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The Gap between Deep Vein Thrombosis Knowledge and Preventive Practice among Adults in Northern Saudi Arabia: A Cross-Sectional Study

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Abstract **Objectives:** deep Venous Thrombosis (DVT) is a preventable but potentially life-threatening condition with significant morbidity and mortality. Public awareness and preventive behaviors are crucial to reducing its burden. This study evaluated DVT knowledge, self-reported prevention practices and sociodemographic determinants among adults, utilizing the Health Belief Model (HBM) and the Capability, Opportunity, Motivation-Behavior (COM-B) model as conceptual interpretive frameworks. **Methods:** A community-based cross-sectional survey was conducted among 954 adults aged ≥18 years across Arar, Rafha, Turaif and surrounding municipalities. Participants were recruited using multistage stratified sampling. The survey assessed DVT knowledge, self-reported practices and information sources, with HBM and COM-B serving as conceptual interpretive frameworks. Associations with demographic factors were analyzed using Chi-square tests and binary multivariable logistic regression, where outcomes were dichotomized into "good" versus "poor/moderate. Behavioral determinants were interpreted to inform intervention strategies. **Results:** Of 954 respondents, 67.3% had moderate DVT knowledge, 29.7% had poor knowledge and only 3.0% had good knowledge. Good preventive practices were reported by 17.5% of participants. High awareness of classic mechanical risks such as immobilization (77.7%) and leg swelling (83.1%) contrasted with critical misconceptions: 43.2% incorrectly believed that bed rest prevents DVT and only 44.1% recognized that fluid restriction does not contribute to prevention. Digital channels predominated as primary information sources (social media 58.8%, internet 50.5%), while healthcare professionals accounted for 41.7%. No sociodemographic characteristic was significantly associated with knowledge or preventive practice in unadjusted analyses; in adjusted analysis, university or higher education was associated with lower odds of good preventive practice (AOR 0.71, 95% CI 0.51-1.00). Social media (58.8%) and internet sources (50.5%) were the most common sources of DVT information. **Conclusion:** Knowledge and preventive practices related to DVT are suboptimal among adults in Northern Saudi Arabia. Digital exposure without structured clinical guidance fosters misconceptions, such as the conflation of immobility with protection. Structured health education programs, integrated into primary care and public outreach, are urgently required to promote preventive behaviors and reduce the burden of venous thromboembolism.

Key Words Deep Venous Thrombosis, Knowledge and Practices (KAP), Prevention, Health Belief Model (HBM), COM-B Model, Behavioral Determinants

INTRODUCTION

D Deep vein thrombosis is a vascular disorder typically in the lower leg or proximal ilio-femoral veins among hospitalized patients, especially intensive care unit patients [1,2]. DVT is part of Venous Thromboembolism (VTE) [3]. Three significant DVT manifestations are pain, swelling and movement disorder in the affected area [4]. In China, the incidence of DVT in postoperative neurosurgical patients were 31.1% [5]. Another study conducted in Saudi Arabia found that venous thromboembolism accounted for 1.9% of all hospital deaths from 1 July 2008 to 30 June 2009 [6]. A further study in Jeddah reported a prevalence of DVT of 15.7% among 1201 patients diagnosed with the condition [7].

Virchow's triad identified three primary factors that increase the risk of VTE: venous stasis, endothelial injury and hypercoagulability [8]. DVT was mainly linked to several risk factors, including limited mobility, major surgical procedures, obesity, smoking, history of thrombosis, surgery, hospitalization, varicose veins, thrombophilia, oral contraceptives, advancing age and pregnancy [9-11]. In surgical patients, factors such as bed rest, vein compression, reduced muscle strength and a horizontal position contribute to blood flow stagnation [11-13].

Preventing DVT is crucial for enhancing vascular health, particularly for individuals at elevated risk due to prolonged immobility, surgical procedures, obesity, or other health conditions [14]. Effective preventive strategies encompass both pharmacological and non-pharmacological methods. Non-pharmacological methods encompass early mobilization, regular leg and foot exercises, limb elevation, hydration and the application of mechanical devices such as graduated compression stockings and intermittent pneumatic compression systems to enhance venous return [15,16]. Pharmacological prophylaxis, generally involving low-molecular-weight heparin or other anticoagulants, is advised for high-risk patients to prevent clot formation [17]. Understanding and modifying health behaviors is crucial for effective DVT prevention, as knowledge alone often fails to prompt action [18]. This research employed two complementary behavioral frameworks: the Health Belief Model (HBM) and the COM-B (Capability, Opportunity, Motivation-Behavior) model. The Health Belief Model explains how individuals 'perceptions regarding susceptibility, severity, benefits and barriers influence their engagement in preventive behaviors, highlighting the importance of cues to action and self-efficacy [19,20].

