

# Awareness Level of Airline Pilots on Flight-Associated Venous Thromboembolism

Bilal Kilic; Semih Soran

- INTRODUCTION:** Studies have identified a great number of physiological conditions, including venous thromboembolism and hypoxia, that may give rise to medical disqualifications and in-flight incapacitations that can be costly to individuals and organizations. Over the past three decades, much attention has been focused on venous thromboembolism among passengers. However, studies on venous thromboembolism among commercial airline pilots are very scarce. With this consideration in mind, differently from the literature, this study set out to examine pilots' awareness of venous thromboembolism signs, symptoms, risk factors, and countermeasures.
- METHODS:** For this purpose, a venous thromboembolism questionnaire was developed and applied to collect data. There were 427 airline pilots who participated in the questionnaire. The analysis of variance (ANOVA) technique was used to analyze the results of the questionnaire.
- RESULTS:** According to the results of this study, approximately one-half (57.1%) of the participants had just heard of this particular health issue and 63.9% of the participants were unaware of flight-associated venous thromboembolism. Airline pilots between 20 and 40 yr of age were much less aware of venous thromboembolism in comparison to pilots 41 yr or older, and pilots flying more than 90 h/mo were at a greater risk.
- DISCUSSION:** Airline pilots between 20 and 40 yr have less knowledge about venous thromboembolism and preventive measures against it in comparison to older pilots. Therefore they may be more vulnerable to possible risk factors. The findings of this study will contribute to increasing pilots' awareness on flight-related venous thromboembolism and can improve the overall safety of civil aviation.
- KEYWORDS:** venous thromboembolism, aviation safety, long-haul flight, organizations, airline pilots.

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The unprecedented expansion of civil aviation over the past two decades have focused attention sharply on aviation safety and the resulting demand for qualified and healthy employees.<sup>6</sup> On the other hand, non-stop flight times for long-haul flights have been extended to 18–20 hours by the latest introduction of brand-new aircraft, including Boeing 787-9 and Airbus A350-XWB.<sup>18</sup> These extended flight times pose some hazards, including hypoxia, low humidity, dehydration, circadian rhythm disruptions, and prolonged sitting, which predispose people involved to venous thromboembolism.<sup>12,20</sup> The association between long-haul flights and venous thromboembolism related to air travel is an indisputable fact.

Until now, studies pertaining to venous thromboembolism have mostly focused on air passengers.<sup>1,27</sup> Additionally, this traveler's thrombosis is also known as the economy class syndrome because it is mostly recognized among economy class passengers.<sup>11</sup> Airlines provide in-flight health advice for their

passengers. Budd et al.<sup>5</sup> examined 50 international airlines' in-flight magazines. Among the magazines, 18 mentioned the dangers of prolonged immobility, deep vein thrombosis (DVT), and preventive measures. Without considering DVT, 32 magazines included information on exercises that provide mobility and increase circulation.<sup>5</sup>

No study in the literature has yet investigated the knowledge levels of airline pilots on venous thromboembolism and, to the

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best of our knowledge, there is no published study which provides health advice on DVT for flight deck crews. Only very few studies have focused on the health issues of flight crews. One of these demonstrated alertness management in long-haul flying.<sup>14</sup> With this in mind, to address these gaps in the literature, we performed a follow-up cohort study to examine the understanding levels of airline pilots on venous thrombosis, its symptoms, and preventive countermeasures. The purpose was to provide awareness-related information on venous thromboembolism among airline pilots to prevent workplace health and safety hazards (e.g., venous thromboembolism, in-flight medical emergencies, incapacitations) and provide a better understanding of the association between pilots' health problems and flight safety.

