



Risk of Venous Thromboembolism Among Individuals who Frequently Travel by Flight for Work

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Abstract

Many research studies have found that venous thromboembolism is common among frequent travellers in all form mainly air travel. Few Indian studies in acute care settings had also mentioned travel history as an important element. Nowadays a section of corporate employees are frequent flyers in India. Hence, we conducted a pilot project to assess and analyze the risk category among these employees. A snowball sampling was used as a sampling technique. The data collection method was done using a google survey link. An anonymous questionnaire link with a unique code of four digit inserted by the participants, had been circulated among the identified study participants. Out of the total 30 respondents, 13 (43.3%) were at high risk, 8(26.7%) at medium risk and 9 (30%) at low-risk categories of venous thromboembolism development. Pre-existing risk factors and post-travel observation (within 8 weeks of flight travel) were recorded and analysed with SPSS 22 version. Family history was significantly associated with risk category of the employees with chi-square (χ^2) value of 22.46 ($p < 0.05$). For high-risk category employees, the venous thromboembolism risk was increased by 44 times (OR 44, 95% CI 3.4-573.4) and for medium-risk category employees 13 times (OR 13.3, 95% CI 1.07-166.4) with the history of infectious disease exposure. Overall presence of certain pre-existing clinical parameters (like heart disease, congenital heart disease, varicose veins, pregnancy, exposure to infectious disease) were significantly associated with a chi-square (χ^2) value of 6.09 ($p < 0.05$). Further knowledge level and practice level of these frequent corporate flyers had a statistically significant association with their risk category. This paved the way to develop holistic need-based guidelines covering all relevant key aspects of venous thromboembolism including the head-neck-foot exercise to prevent venous thromboembolism while flying.

Keywords: -Indian corporate employees, frequent flyers, venous thromboembolism (VTE)

Introduction

Venous Thromboembolism is a condition commonly tracked in hospitals as one of the important quality indicators to address. But for the public, it is a rarity. Some cases were detected among frequent long-distance travellers mainly through road and air (Kelman, 2003) where people are bound to be seated for long hours (Sinha Kounteya, 2010). Forced immobilization happens in the case of air travellers (Choudhry & Upadhyay, 2009) with additional hypobaric hypoxia (Toff et al., 2006) state due to high altitude.

World Health Organisation aimed at understanding the relationship between travel in air and the absolute VTE risk. The cumulative conclusion from the five epidemiological studies and two pathophysiological studies was published in the WRIGHT (WHO Research Into Global Hazards of Travel) phase I report in the year 2015 (WHO Research into Global Hazards of Travel (Wright) & World Health Organization., 2007).

The absolute risk of VTE per more than four-hour flight, in a cohort of healthy individuals, was 1 in 6000. (Kuipers, Venemans-Jellema, et al., 2014)

The report clarified that the risk of VTE increases with the duration of the flight journey particularly in the situation of long-haul flights (> 4 hrs) and with even short-duration multiple flights within a short period (Cannegieter et al., 2006). Further existence of certain other known risk factors like obesity, extremes of height, oral contraceptive usage (Mahmood et al., 2022; Ram et al., 2022, 2023) and prothrombotic blood disorders contributes in aggravating the VTE risk significantly among flight passengers. (Kuipers, Venemans, et al., 2014)

The annual incidence of deep vein thrombosis in the general population is estimated to be about 1 per 1000. Maximum available published articles speak about the gravity of deep vein thrombosis and venous thromboembolism among the Indian population admitted in various hospital settings (Neeman et al., 2022). In the WRIGHT project, one five-year extensive cohort study (Kuipers et al., 2007) was conducted among 8755 employees from 10 large international companies and organizations to identify the occurrence of symptomatic venous thrombosis on exposure to air travel (Dimberg et al., 2006).

Material and Methods

A descriptive exploratory research design was adopted by the investigators to study the corporate employees frequently flying in selected Indian multinational companies. The study objectives were to identify the pre-existing associated risk factors among the employees and classify their risk category accordingly. Further, the investigators wanted to identify any indication of VTE development post-travel among the employees.

Inclusion criteria consisted of all Indian corporate employees aged above 21 years exposed to frequent air travel due to job assignment. Indian corporate employees who were only travelling by bus or train, by air 2-3 times in a year and were on the verge of retirement or on long sick leave during the study period were excluded. (McKerrow Johnson et al., 2022).