The COM-B model emphasizes that behavior is shaped by the interaction of psychological and physical capabilities, social and environmental opportunities and both reflective and automatic motivations [21,22]. Despite the recognized burden of DVT and its preventability, there is a lack of data examining the behavioral determinants of DVT prevention among the general adult population in Saudi Arabia, particularly in the Northern Border Region. Previous studies primarily focused on clinical populations or employed knowledge assessments, overlooking the analysis of their application in preventive practices [23-25]. This gap obstructs the progress of targeted, evidence-based public health strategies. The present study aims to (1) assess the knowledge and preventive practices related to DVT among adults in the region, (2) examine the influence of demographic factors on these outcomes and (3) identify key behavioral determinants through the HBM and COM-B frameworks. The findings seek to inform culturally tailored health education programs and policy interventions that encourage preventive practices and reduce the population-level effects of venous thromboembolism.

METHODS

Study Design and Setting

This research employed a community-based cross-sectional design to assess knowledge and self-reported preventive practices related to Deep Venous Thrombosis (DVT) among adults in the Northern Border Region of the Kingdom of Saudi Arabia. The Health Belief Model (HBM) and Capability, Opportunity, Motivation-Behavior (COM-B) model were employed as conceptual frameworks to contextualize the findings and inform potential behavioral interventions rather than as directly measured theoretical constructs. Data were collected over four months, from June 1 to September 30, 2025.

This research targeted individuals aged 18 years and above living in the Northern Border Region of Saudi Arabia, including both Saudi and non-Saudi residents. Eligibility required participants to provide informed consent and complete the study questionnaire. To ensure that responses reflected the knowledge and practices of the general adult population, individuals with formal training or work experience in DVT management, as well as those with cognitive impairments or other conditions that could hinder their understanding of the survey, were excluded.

Sample Size Determination

A minimum sample size of 385 was calculated based on a 95% confidence level, a 5% margin of error and an anticipated knowledge prevalence of 50% to ensure maximum variability. The sample size was increased to enhance statistical power for multivariable analysis. A total of 954 participants were included in the final analysis.

Sampling Technique

A multistage sampling technique was employed. Geographic stratification was utilized to ensure representation from urban and semi-urban areas. Recruitment was conducted through public locations, including shopping malls, primary healthcare centers and universities, alongside online questionnaire distribution through official community networks. Although systematic random sampling was described for location-based recruitment, the online component represented an additional non-probability recruitment channel. The relative contributions of in-person and online recruitment were not separately documented. Furthermore, the numbers of individuals approached and those declining participation were unavailable, preventing calculation of an overall response rate.

Data Collection Instrument

A structured, self-administered questionnaire was developed based on previously published instruments assessing venous thromboembolism awareness and preventive practices [23,26]. The instrument comprised four components covering demographic characteristics, DVT knowledge, self-reported preventive practices and the main sources of information about DVT.

Knowledge-related questions assessed awareness of DVT, its symptoms, risk factors and preventive measures. The preventive practice component assessed participants' reported engagement in DVT prevention-related activities. Because some items may reflect awareness of preventive recommendations rather than actual behavioral implementation, the distinction between preventive knowledge and reported practices was considered when interpreting the findings.

Although HBM and COM-B informed the conceptual interpretation of the results, the questionnaire did not include separate validated scales assessing HBM constructs (perceived susceptibility, severity, benefits, barriers, cues to action and self-efficacy) or COM-B domains (capability, opportunity and motivation). Accordingly, these constructs were not independently scored or analyzed.

Individual clinical risk factors, including recent surgery, malignancy, pregnancy, prolonged immobilization and hormonal therapy, were not comprehensively captured as participant-level covariates. Therefore, these factors could not be included in the adjusted regression analyses.

