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Original Research Article

Factors associated with travel health engagement among international travellers in Riyadh: a clinic-based cross-sectional study 2026

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ABSTRACT

Background: Despite the availability of travel medicine services, engagement remains suboptimal, particularly in primary healthcare settings in Saudi Arabia. The objective was to assess travel health knowledge, attitudes, and preventive practices (KAP) among international travellers attending primary healthcare clinics in Riyadh and to identify factors associated with preventive engagement.
Methods: A cross-sectional study was conducted among 400 adult travellers attending primary healthcare clinics at Prince Sultan Military Medical City, Riyadh. Data were collected using a structured, self-administered questionnaire. KAP domains were assessed and categorized using Bloom's cutoffs. Associations between participant characteristics and KAP outcomes were examined using univariate tests and multivariable logistic regression.
Results: Participants were largely male (57.8%), with most traveling for tourism (80.5%). Preventive practices were notably suboptimal, with 66.2% classified as poor, compared with more balanced distributions in knowledge (34.0% poor) and attitude (47.0% poor). Only 38.2% of participants sought pre-travel health information. In multivariable analyses, preventive practices were strongly associated with travel to Africa (aOR, 7.69; 95% CI, 2.61–22.63) and traveling with companions (aOR, 5.61; 95% CI, 1.84–17.10). Higher education and income were significantly associated with improved knowledge, while obtaining pre-travel health information (aOR, 5.50; 95% CI, 3.05–9.92).
Conclusions: Preventive practices among international travellers in Riyadh remain inadequate despite moderate knowledge levels. Engagement appears to be driven primarily by behavioural and contextual factors rather than knowledge alone. Strengthening pre-travel counselling, promoting early trip preparation, and improving access to travel health services are critical to enhancing preventive uptake and optimizing primary care–based travel medicine services.

Keywords: Travel medicine, Preventive behaviour, Knowledge attitudes practices, International travellers, Saudi Arabia

INTRODUCTION

International travel has expanded rapidly over the past two decades, reshaping patterns of exposure to infectious and non-infectious health risks and increasing the public health importance of travel medicine.[1,2] Travellers may encounter vaccine-preventable diseases, vector-borne infections, food- and water-borne illnesses, and destination-specific environmental hazards, many of which can be mitigated through timely pre-travel consultation, vaccination, and adherence to preventive advice.[3] Yet despite the availability of evidence-based travel medicine interventions, engagement with preventive services remains inconsistent, and uptake of recommended measures is frequently suboptimal.[4] A persistent gap exists between awareness of travel-related risks and actual engagement in preventive behaviours. Studies across diverse settings have shown that many travellers do not seek professional pre-travel advice, delay consultation until too close to departure, or rely on informal sources of information rather than trained health professionals.[5,6] This gap appears particularly important for vaccination uptake,

where risk perception, confidence in vaccine benefit, trust in health systems, and access barriers may all shape behaviour. Prior studies have often framed these patterns primarily through knowledge-attitudes-practices paradigms, but increasing evidence suggests that preventive engagement is also strongly influenced by structural, behavioural, and service-level factors, including convenience, accessibility, provider recommendation, perceived relevance of travel medicine services, and organizational readiness of clinics delivering preventive interventions.[7]

Understanding these factors is especially important in Saudi Arabia, where international mobility is high and travel-related risk is shaped by tourism, business travel, visiting friends and relatives, and religious travel associated with Hajj and Umrah. Existing Saudi evidence suggests gaps in travel health knowledge and preventive practices, including low uptake of recommended vaccination and limited engagement with professional travel health advice.[6,8] However, much of this evidence has been generated from airport-based or community surveys, which provide valuable information about traveller characteristics but offer limited insight into engagement behaviors within clinical settings where preventive interventions are actually delivered.

Primary healthcare clinics represent a critical but understudied point of intervention. These clinics provide opportunities not only for vaccine delivery, but also for risk communication, individualized counseling, malaria prevention advice, destination-specific guidance, and reinforcement of preventive decision-making.[9] While previous studies have predominantly examined travel health knowledge, vaccine uptake, or pre-travel consultation behaviors, limited evidence has explored travel health engagement as a multidimensional construct encompassing knowledge, attitudes, preventive behaviors, and interaction with clinic-based preventive services. Understanding these determinants within primary care settings is essential for designing interventions that move beyond awareness toward actual preventive action. Conversely, engagement may be facilitated by enabling factors such as physician referral, prior travel-related illness, higher perceived risk, positive prior experiences with vaccination, convenient access to services, and culturally appropriate counseling. Although previous studies have investigated predictors of travel vaccine uptake or pre-travel health-seeking behavior,[10] fewer studies have focused specifically on engagement in travel medicine clinic preventive interventions as a broader behavioral construct. This distinction matters because engagement may encompass more than vaccine receipt alone and may include attendance at pre-travel consultation, acceptance of counseling, adherence to preventive recommendations, and willingness to act on travel health advice.

This question is also timely given growing interest in strengthening preventive services in Saudi Arabia within primary care and ambulatory systems with Vision 2030.[11] In institutional settings such as Prince Sultan Military Medical City in Riyadh, travel medicine clinics may represent an important but underused platform for prevention. Identifying modifiable factors in this context could inform service redesign, targeted education, risk communication strategies, and clinic-level interventions to improve engagement and optimize preventive delivery. Such evidence may also support broader national goals related to infectious disease prevention, vaccine uptake, and health system preparedness. Accordingly, this study aims to examine factors associated with engagement in travel medicine clinic preventive interventions among adults planning international travel in Riyadh.