As per the absolute risk of venous thromboembolism per flight (1/6000) the total sample size was calculated by SPSS 22 version was 161. As a pilot project, we targeted 30 samples.

We had initially recruited 50 employees working in corporate through social media (LinkedIn etc.) and professional networking for a period of three months (April – June 2023). Under non-probability sampling, snowball sampling was adopted. Out of which responses from 30 employees were considered based on the inclusion criteria.

We had prepared a tool to objectively gather information to discover the associated pre-existing risk factors (clinical parameter that might lead to VTE) prior to flight travel as well as 8 weeks post-travel VTE signs and symptoms to determine the probability of the venous thromboembolism occurrence.

The risk categories as per Dr. Caprini's Risk Assessment Tool (Caprini, 2023) was the guidelines for the development of a tool for data collection (Hayssen et al., 2022). The tool was validated by ten experts from senior nursing and medical professionals. The tool was prepared in Google form which would only be opened by giving a unique code within four digits of their own by each participant.

Ethical Consideration

Institutional ethical clearance was taken by maintaining all the ethical principles as per declaration of Helsinki. The research protocol had been approved by the Research Ethics Committee of Amity University Haryana, India vide reference number IEC-AIB/AUH/2023-10 dated 19th September 2023.

Results

Among the thirty respondents majority were from the pharma industry and health industry followed by the IT sector and medical equipment companies and academics. Also few respondents were entrepreneurs, architects and were from the retail chain, real estate industry and aviation industries. (Academic -3, Pharma- 7, Entrepreneur -2, Health Industry-5, Quality-2, IT Sector-4, Medical Equipment – 3 and Real estate, Retail chain, Aviation, Architect – 1 each)

The study covered all age groups from 21 years still 60 years. Mostly 43.33% of participants belong to the age group of 51-60 years and 36.67% of employees were of the age group of 41- 50 years. A total of 66.67% were male and 33.33% were females. The Majority (n=28) were having height between 5ft and 6ft. Total employees were within an average weight of 51-80 Kg (n= 19) and 81-100 Kg (n=11).

Considering the age, height and weight the exact BMI had been calculated. The total employees with BMI ≤ 25 was only 16.7%. However, 83.3 % of corporate employees with BMI > 25 had some risk of venous thromboembolism.

Air travel history was captured. Roundtrip domestic (2-4 hr duration) flying schedules were asked. Average gap period between two consecutive flight schedules was also considered. Additionally roundtrip international (>4 hr duration) flight travel were also captured (MacCallum et al., 2011; Scurr et al., 2001). Out of the total thirty employees, 4 employees (13.3%) travel domestic (roundtrip) for 4-6 times in a year, 8 employees (26.7%) travel 8-12 times in a year and majority 18 (60%) travel > 12 times in a year. International travel taken for 2-4 times in a year by 4 (13.3%) employees and 1-2 times in a year by 13(43.3%) employees. Rest 13 employees had not travelled internationally. The average gap period between two consecutive flight travel was found ≤ 7 days among 9 (30%) employees, 8-14 days among 2(6.7%) employees, 15-30 days among 9 (30%) employees and >30 days among 10 (33.3%) employees.

Family history of heart disease, bronchial asthma, deep vein thrombosis and haemophilia or thrombophilia were asked. Among the 30 respondents, 16 (53.3%) had a positive family history with twelve having heart disease, one having bronchial asthma and three having a history of both. (Abdool et al., 2017; Koh, 2021; Possick & Barry, 2006)

Employees were assessed for existing risk factors objectively. Total 16 (54%) employees had a history of infectious disease like Covid (Chen et al., 2021; Parker & Mahomed, 2020), whereas 2 employees had a history of heart disease (Chaudhary et al., 2021; Lapostolle et al., 2001). Again one respondent was pregnant, one had congenital heart disease and one had both varicose vein plus exposure to infectious disease. The rest 9 (30%) respondents had no preexisting risk factors. (Fig 1) Out of the existing parameter present, 4 were low risk, 5 were medium risk and 12 were at high risk category