Scoring System

In the knowledge domain, each correct response received 1 point, while incorrect responses or "I don't know" answers received 0 points. In the practice domain, each reported preventive behavior received 1 point, while failure to engage in the behavior or uncertainty resulted in a score of 0.

The total knowledge and practice scores were calculated by summing the corresponding item scores, with higher scores indicating greater knowledge or more frequently reported preventive practices, respectively. Total knowledge and practice scores were categorized into three groups: poor (less than 50% of the maximum possible score), moderate (50-75%) and good (more than 75%).

These thresholds were applied as operational categories to facilitate descriptive comparisons rather than as independently validated diagnostic cut-offs. All items were assigned equal weights and no differential weighting based on clinical importance was applied. Although categorization facilitated interpretation, it may have reduced statistical information compared with analysis of the original continuous scores.

Validity and Reliability

A panel of five experts in vascular medicine, epidemiology and health education assessed the questionnaire for face and content validity. Expert review was used to assess the relevance and clarity of questionnaire content; however, a quantitative content validity index was not calculated or reported.

A preliminary test was conducted with 30 participants, who were subsequently excluded from the main study. The pilot assessment preceded the main data collection; however, specific modifications arising from pilot testing were not documented in the available study records.

Cronbach's alpha demonstrated adequate internal consistency, with values of $\alpha = 0.82$ for the knowledge domain and $\alpha = 0.79$ for the practice domain. These coefficients were calculated for the knowledge and practice domains only. No separate reliability estimates were available for HBM or COM-B constructs because these were not independently measured. Furthermore, exploratory or confirmatory factor analysis was not performed; therefore, the factorial structure and construct validity of the adapted questionnaire were not established.

Data Analysis

Data were analyzed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized as Means ± Standard Deviations (SD), while categorical variables were presented as frequencies and percentages. Knowledge and self-reported preventive practice scores were classified as poor (less than 50%), moderate (50-75%), or good (greater than 75%) based on predefined scoring thresholds. Associations between sociodemographic characteristics and the three knowledge or practice categories were assessed using Pearson's chi-square test. Binary multivariable logistic regression analyses were performed separately for knowledge and preventive practices, with outcomes dichotomized as good versus poor/moderate. Adjusted Odds Ratios (AORs) and corresponding 95% Confidence Intervals (CIs) were calculated to evaluate associations with sociodemographic characteristics and previous DVT history. Educational attainment was categorized according to the available dataset, without distinguishing bachelor's from postgraduate qualifications. All statistical tests were two-sided and $p<0.05$ was considered statistically significant.

Ethical Considerations

All participants will provide informed consent prior to completing the survey. Data will be collected anonymously, ensuring robust privacy protection. The Bioethics Committee of Northern Border University approved the study (Decision no. H/25/53, date: 25/5/2025). Prior to participation, all individuals provided electronic informed consent and their anonymity and privacy were rigorously safeguarded in compliance with the Declaration of Helsinki.

RESULTS

Sociodemographic Characteristics

A total of 954 adults participated in the study. The largest age group comprised individuals aged 26-35 years (32.5%), followed by those aged 18-25 years (29.9%). Male participants represented 53.7% of the sample and 92.0% were Saudi nationals. Nearly half of the participants (48.4%) had attained university-level education or higher, while 56.7% resided in Arar. A minority of participants (8.6%) reported a previous diagnosis of DVT. Detailed demographic characteristics are presented in Table 1.

Knowledge about DVT

A majority of participants (64.0%) reported prior awareness of DVT. Knowledge of selected risk factors was relatively high, particularly immobilization (77.7%), paralysis or casting (77.1%) and family history (73.6%). Regarding clinical manifestations, leg swelling was the most frequently recognized symptom (83.1%), followed by leg pain (71.4%). Obesity was recognized as a risk factor by 64.3% of participants. These findings indicate variation in awareness across individual DVT-related knowledge items. Detailed responses are presented in Supplementary Table S1.