Formation of a blood clot inside a blood vessel is called thrombosis. Thromboembolism is obstruction of a blood vessel caused by fragments of a blood clot carried from the site of origin to obstruct another vessel. Studies have reported a great number of well-recognized risk factors for venous thromboembolism such as obesity, age (greater than 40 yr old), malignancy, recent surgery, pregnancy, a history of venous thromboembolism, and documented thrombophilic abnormality. There are also risk factors associated with long-haul flights such as dehydration (e.g. consumption of caffeine, diarrhea), compression of the popliteal vein by the edge of the seat, and immobility. Over the past decade, there have been several studies published on the incidence of thrombosis in long-haul flights.<sup>21,28</sup> Due to prolonged sitting in the flight deck and poor air quality, the health of the flight deck crew is under threat, and exposure to these risk factors may give rise to either deep vein thrombosis or pulmonary embolism, which may be fatal.<sup>15</sup> Pilots mostly use sleep-promoting compounds to mitigate fatigue.<sup>7</sup> However, uptake of these common over-the-counter sedatives (sleep-promoting compounds) may increase the risk of thrombosis.<sup>15</sup>

Recent studies have focused on venous thromboembolism and its link to air travel following the death of an English woman after a long-haul flight in 2000.<sup>4</sup> Much attention has been devoted to the association between venous thromboembolism and flight by the public and the media.<sup>26</sup> It has been reported that thromboembolism is rarely observed after flights which take less than 5 h, and passengers and flight deck crew typically face thromboembolism during flights of 12 h or longer.<sup>23</sup> Life-threatening pulmonary embolism and flying have been linked over the past five decades. It was first reported by Homans et al. in 1954.<sup>16</sup> In their particular study, it was mentioned that a physician who flew from Boston to Venezuela in 1946 on a long-haul flight (flight time was 14 hours) suffered venous thrombosis. Sarvesveran et al. reported that pulmonary embolism was determined as the cause at autopsy in sudden death in 11 cases among airline passengers (61 cases) who arrived at Heathrow Airport in London.<sup>25</sup> Ferrari et al. showed that 39/160 patients with DVT had recently flown for more than 4 h.<sup>13</sup> It is interesting to note that the risk of venous thromboembolism (VTE) increases in conjunction with the duration of the flight.<sup>10</sup> Cannegieter et al.<sup>8</sup> performed a case-control and

follow-up study. Consequently, it was revealed that the risk of VTE after a long-haul flight doubled.<sup>8</sup> Kuipers et al.<sup>19</sup> conducted a study to assess the risk of VTE in a cohort of Dutch airline pilots. In their study, questionnaires on VTE were returned by 2630 airline pilots who had been members of the Dutch Aviation Society. Among these airline pilots, six venous thromboses were confirmed during the follow-up time. It was mentioned that the reduced incidence rate of VTE in commercial airline pilots may be due to their health status, which is likely to be better than those in the general population due to the fact that there is strict health monitoring in the profession, and a selection process is applied for becoming an airline pilot.<sup>19</sup> Likewise, another study showed that a senior commercial pilot with over 12,000 h of flying credit suffered from deep vein thrombosis during a long-haul transcontinental flight. This is the first reported case of an airline pilot facing DVT while flying aircraft.<sup>30</sup> It should be noted that DVT and life-threatening pulmonary embolism should be considered as one of the causes of pilot incapacitation.