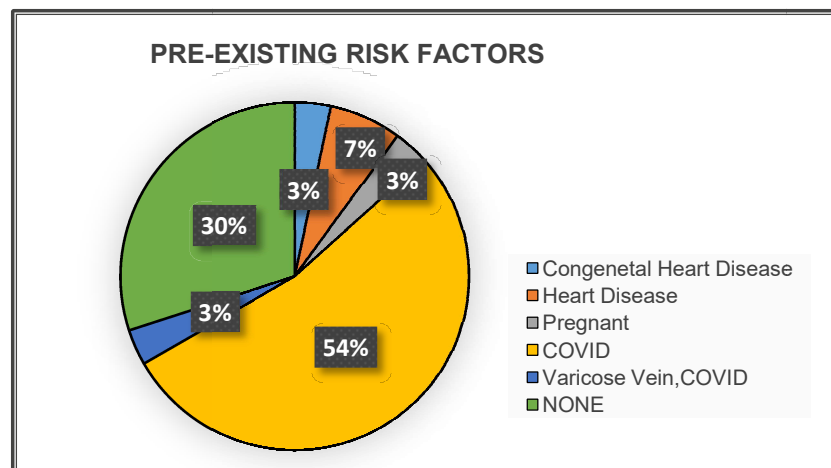


Fig 1: Pre-Existing Risk Factors present among employees

Signs and symptoms of venous thrombotic events within 8 weeks post travel by flight, were objectively asked from the employees. Out of total responded employees 19 presented some sort of signs and symptoms unlike 11 other respondents. Leg swelling after prolonged sitting/standing was found among 10 (33.3%), pain in calf muscle among 6 (20%) whereas at least one participant in each case stating a feeling of dizziness or light headedness, blackish discolouration in the lower limb and both pain in calf muscle plus chest pain (Table1).

VTE Signs & Symptoms Post Travel (within 8 weeks)	Employee	Percentage
A feeling of dizziness, lightheadedness or fainting	1	3.3
Blackish discolouration in the lower leg	1	3.3
Leg swelling after prolonged sitting/standing	10	33.3
Pain in calf muscles	6	20
Pain in calf muscles, Chest Pain	1	3.3
No Signs and Symptoms	11	36.7
Total	30	100

Table 1: Post Travel Observation within 8 weeks after flight travel

Data analysis and interpretation

As per the points in the Dr. Caprini Risk Assessment tool the pre-existing risk factors like age, family history and some post-travel observation (oedema in lower limb) were considered to assign the employees into low, medium and high-risk categories of VTE development. Out of the total 30 employees, 13 (43.3%) were at high risk, 8 (26.7%) had medium risk and 9 (30%) had low risk.(Fig 2)



Fig 2: VTE risk categories of employees

The questionnaire was set to assess the awareness of venous thromboembolism among the employees who were frequently flying due to their job assignment (Lutsey & Zakai, 2023). The three domains of knowledge, understanding and application were considered. The knowledge criteria were set as adequate (>50%), moderate (50%) and inadequate (<50%). A total 26 (86%) employees' knowledge level was inadequate whereas 4 (14%) employees were moderate. Out of the inadequate knowledge group, 9 employees were low risk, 8 employees were medium and 9 employees were of high risk categories. All employees with moderate knowledge levels were in the high-risk group.(Fig 3)

While taking long-haul flights (>4hrs) or frequent flying (8-12 times in a year or more) certain precautionary steps to prevent deep vein thrombosis had to be followed. These include drinking plenty of water and less coffee/tea/alcohol, walking through the aisle in between, consuming any prescribed anti-coagulant tablet or applying anti-embolic stockings and performing head, neck and leg exercises. Objectively this was assessed by a floating questionnaire. Inadequate practice level (<50%) had been found among 17(56.6%) employees whereas 13(43.3%) employees with moderate practice level (50%) followed some steps by default. Out of the above 17 employees, 1 employee was of low risk, 5 were medium risk and 11 were in the high-risk category of venous thromboembolism development. Likewise, 2 high-risk employees, 3 medium-risk employees and 8 low-risk employees had moderate practice levels.(Fig 4)

Statistical analysis with the SPSS 22 version was used for data interpretation. A chi-square analysis was done for all the background variables and associated pre-existing risk factors. Age, sex, BMI, and smoking were not found associated. Family history had been significantly associated with the risk status of the employees with a chi-square (χ^2) value of 22.46 ($p < 0.05$)(Table 2).The overall presence of pre-existing clinical parameters like Covid, heart disease, pregnancy and congenital heart disease had a significant association with a chi-square (χ^2) value of 6.09 ($p < 0.05$). (Table 3)