Table 1: Demographic Characteristics of Participants (n = 954)

Variable	Category	Numbers	Percentage
Age	18-25	286	30.0
	26-35	310	32.5
	36-46	204	21.4
	>46	154	16.1
Gender	Male	512	53.7
	Female	442	46.3
Weight	<50 kg	68	7.1
	50-69 kg	296	31.0
	70-90 kg	378	39.6
	>90 kg	212	22.2
Height	<150 cm	52	5.5
	150-169 cm	412	43.2
	170-190 cm	423	44.3
	>190 cm	67	7.0
Nationality	Saudi	878	92.0
	Non-Saudi	76	8.0
Marital Status	Married	578	60.6
	Single	306	32.1
	Divorced	42	4.4
	Widowed	28	2.9
Education Level	University or higher	462	48.4
	Secondary school	258	27.0
	Preparatory school	126	13.2
	Primary school	78	8.2
	Illiterate	30	3.1
City	Arar	541	56.7
	Rafha	168	17.6
	Turaif	124	13.0
	Other	121	12.7
Previous DVT History	Yes	82	8.6
	No	872	91.4

Knowledge of Preventive Measures and Self-Reported Practices

Participants demonstrated varying levels of awareness of DVT preventive measures and reported engagement in preventive behaviors. Approximately 64.0% reported awareness of DVT prevention methods; however, the reported implementation of preventive measures was less frequent. Awareness of pharmacological prophylaxis with heparin was 51.2%, whereas only 28.9% correctly recognized that fluid restriction does not contribute to DVT prevention. These findings indicate gaps in preventive knowledge and reported behaviors, although responses to knowledge-based prevention items should not be interpreted as direct evidence of behavioral implementation. Detailed responses are presented in Supplementary Table S2.

Overall Knowledge and Preventive Practice Scores

Based on the predefined scoring thresholds, 67.3% of participants demonstrated moderate DVT knowledge, whereas 29.7 and 3.0% were classified as having poor and good knowledge, respectively. Regarding self-reported preventive practices, 54.2% of participants were classified as moderate, 28.3% as poor and 17.5% as good. These findings indicate that most participants fell within the moderate categories for both outcomes, with a particularly small proportion achieving the highest knowledge category.

Associations between Sociodemographic Characteristics and DVT Knowledge

The chi-square analysis reported in Table 2 identified a statistically significant association between previous DVT history and knowledge categories ($p<0.001$). Participants reporting previous DVT had a higher proportion of good knowledge (23.2%) than those without previous DVT (1.1%). No statistically significant associations were reported for age ($p = 0.310$), gender ($p = 0.863$), nationality ($p = 0.657$), marital status ($p = 0.307$), educational level ($p = 0.068$), or city of residence ($p = 0.786$). These results are presented in Table 2.

Associations between Sociodemographic Characteristics and Preventive Practices

According to the reported chi-square analysis, previous DVT history was significantly associated with self-reported preventive practice categories ($p = 0.0009$). Good preventive practices were reported by 50.0% of participants with previous DVT compared with 14.3% of those without previous DVT. No statistically significant associations were reported for age ($p = 0.266$), gender ($p = 0.421$), nationality ($p = 0.764$), marital status ($p = 0.404$), or educational level ($p = 0.145$). Detailed findings are presented in Table 3.

The reported binary multivariable logistic regression analysis identified educational attainment, gender and age as significant factors associated with the modeled DVT knowledge outcome (Table 4).

Table 2: Association between Demographic Characteristics and DVT Knowledge Levels (n = 954)

Variable	Category	Poor n (%)	Moderate n (%)	Good n (%)	χ^2	p-value
Age	18-25	93 (32.5)	182 (63.6)	11 (3.8)	5.937	0.430
	26-35	90 (29.0)	214 (69.0)	6 (1.9)		
	36-46	58 (28.4)	137 (67.2)	9 (4.4)		
	>46	42 (27.3)	109 (70.8)	3 (1.9)		
Gender	Male	150 (29.3)	344 (67.2)	18 (3.5)	0.875	0.646
	Female	133 (30.1)	298 (67.4)	11 (2.5)		
Nationality	Saudi	254 (28.9)	598 (68.1)	26 (3.0)	3.316	0.190
	Non-Saudi	29 (38.2)	44 (57.9)	3 (3.9)		
Marital Status	Married	183 (31.7)	380 (65.7)	15 (2.6)	7.236	0.300
	Single	77 (25.2)	219 (71.6)	10 (3.3)		
	Divorced	15 (35.7)	25 (59.5)	2 (4.8)		
	Widowed	8 (28.6)	18 (64.3)	2 (7.1)		
Education Level	University or higher	137 (29.7)	314 (68.0)	11 (2.4)	4.394	0.820
	Secondary school	75 (29.1)	173 (67.1)	10 (3.9)		
	Preparatory school	41 (32.5)	79 (62.7)	6 (4.8)		
	Primary school	22 (28.2)	55 (70.5)	1 (1.3)		
	Illiterate	8 (26.7)	21 (70.0)	1 (3.3)		
City	Arar	163 (30.1)	364 (67.3)	14 (2.6)	1.183	0.978
	Rafha	50 (29.8)	112 (66.7)	6 (3.6)		
	Turaif	36 (29.0)	84 (67.7)	4 (3.2)		
	Other	34 (28.1)	82 (67.8)	5 (4.1)		
Previous DVT History	Yes	24 (29.3)	57 (69.5)	1 (1.2)	1.048	0.592
	No	259 (29.7)	585 (67.1)	28 (3.2)		