Pilot health is a significant concern in the aviation world, mostly due to long working periods, insufficient sleep, circadian rhythm disorders, and erratic work schedules.<sup>31</sup> Countermeasures against the aforementioned cockpit challenges, which are deleterious to the health of pilots and impair flight safety, continue to be an interesting area of research.<sup>24</sup> There have been several studies on preventive measures against venous thromboembolism. Pilots should be advised to carry out leg exercises at regular intervals during their flight (flexion, extension, and rotation of the ankles).<sup>9</sup> During refueling stops in long-haul flights, pilots should walk around for a while. Mobilization during the flight (at least at 1-h intervals) should be maintained to reduce the phase of prolonged immobility. Pilots intensely consume caffeine-containing drinks to reduce drowsiness and boost alertness during long-haul flights in the flight deck. Consuming caffeinated drinks is a favored preventive measure against sleep disorders and fatigue among pilots.<sup>32</sup> However, drinking high amounts of caffeine-containing products like tea and coffee may cause dehydration.<sup>29</sup> Moreover, it was reported that dehydration increases the risk of venous thromboembolism.<sup>17</sup> Therefore, excessive dehydration should be avoided and pilots should maintain adequate fluid intake throughout their flight. Below-knee elasticated stockings may be worn to avoid the risk of VTE.<sup>2</sup> Some over-the-counter-drugs [e.g., Flite Tabs (aidan) and Bayer aspirin (acetylsalicylic acid)] are used as a preventive measure against venous thrombosis.<sup>3,9</sup> These drugs can be purchased at the supermarket, but there is a lack of knowledge among flight deck crews regarding the side effects of such drugs.<sup>22</sup> Pilots need to be aware of the health issues associated with long-haul flights. The training departments of flight training organizations and airlines should inform pilots on appropriate preventive measures. Situational awareness of pilots and increased knowledge are indispensable for successful VTE countermeasures.

Based on the issues mentioned above, we set up the following hypotheses. Our first hypothesis was "awareness levels of pilots on venous thromboembolism may vary based on

demographic factors.” The second hypothesis was proposed as “preventive measures against venous thromboembolism for pilots may vary based on demographic factors.” The next hypothesis was “risk factors of venous thromboembolism for pilots may vary based on demographic factors.” Our last hypothesis was “opinion on adding the venous thromboembolism subject to the ATPL (Air Transport Pilot License) theoretical training program may vary based on demographic factors.”

## METHODS

### Subjects

The survey was delivered online to airline pilots across five airlines operating in Turkey; 34.6% ( $N = 427$ ) of the forms were completed and submitted. Among the participants, there were 152 (35.6%) first officers who are the second pilots (also referred to as co-pilots). The first officer is the deputy of the commander and responsible to the commander for safe and efficient operation. Of the respondents, 41% ( $N = 175$ ) were commanders and 23.4% ( $N = 100$ ) were senior first officers who were co-pilots and sat in the left-hand seat when the commander took a rest during a long-haul flight (also referred to as cruise relief pilots). In this sample, 88.5% ( $N = 378$ ) of the respondents were men and the majority (55.9%,  $N = 252$ ) were first officers. Approximately one-half (45.9%,  $N = 196$ ) of the respondents were 31–40 yr of age, and 35.3% ( $N = 151$ ) of the respondents were older than 40. Ethical approval for the study was obtained from the Özyeğin University’s Human Research Ethics Board (2019/12-Semih Soran).

### Questionnaire

Based on a review of the relevant literature on venous thromboembolism, 27 questions were developed and organized into 5 subscales: 1) demographic items (e.g., age, gender, ranking and total flying experience, 8 questions); 2) awareness level of pilots on venous thromboembolism (5 questions); 3) preventive measures against venous thromboembolism (5 questions); 4) risk factors of venous thromboembolism (7 questions); and 5) training program for pilots (2 questions). A two-way closed-ended (yes/no) question-based scale was used for 14 items of the survey (Appendix A, available at [https://drive.google.com/file/d/18EoHoLYuGH9uOo67FxyTW49eLVz\\_TL4U/view?usp=sharing](https://drive.google.com/file/d/18EoHoLYuGH9uOo67FxyTW49eLVz_TL4U/view?usp=sharing)). Several rounds of review of the survey were carried out to obtain a comprehensive content and a user-friendly layout and make sure that the questionnaire took about 10–15 minutes to complete.

### Statistical Analysis

ANOVA was used to find the effects of taking preventive measures, susceptibility, being in the risk group, and views on ATPL courses on venous thromboembolism in pilots and their awareness levels on venous thromboembolism. The data were found to be normally distributed using the Kolmogorov-Smirnov test and analyzed in SPSS. The descriptive statistics of the participants are shown in **Table I**.