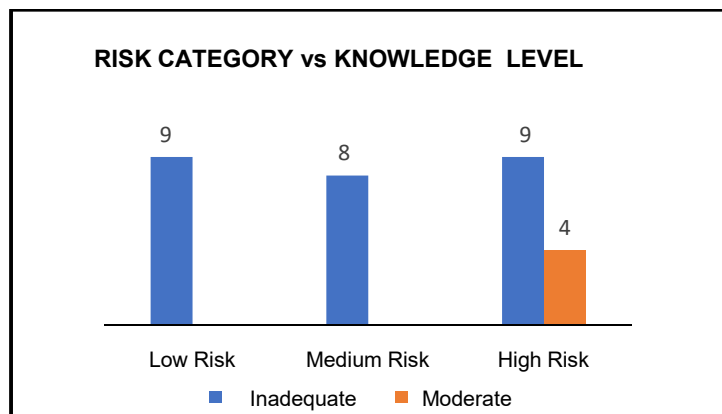
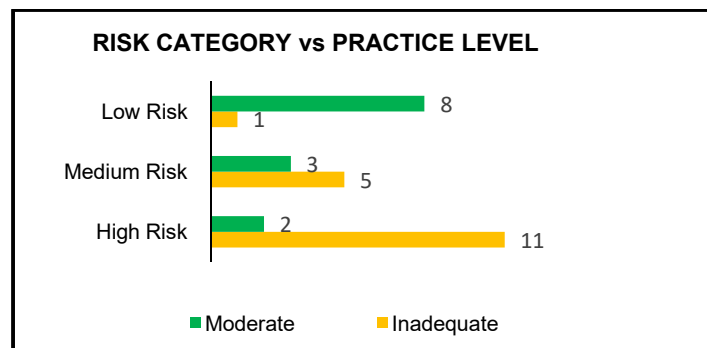
VTE RISK CATEGORIES		FAMILY HISTORY		Chi Square value χ^2 X
		ABSENT	PRESENT	
RISK CATEGORY	Low risk	9	0	22.47
	Medium risk	5	3	
	High risk	0	13	
Total Employees		14	16	

Table 2: Association between Family History and VTE risk categories of the employees

VTE RISK CATEGORIES		EXISTING CLINICAL PARAMETER ³		Chi Square value χ^2 X
		ABSENT	PRESENT	
RISK CATEGORY	Low risk	5	4	6.09
	Medium risk	3	5	
	High risk	1	12	
Total Employees		9	21	

Table 3: Association between Existing Clinical Parameter and VTE risk categories of the employees

The knowledge and practice levels of employees were significantly associated with the risk status of employees with the chi-square (χ^2) value of knowledge level 6.04 ($p < 0.05$) and practice level 11.85 ($p < 0.05$) respectively.

**Fig 3:** VTE risk categories and knowledge level among employees**Fig 4:** VTE risk categories and practice level among employees

Discussion

Metanalysis by Chandra D (2009) had concluded that VTE risk increases three times with each two hours increase in travel duration. A review of 254 studies related to air travel and deep incidence was conducted by Adi Y (Adi *et al.*, 2004). The review ultimately included ten studies on deep vein thrombosis incidence and risk factors as per the objectives. Travel history was asked from the OPD patients who had come for doctor check-ups with deep vein thrombosis like signs and symptoms.

Outpatient visits of 788 patients with suspected deep vein thrombosis were scrutinized about travel history (Bergmann *et al.*, 2008), particularly about taking a flight of more than three hours in the preceding month. Out of the confirmed deep vein thrombosis cases of 186, flight travel was taken by 4 patients.

Aryal K *et al* identified that the presence of one or more additional risk factors in patients with plane travel > 8 hours travel had been statistically significant. However flight travel > 8hrs among 568 suspected VTE patients was not associated with a statistically increased risk.(Aryal & Al-khaffaf, 2006)

In this study duration of travel time was not found statistically significant. However presence of pre-existing risk factors were found to be associated significantly.

In India two studies had mentioned travel history. In Kamekar *et al.* (2016) study, among the total 549 diagnosed venous thromboembolism cases, 0.9% had a history of long-distance travel, including air travel. Singh S *et al* (Singh *et al.*, 2021) study had identified a history of recent travel of 2 patients among the total 73 VTE patients who had some exiting risk factors.

In the present study, as the researchers had initially limited the nature of the participants to be corporate employees, so primarily they wanted to know the frequency of flight travel among the participants. In India, the domestic flight distance between two cities ranges a maximum of 2-3 hrs non-stop which increases in case there is a layover. Hence for day trips and visits to multiple cities within a short span of time caused more hours of flight travel.