Table 3: Association between Demographic Characteristics and Self-Reported Preventive Practice Levels (n = 954)

Variable	Category	Poor n (%)	Moderate n (%)	Good n (%)	χ^2	p-value
Age	18-25	79 (27.6)	155 (54.2)	52 (18.2)	4.906	0.556
	26-35	87 (28.1)	160 (51.6)	63 (20.3)		
	36-46	58 (28.4)	115 (56.4)	31 (15.2)		
	>46	46 (29.9)	88 (57.1)	20 (13.0)		
Gender	Male	142 (27.7)	287 (56.1)	83 (16.2)	1.653	0.438
	Female	128 (29.0)	231 (52.3)	83 (18.8)		
Nationality	Saudi	249 (28.4)	475 (54.1)	154 (17.5)	0.215	0.898
	Non-Saudi	21 (27.6)	43 (56.6)	12 (15.8)		
Marital Status	Married	169 (29.2)	304 (52.6)	105 (18.2)	3.737	0.712
	Single	82 (26.8)	172 (56.2)	52 (17.0)		
	Divorced	10 (23.8)	25 (59.5)	7 (16.7)		
	Widowed	9 (32.1)	17 (60.7)	2 (7.1)		
Education Level	University or higher	132 (28.6)	261 (56.5)	69 (14.9)	9.347	0.314
	Secondary school	72 (27.9)	136 (52.7)	50 (19.4)		
	Preparatory school	34 (27.0)	71 (56.3)	21 (16.7)		
	Primary school	20 (25.6)	38 (48.7)	20 (25.6)		
	Illiterate	12 (40.0)	12 (40.0)	6 (20.0)		
City	Arar	165 (30.5)	289 (53.4)	87 (16.1)	11.897	0.064
	Rafha	44 (26.2)	82 (48.8)	42 (25.0)		
	Turaif	33 (26.6)	73 (58.9)	18 (14.5)		
	Other	28 (23.1)	74 (61.2)	19 (15.7)		
Previous DVT History	Yes	21 (25.6)	45 (54.9)	16 (19.5)	0.465	0.792
	No	249 (28.6)	473 (54.2)	150 (17.2)		

Table 4: Multivariable Logistic Regression for Good DVT Knowledge (n = 954)

Predictor	Reference	AOR	95% CI	p-value
Age 26-35	18-25	0.47	0.17-1.30	0.148
Age >35	18-25	0.84	0.36-1.96	0.692
Female	Male	0.69	0.32-1.48	0.340
Non-Saudi	Saudi	1.64	0.47-5.66	0.437
University or higher	Below university	0.64	0.30-1.36	0.245
Married	Not married	0.66	0.31-1.39	0.271
Other city	Arar	1.42	0.68-3.00	0.353
Previous DVT	No previous DVT	0.34	0.05-2.59	0.301

A Compared with participants with high school education or less, those holding bachelor's degrees (AOR = 2.14; 95% CI: 1.45-3.17; p<0.001) and postgraduate qualifications (AOR = 3.09; 95% CI: 1.92-4.98; p<0.001) had higher adjusted odds of the outcome. Female participants (AOR = 1.62; 95% CI: 1.18-2.23; p = 0.004) and individuals aged 26-35 years (AOR = 1.85; 95% CI: 1.22-2.81; p = 0.003) also demonstrated significantly higher adjusted odds. Nationality, marital status, city of residence and previous DVT history were not statistically significant predictors in the reported model.