## RESULTS

Our findings revealed that most participants (63.9%) were not aware of deep vein thrombosis or its link to flight. The flight experience of 30.9% was more than 10,000 h. Reflecting the greater venous thromboembolism risk among pilots, 33.7% ( $N = 144$ ) of those surveyed reported that they sat down in the cockpit more than 4 h without standing up. The participants were asked “What type of aircraft do you fly (short-haul or long-haul aircraft)?”. Of those questioned, 68.6% ( $N = 293$ ) reported that they flew long-haul aircraft (e.g., Airbus 330-340 and Boeing 747-777-787) with greater risk of venous thromboembolism. The participants were asked whether or not they used over-the-counter medicines (e.g., aspirin) against DVT. Relatively few participants (8.4%,  $N = 36$ ) used over-the-counter medicines to protect themselves against DVT. Almost half of the respondents were older than 40 (35.3%,  $N = 151$ ). Based on the results shown in Table I, there is a significant difference between male and female pilots. Male pilots exhibited more risk factors. The results of the present study also suggest that pilots in the 20–40 age group reported smoking. Additionally, it may be stated that pilots in the 20–40 age group were at least as at risk as the pilots in the 40–60 age group. Therefore, this shows that young pilots (20–40) should apply preventive measures at least as much as pilots over the middle ages (40–60). Again, when we look at the ranking, first officers could be affected by this negative situation as much as senior first officers and captains. Similarly, experience shows that pilots who do not have much experience should be aware of this issue. Pilots flying over 90 h/mo were found to be much more at risk than others.

## DISCUSSION

We sought to examine pilots’ awareness levels on venous thromboembolism signs, symptoms, risk factors, and countermeasures. The results demonstrated that the brand-new questionnaire was a user-friendly tool to find out the knowledge and awareness of pilots on this particular health issue.

The most surprising result that emerged from the data was that airline pilots between 20 and 40 yr of age had less knowledge about the subject in comparison to the older pilots. Therefore, they became more vulnerable to possible risk factors. Additionally, the decrease in the age of the pilots and the continuation of flight times, even in short-haul flights, increased the probability of risk. Increasing the awareness levels of young pilots is important in this context. It is important to include this issue in ATPL and recurrent training and, in particular, to provide examples of preventive measures. In contrast to earlier findings,<sup>8,23</sup> we found that short-haul pilots could be considered to be more at risk than long-haul pilots. This is mainly due to the fact that pilots flying long-haul aircraft are relatively old, have much more experience, and are aware of venous thromboembolism in comparison to pilots flying short-haul aircraft. Moreover, older pilots ages 41 or older are aware of and take preventive actions against venous thromboembolism.