A study about a group of 83 dignitaries attending a medical conference in Hawaii in regard to any symptomatic deep vein thrombosis in the 4 weeks following flying (≥ 5 hours) was conducted by Arvidsson (2001)

Here this study had the limitation of confirming VTE diagnosis through investigation. However related signs and symptoms of VTE post-flight travel were objectively found. Out of 19 (63%) employees 2 had shared two signs & symptoms whereas the rest had only one symptom related to the development of VTE(Mwansa *et al.*, 2023).

The gap between the two consecutive flight travels was captured. Among the data from thirty employees, the majority 20 (67 %) had a travel history of less than a month of which 9 employees had even a travel history within a week.

In the review conducted by Karsanji DJ *et al.*(2020) on the risk and prevention of venous thromboembolism among the pregnant travellers, the absolute VTE risk per flight for the average pregnant(Righini & Suhl, 2023) or postpartum traveller was < 1%. However the risk increases >1% in case of obesity, immobility due to pregnancy, past history of VTE or thrombophilia and family history of thrombophilia.

In this study, we had got only one pregnant traveller with a Covid history and pain in calf muscle post-travel. However, it was identified that she was not a frequent traveller and her average travel in a year was four times domestic and twice international. She had fallen under low-risk category of venous thromboembolism development (Righini & Suhl, 2023).

Medical issues in flight had been elaborated in some studies including jet lag effect and the spread of infectious diseases in closed cabins. (Koh, 2021; Silverman & Gendreau, 2009) Multiple factors related to VTE risk and air travel like endurance athletes and long-distance runners who experience multiple trauma, Covid exposure etc. had been highlighted in some studies (Krasiński *et al.*, 2021).

Score		Odds Ratio	95% Confidence Interval for Odds Ratio	
			Lower Bound	Upper Bound
Moderate risk	Infectious disease	13.33	1.07	166.37
High risk	Infectious disease	44.00	3.38	573.41
a. The reference category is: Low risk.				
Score		Odds Ratio	95% Confidence Interval for Odds Ratio	
			Lower Bound	Upper Bound
High risk	Infectious disease	3.30	0.41	26.37
a. The reference category is: Moderate risk.				

Table 4:VTE risk categories and history of exposure to infectious disease among employees

In the present study (Table 4)passengers with a history of infectious disease like Covid had been recorded. For high-risk category employees, the VTE risk was increased by 44 times (OR 44, 95% CI 3.4-573.4) and for medium-risk category employees 13 times (OR 13.3, 95% CI 1.07-166.4) with the history of Covid exposure.

A decade ago few studies had been conducted among pilots (Kuipers, Venemans-Jellema, *et al.*, 2014) to understand their risk exposure. The term travellers' thrombosis was first identified (Johnston & Hudson, 2014). Although several studies were conducted to correlate flight passengers and venous thromboembolism; the renowned one was the six-year study on near about seven million passengers in Madrid Barajas airport, Spain (Pérez-Rodríguez *et al.*, 2003) The outcome of almost all studies proved thrombosis risk presence with air travel, which increases with the duration of travel. Associated existing risk factors(Mwansa *et al.*, 2023) were found to enhance this risk.

Conclusion

Present study among the corporate travellers in Indian multinational companies who had flight travel as an integrated part of their work routine found similar pre-existing risk factors that were even statistically significant in association with air travel. If calculated in some cases the total flight travel hours in a week surpasses a long-haul international flight travel to one destination.This study paved the way to develop holistic need-based guidelines covering all relevant key aspects of venous thromboembolism including the head-neck-foot exercise to prevent venous thromboembolism while flying.

Limitations

Our study had the limitation of confirming DVT diagnosis through investigation. However related signs and symptoms of VTE post-flight travel were objectively found. Data collection method through survey form recall nonresponsive rate pretty higher compare to a face to face interview.

Recommendation

Global public awareness of venous thromboembolism (Wendelboe *et al.*, 2015) study had identified an average 50-70% awareness level from nine countries. In India this awareness level needs to be emphasised. (Sarkar *et al.*, 2023). This study with a small group can be replicated by involving a larger group of corporate employees in India. Brar R and Saha PK (2020) stressed the fact that aviation companies should create public awareness with inflight announcements about certain basic precautionary steps to prevent VTE. Hence a popular social media platform eg YouTube video on need-based guidelines can be uploaded clubbing the necessary facts about VTE and the precautionary steps with exercises during frequent flight travel (de Jong *et al.*, 2023).

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Conflict of Interest

The authors declare no conflict of interest.

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