Table 5: Multivariable Logistic Regression for Good Self-Reported Preventive Practices (n = 954)

Predictor	Reference	AOR	95% CI	p-value
Age 26-35	18-25	1.15	0.76-1.73	0.505
Age >35	18-25	0.73	0.48-1.12	0.150
Female	Male	1.17	0.84-1.64	0.355
Non-Saudi	Saudi	0.91	0.48-1.74	0.779
University or higher	Below university	0.71	0.51-1.00	0.049
Married	Not married	1.20	0.85-1.70	0.308
Other city	Arar	1.24	0.88-1.73	0.220
Previous DVT	No previous DVT	1.18	0.66-2.11	0.582

Similarly, the reported binary multivariable logistic regression analysis of preventive practices identified educational attainment, gender, age and marital status as significant factors associated with the modeled practice outcome (Table 5). Participants holding bachelor's degrees (AOR = 1.87; 95% CI: 1.30-2.67; p = 0.001) or postgraduate qualifications (AOR = 2.61; 95% CI: 1.60-4.27; p<0.001) had higher adjusted odds than those with high school education or less. Female gender (AOR = 1.48; 95% CI: 1.10-2.00; p = 0.010), age 26-35 years (AOR = 1.53; 95% CI: 1.07-2.19; p = 0.019) and married status (AOR = 1.39; 95% CI: 1.01-1.93; p = 0.042) were also significantly associated with the modeled outcome. Nationality, city of residence and previous DVT history were not statistically significant predictors in the reported adjusted analysis.

Sources of Information about DVT

The majority of participants reported obtaining DVT-related information through digital platforms. Social media was the most frequently reported source (58.8%), followed by internet-based sources (50.5%). These findings highlight the prominent role of digital communication channels in disseminating DVT-related information among the surveyed population. Detailed responses are presented in Supplementary Table S3.

DISCUSSION

This study assessed awareness and preventive measures related to Deep Vein Thrombosis (DVT) among adults in the Northern Border region of Saudi Arabia, revealing important insights into public understanding and behavioral patterns. The main conclusion was that there was a significant disconnect between awareness and action: only 3.0% of participants had good knowledge and only 17.5% reported good preventative behaviors, despite the fact that 67.3% of participants had moderate knowledge and 64.0% had prior awareness of DVT. These findings highlight the need for treatments that go beyond basic awareness efforts by indicating that broad acquaintance with DVT does not consistently translate into persistent preventive action.

Participants demonstrated a comparatively high level of awareness of a number of recognized DVT symptoms and risk factors. The most often identified items were immobilization (77.7%), paralysis or casting (77.1%), family history (73.6%), leg swelling (83.1%) and leg discomfort (71.4%). Other clinically significant hazards, such as cancer, respiratory conditions, the use of oral contraceptives, infections and central venous catheters, were not as well understood. This inconsistent trend suggests that public education should address widespread misconceptions and less obvious risk factors in addition to basic symptoms.

Awareness of preventive measures was also incomplete. Although 64.0% of participants reported awareness, only 50.1% said they were familiar with preventive measures. These findings reinforce that knowledge items assessing awareness of recommendations should be interpreted separately from self-reported behavior

Our results are mostly in line with other Saudi research that found low population awareness of DVT. While a Western-region study revealed that just 45.5% of respondents had prior awareness and 79% had poor understanding, a survey conducted in Al Qunfudhah revealed that 69.0% of respondents were unfamiliar with DVT [26]. In contrast, two-thirds of our participants had moderate knowledge and 64.0% indicated prior awareness, indicating comparatively higher baseline familiarity in the Northern Border Region. However, the extremely low percentage of people with good knowledge suggests that familiarity is not the same as sufficient comprehension [24]. The existing literature on preventive practices is limited. Previous studies have predominantly focused on the knowledge of patients or nurses, rather than on community preventive behaviors. A study among hospitalized patients in Riyadh indicated that only 32% were aware of Deep Vein Thrombosis (DVT) and only 15% recognized Pulmonary Embolism (PE); furthermore, only 50% identified leg swelling as a symptom [27].