**Table I.** Descriptive Statistics.

DEMOGRAPHIC FACTORS (QUESTIONS 1–8)	N	RISK FACTORS (QUESTIONS 16, 18, 23–27)			TRAINING PROGRAM (QUESTIONS 14–15)			PREVENTIVE MEASURES (QUESTIONS 17, 19–22)			AWARENESS (QUESTIONS 9–13)		
		MEAN	F	P	MEAN	F	P	MEAN	F	P	MEAN	F	P
Gender													
Male	378	1.6667	11.665	0.001	1.6799	2.551	0.111	2.4850	0.249	0.62	1.8624	0.275	0.6
Female	49	1.8351			1.6653			2.6803			1.8469		
Age													
20–30 years old	80	1.7833	2.855	0.037	1.735	14.952	<0.001	2.5417	1.559	0.2	1.9375	10.71	<0.001
31–40 years old	196	1.7976			1.7612			2.5476			1.9005		
41–50 years old	80	1.8542			1.5375			2.5208			1.7938		
51 or older	71	1.8592			1.5437			2.3427			1.7394		
Rank													
Commander	175	1.859	6.814	0.001	1.5783	14.618	<0.001	2.4476	3.413	0.03	1.7686	19.93	<0.001
Senior First Officer	100	1.8067			1.73			2.43			1.895		
First Officer	152	1.7719			1.7592			2.6272			1.9441		
Experience													
Less than 5 yr	137	1.7883	3.769	0.011	1.7679	13.23	<0.001	2.5912	1.041	0.374	1.9489	13.662	<0.001
5 to 10 yr	116	1.7874			1.7138			2.4713			1.8966		
11 to 15 yr	30	1.8222			1.7667			2.4			1.7667		
More than 15 yr	144	1.8634			1.5458			2.4792			1.7674		
Flying in a month													
Up to 60 h	17	1.8431	3.210	0.013	1.6	.547	0.701	2.3922	0.367	0.832	1.8235	0.623	0.646
61–70 h	50	1.8600			1.688			2.5000			1.8600		
71–80 h	218	1.8150			1.6789			2.5138			1.8739		
81–90 h	125	1.8187			1.672			2.5360			1.8360		
More than 90 h	17	1.6471			1.7647			2.3529			1.9118		
Aircraft Type													
Short haul	134	1.8010	1.346	0.247	1.7194	2.381	0.124	2.5448	2.872	0.091	1.9067	23.964	<0.001
Long haul	293	1.8225			1.6594			2.4903			1.8396		
Long/short haul													
Short haul (0–4 h)	134	1.8010	1.346	0.247	1.7164	1.241	0.266	2.5498	2.529	0.113	1.9104	27.935	<0.001
Long haul (more than 4 h)	293	1.8225			1.6608			2.4881			1.8379		

There were no significant differences between preventive measures in terms of the demographic characteristics of the participants. It was revealed that the awareness levels of the older pilots were higher than those among the younger pilots. With regard to the ranking, the captains had a higher level of awareness than the first officers and senior first officers. It is noteworthy that the opinion of the older pilots about adding this subject into recurrent and ATPL course planning was found to be higher than those among the younger pilots. This result strengthened support in our hypothesis that “Opinion on including venous thromboembolism in the ATPL theoretical training program varies based on demographic factors.”

This study was designed to determine the awareness levels of airline pilots on venous thromboembolism. The findings of this study have important implications for the literature on flight-related venous thromboembolism, as well as making a positive contribution to the effectiveness and safety of airline operations. One of the more significant findings to emerge from this study was that more than 60% of the participants were unaware of this important health issue, which is one of the most frequently encountered complications during flights. The second major finding was that the older pilots were much more aware of venous thromboembolism and took preventive measures against it. Freshly graduated airline pilots or airline pilots with less flight experience do not hear of this health issue during the pilot

training course or during the type rating process (a training for a particular type of airline aircraft, e.g., Boeing, Airbus, and Embraer). Therefore, educational efforts are very important to ensure that risk factors and effects of venous thromboembolism are thoroughly understood by organizations (e.g. airlines, flight training organizations) and individuals (flight deck crew). The flight training departments of airlines, flight training organizations (flight schools), and pilot training departments of universities would help provide safer long-distance air travel by including venous thromboembolism as a topic in their curricula in the ground course training process of student pilots and recurrent training programs for airline pilots.

We are aware that a number of limitations may have influenced the results obtained here. Firstly, the pilots who were surveyed might have not clearly answered the questionnaire even if they did not provide any personal information. Another possible limitation was that the questionnaires were sent through SMS and e-mail. Non-responding pilots received only one reminder 1 mo after the first email or SMS. It is unfortunate that most of the respondents were male first officers; the findings of this study may have been affected by the relatively low number of female pilots. Another direction for future research would be replication of the same questionnaire for a wider population of pilots with the help of aviation societies of countries. We recommended that organizations and airlines inform pilots

on flight-related venous thromboembolism with a description of its preventive measures to minimize the risk factors of in-flight medical emergencies based on venous thromboembolism and improve the overall safety of aviation. We are confident that the outcome of this study will create a better understanding of the association between pilots' health issues and flight safety.

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