]. In our study, the mean age was 35 and our study prevalence of VVD in cabin crews was higher (23.5%) than published population prevalence. Numerous studies have shown that aging increases the risk of VVD by up to 10% per year [14,15]. Likewise, individuals aged sixty-five or older were found to be at increased risk of developing VVDs in numerous studies [9,14,16]. Similar to the published literature, aging increased the VVD rate in our study.

Female gender was a risk factor for VVD [12,17,18] and consistent with the literature, it was found in our study that females had a higher rate of VVD (29%) than males (6.3%), and this difference was found to be statistically significant.

It has been reported that pregnancy, HRT usage, and wearing high-heeled shoes affected the frequency of VVD [19]. VVD was more prevalent with the increase in the number of pregnancies. Prevalence of VVD in cabin crews who had been pregnant once to four times (or more) was reported as 38%, 43%, 48%, and 59%, respectively [20]. In our study, the rate of VVD was higher in females who had given birth, but the difference was insignificant. In Tepper NK et al.'s study, the rate of VVD was 43% in the HRT group, while the rate of VVD was 45% in high heeled shoe-wearing group [21]. No association can be shown between these risk factors and the prevalence of VVD in our study.

Some studies did not show a connection between smoking history and VVD [19]. In contrast to this, in Gourgou S.'s study, those who smoked less than 20 cigarettes per day had a 1.5 times higher risk of developing VI, and those who smoked more than 20 cigarettes per day had three times higher risk [22]. Duration of smoking studied in Elamrawy S et al.'s study and the risk of VVD was found to be 2.53 times higher in smokers when compared with ex/non-smokers [23]. Smoking rates were found to be low in our study. Cabin crews' socioeconomic and education levels were higher than the general population's, which might explain this lower rate. Although the smoking rate was higher in males diagnosed with VVD, no statistical significance was shown between the smoking rate, and the diagnosis of VVD.

Positive Family history of VVD is a significant risk factor in those diagnosed with VVD [12,24]. It has been reported that 60–

65% of females with VVD have a positive family history of VVD [19,25]. In line with the literature, in our study, participants with a family history of VVD were more likely to have a diagnosis of VVD in both genders, and it was also found to be statistically significant in females.

Although there hasn't been any research related to VVD in cabin crews, it is known that standing still for long periods of time increases the risk of developing VVD [24-26]. We found that males had more flight time, while females had more occupational break times. Our study could not demonstrate a significant correlation between VVD diagnosis and total flight time or other form of occupational exposure time. The fact that cabin crews are selected among young and healthier people and have regular medical checks during their profession might contribute to these findings in our study.

According to the World Health Organization (WHO), venous problems can arise during four hours or longer flights in passengers [26]. Interestingly in our study, VVD was more common in cabin crew, who worked in short flights (4 hours and less) in both genders. However, the statistical significance of this finding could not be demonstrated (Table 5). Regardless of the flight type (short, medium, or long, etc.), total daily flight times for cabin crews are similar in duration according to aviation regulations. Viewing a flight through the lens of a flight attendant involves several distinct phases. These include individual preparation before the flight, arrival at the aircraft, and aircraft preparation. They also involve welcoming passengers aboard, assisting them to their seats, managing take-off procedures, handling in-flight food and beverage service, overseeing the landing process, ensuring the safe disembarkation of passengers, and completing post-flight duties. Throughout these phases, cabin crew members frequently find themselves standing for extended periods, particularly during tasks such as passenger boarding, meal and beverage service, and overseeing the safe exit of passengers. For longer flights, additional rest periods are often scheduled before or after service duties to maintain crew alertness and efficiency. In long-haul flights, cabin crew members have the opportunity of more resting time and can elevate their feet as needed, whereas on short-haul flights, they are unable to do either and cabin crews work much harder on short flights. Contrary to literature and expectations, VVD rate was higher among cabin crews who flew multiple short-haul flights daily rather than just one long flight in our study. We believe this exciting finding requires much further investigation.

Regular exercise and sports are known to be the countermeasures against VVD [12]. VMP is the forefront activity that regulates venous return and reduces peripheral vascular resistance [27]. In our study, sports and exercise decreased the rate of VVD.

Wearing compression stockings is often the first approach as a countermeasure. The stockings squeeze the legs, helping veins and leg muscles move blood more efficiently. Wearing compression stockings is not a common practice in cabin crews. Unless wearing is contraindicated, we suggest that all cabin crews who suffer from general symptoms of VDD should wear the compression stockings while practicing their duty.

Sensitivity of VVDES is higher as a screening scale. This scale is very short, easily used and helpful to diagnosis of VVD. Authors suggests that VVDES can be used as a self-testing modality especially by female cabin crews.

CONCLUSION

Our study showed that 23.5% of civil aviation cabin crews had VVD. Family history of VVD was a crucial factor in terms of VVD. Short flights have been linked to an increased risk for VVD, and this finding should be considered in future investigations. A VVDES has been developed in our study, and the developed high-sensitivity VVDES can be used clinically as a screening test in cabin crews.

Study Limitations

The study's primary limitation is the difficulty in engaging aviation personnel in research and ensuring accurate responses due to professional constraints. Despite efforts to design survey questions that encourage completion and accurate answers, these surveys inherently face limitations. Specifically, complex queries related to flight schedules and rest times may not have been fully understood by participants, which impacts the study's comprehensiveness.

Ethics Committee Approval: The Health Sciences University Gülhane Scientific Research Ethics Committee approved the study (2022/133).

Patient Consent for Publication: All participants were informed about the study and consent was obtained.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: All authors contributed equally to the article.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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