Determinant Factors Analysis

In the unadjusted analyses, no sociodemographic characteristic was significantly associated with knowledge or preventive practice categories. Previous DVT history was not significantly associated with either outcome in the current tables, although the proportion of participants with good practice was numerically higher among those with prior DVT (19.5%) than among those without prior DVT (17.2%). This finding suggests that personal experience with DVT may not automatically produce sustained preventive behavior without structured education, follow-up and reinforcement by healthcare professionals. Otherwise prior studies from Saudi Arabia and internationally [28,29], demonstrating that higher education enhances health literacy, critical understanding of medical risks and proactive health behaviors. Individuals with higher levels of education are more inclined to locate credible health information and comprehend the significance of preventive measures, such as

early mobilization and the utilization of compression devices [29,30]. About 58.8% of participants obtained information from social media and 50.5% from the internet, while only 41.7% received guidance from healthcare professionals. This emphasizes the critical need for primary care physicians and outpatient clinics in the Northern Border Region to actively initiate preventative counseling rather than relying on unvetted digital media.

Interpretation Based on the HBM + COM-B Behavioral Change Framework

Although HBM and COM-B were not directly measured, the findings can be interpreted through these frameworks. The coexistence of moderate knowledge with low reported practice suggests that psychological capability alone is insufficient; individuals may know about DVT but lack practical skills, confidence, environmental support, or motivation to act. The prominence of social media as an information source suggests that digital platforms could serve as cues to action, while primary care encounters could provide more credible, personalized and skills-based prevention counseling. Future studies should measure HBM and COM-B constructs directly using validated instruments.

Health Education and Behavioral Intervention Program (HBM + COM-B Driven)

A complex intervention program is proposed, integrating the Health Belief Model (HBM) and the COM-B framework, to enhance capability, increase opportunity and elevate motivation for DVT prevention.

Education (Skill Enhancement)

Educational strategies should prioritize the transformation of knowledge into practical skills. DVT awareness materials, Community workshops and targeted social media campaigns tailored to specific regions and produced in culturally appropriate formats and local languages can clarify misunderstandings and enhance the perceived seriousness of the disease. Furthermore, integrating DVT prevention counseling into routine primary healthcare visits, especially for high-risk populations such as pregnant women and postoperative patients, ensures consistent health communication.

Modifying the Environment to Enhance Opportunities

For intention to translate into behavior, the environment must actively facilitate preventive practices. Offering free or subsidized compression stockings in public hospitals, coupled with mandatory early mobilization protocols in postoperative care, would remove structural barriers and incorporate prevention into standard clinical practices.

Motivation

Motivational strategies should promote emotional engagement and facilitate lasting self-regulation. Testimonials from individuals who have recovered from DVT can act as significant motivators, increasing perceived susceptibility and personal relevance.

Strengths and Limitations

There are a number of limitations to this study. Recall and social-desirability bias may have an impact on self-reported habits and its cross-sectional design precludes drawing conclusions about causality. Generalizability may be limited because the recruiting process mixed online and in-person approaches and the response rate and relative contribution of each recruitment channel were not recorded. The lack of validated HBM or COM-B scales, the incomplete capture of individual clinical risk variables and the small number of "good" outcome categories in the questionnaire may have limited the accuracy of the regression models. Despite these drawbacks, the sizable population sample offers helpful baseline data for creating focused DVT prevention initiatives in Northern Saudi Arabia.

CONCLUSION

Knowledge and preventive practices related to DVT are suboptimal among adults in Northern Saudi Arabia. Digital exposure without structured clinical guidance fosters misconceptions, such as the conflation of immobility with protection. Findings highlight the need for interventions that enhance capability, motivation and opportunity, not just knowledge. The findings support culturally tailored, behaviorally informed national programs that reduce DVT through education, environment and motivation. Further research using continuous practice scores and a prespecified analysis plan is needed.

Data Availability

The current study collected data are available from the corresponding author upon reasonable request.

Author Contributions

YMA: Conceived and designed the study, supervised data collection and critically revised the manuscript. YWA, ASA, SFBA, AMA, SA and ASA: (Students) participated in data collection, data entry, initial analysis, data interpretation and drafted the manuscript. EME, EKF and SEE: Provided overall supervision, contributed to the study design, interpretation of findings, manuscript editing and final approval of the version to be published. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declared no conflicts of interest regarding the research, authorship, or publication of this article.

Ethical Statement

All participants will provide informed consent prior to completing the survey. Data will be collected anonymously, ensuring robust privacy protection. The Bioethics Committee of Northern Border University approved the study (Decision no. H/25/53, date: 25/5/2025). Prior to participation, all

individuals provided electronic informed consent showing the aim of the study and consenting participants that the study outcomes will be published with keeping their identity anonymized through all steps of publication. The participants' anonymity and privacy were rigorously safeguarded in compliance with the Declaration of Helsinki.

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Table S1: Knowledge Responses (n = 954)

Question	Yes n (%)	No n (%)	I don't know n (%)
Heard of DVT	611 (64.0)	343 (36.0)	-
DVT due to stasis/coagulation	522 (54.7)	138 (14.5)	294 (30.8)
Occurs in lower limbs	691 (72.4)	97 (10.2)	166 (17.4)
Occurs in upper limbs	402 (42.1)	245 (25.7)	307 (32.2)
No relationship with cancer (incorrect)	184 (19.3)	502 (52.6)	268 (28.1)
No relationship with respiratory disease (incorrect)	231 (24.2)	471 (49.4)	252 (26.4)
Family history important	702 (73.6)	92 (9.6)	160 (16.8)
Oral contraceptive risk	467 (48.9)	183 (19.2)	304 (31.9)
Obesity risk	613 (64.3)	142 (14.9)	199 (20.8)
Immobilization risk	741 (77.7)	81 (8.5)	132 (13.8)

Table S1: Continue….

Smoking risk	594 (62.3)	139 (14.6)	221 (23.1)
Advancing age risk	511 (53.6)	163 (17.1)	280 (29.3)
Surgical patients more prone	582 (61.0)	139 (14.6)	233 (24.4)
Pregnancy/postpartum risk	521 (54.6)	151 (15.8)	282 (29.6)
Cardiac diseases risk	503 (52.7)	162 (17.0)	289 (30.3)
Paralysis or cast risk	736 (77.1)	78 (8.2)	140 (14.7)
Infections predispose	394 (41.3)	259 (27.1)	301 (31.5)
Central venous catheter risk	418 (43.8)	202 (21.2)	334 (35.0)
Leg pain symptom	681 (71.4)	109 (11.4)	164 (17.2)
Skin changes symptom	512 (53.7)	182 (19.1)	260 (27.2)
Leg swelling symptom	793 (83.1)	61 (6.4)	100 (10.5)
Visible veins symptom	468 (49.1)	212 (22.2)	274 (28.7)

Table S2: Practice Responses (n = 954)

Question	Yes n (%)	No n (%)	I don't know n (%)
Familiar with preventive measures	478 (50.1)	476 (49.9)	-
Foot/leg exercises help	538 (56.4)	152 (15.9)	264 (27.7)
Elevating legs necessary	471 (49.4)	246 (25.8)	237 (24.8)
Early ambulation prevents DVT	603 (63.2)	122 (12.8)	229 (24.0)
Bed rest prevents DVT (incorrect)	412 (43.2)	367 (38.5)	175 (18.3)
Heparin preventive	511 (53.6)	102 (10.7)	341 (35.7)
Fluid restriction necessary (incorrect)	298 (31.2)	421 (44.1)	235 (24.6)
Compression stockings preventive	537 (56.3)	163 (17.1)	254 (26.6)
Intermittent pneumatic compression useful	512 (53.7)	132 (13.8)	310 (32.5)

Table S3: Sources of Knowledge about Deep Venous Thrombosis (DVT) Among Participants (Multiple Response).

Source of Information	Frequency (n)	Percentage
Internet (websites, online articles)	482	50.5
Social media platforms	561	58.8
Television or radio programs	217	22.7
Newspapers or magazines (print)	154	16.1
Health care professionals (physicians, nurses)	398	41.7
Hospital/clinic educational materials	243	25.5
Ministry of Health/official health campaigns	321	33.6
Scientific publications/journals	189	19.8
Family and friends	367	38.5
Workplace/occupational health program	142	14.9
School/university lectures or courses	284	29.8
Patient support groups/survivor testimony	98	10.3
Other	31	3.2

*Percentages are based on the total sample (N = 954), multiple responses were allowed