METHODS

Study design

We conducted a cross-sectional study to identify factors associated with preventive behavior and vaccine uptake among adult patients attending primary health care (PHC) clinics at Prince Sultan Military Medical City (PSMMC) in Riyadh, Saudi Arabia. Data collection was conducted between 01 January to 28 February 2026 among eligible international travellers attending primary healthcare clinics at Prince Sultan Military Medical City, Riyadh, Saudi Arabia. The cross-sectional design was selected as appropriate for measuring the prevalence and distribution of knowledge, attitudes, and preventive practices (KAP) at a single point in time, and for identifying their sociodemographic and behavioral predictors, consistent with the research question and study hypothesis. The study was designed, conducted, and reported in accordance with the strengthening the reporting of observational studies in epidemiology (STROBE) checklist for cross-sectional studies.[12]

Study population and eligibility criteria

The target population comprised adult patients aged 18 years or older who were registered at PSMMC PHC clinics and were international traveller outside Saudi Arabia within the last 12 months. Eligibility was assessed prospectively using a two-item verbal pre-screening tool administered by the research assistant before consent was sought.

Study population and eligibility criteria

Inclusion criteria

The target population comprised adult patients aged 18 years or older who were registered at the primary healthcare clinics of Prince Sultan Military Medical City (PSMMC) and had travelled internationally outside Saudi Arabia within the previous 12 months. Eligibility was assessed prospectively using a two-item verbal pre-screening tool administered by the research assistant before informed consent was obtained. Participants were

eligible if they were aged 18 years or older, actively registered as patients at PSMMC primary healthcare clinics (including both Saudi and non-Saudi military personnel and their dependents), had travelled internationally within the previous 12 months, possessed sufficient Arabic or English literacy to complete the self-administered questionnaire, and were willing and able to provide written informed consent.

Exclusion criteria

Patients were excluded if they were younger than 18 years of age, had not travelled internationally within the previous 12 months, were severely ill, cognitively impaired, or experiencing acute distress at the time of recruitment, as determined by the attending clinician or research assistant based on observable clinical presentation, or declined participation after receiving information about the study.

International travel was defined as any trip crossing the Saudi national border, regardless of purpose, and included tourism, business travel, visiting friends and relatives (VFR), educational travel, and religious pilgrimage (Hajj and Umrah). Pilgrimage travel was specifically included because of its epidemiological significance as a recurring mass-gathering event associated with distinct vaccine-preventable disease risks, including mandatory meningococcal vaccination requirements, and its high prevalence among Saudi residents attending primary healthcare clinics.

Sampling method and participant recruitment

A convenience sampling strategy design was employed. Patients were approached by the research assistant in the PHC waiting area after triage and registration but before their clinical consultation, to avoid disrupting care delivery and to ensure all approached patients had completed the administrative intake process.

Instrument development and procedure

Data were collected using a structured, self-administered questionnaire developed for the present study but systematically grounded in previously validated instruments from the local and international travel health literature.[15-22] The item pool was assembled following a targeted review of published KAP surveys in travel medicine, with source instruments selected on the basis of documented use in comparable cross-sectional or airport-based travel health surveys, availability of item-level psychometric data, and relevance to the Saudi and Gulf regional epidemiological context.

The primary source instruments informing item content were the European Airport Survey conducted across six international airports by Van Herck et al and the contemporaneous United States airport survey by Hamer and Connor, both of which established the foundational KAP item architecture that has since been adapted in numerous regional travel health studies.[15-17] Items addressing pre-travel consultation behavior and its determinants were additionally informed by the recent Saudi primary care study of AlAmer and the traveller's diarrhea knowledge items were informed by Estrada et al.[18,19] Additional attitudinal and behavioral items were adapted from the international traveler survey by Kalanlar et al and the pre-travel health-seeking behavior study by LaRocque et al.[20-22]

Items from these source instruments were not reproduced verbatim but were adapted to reflect the study's primary care setting, the Saudi healthcare context, and the specific exposures of interest, in accordance with established instrument development methodology.

Variables

Primary outcome variables

The study designated three binary ordinal primary outcome variables, each corresponding to a distinct and clinically meaningful dimension of travel health behavior vaccination knowledge, food and water safety and attitude and practice. More details are found in the supplementary file.

Independent variables (candidate predictors)

The following independent variables were assessed as candidate predictors of the primary outcomes, selected a priori based on their documented associations with travel health behavior in the regional and international literature.[15-22]

Sociodemographic

Age group (18–25, 26–35, 36–45, >45 years); sex (male, female); educational attainment (high school or less, diploma, bachelor's degree, postgraduate); average monthly household income (<10,000 SAR, 10,000–14,999 SAR, 15,000–19,999 SAR, ≥20,000 SAR; categories merged from the original five-level variable).

Travel characteristics

Destination region (Africa, Asia, Middle East, Europe, North America); purpose of travel (tourism (reference), business, visiting friends or relatives (VFR), other); duration of stay (≤1 week (reference), >1 week to 1 month, >1 month); time of trip preparation (≥1 month before (reference), 2–4 weeks, 1–2 weeks, during the week of travel); number of travel companions (none (reference), one, two, more than two); accommodation type (hotel/resort (reference), private home, other).

Health status

Presence of a chronic medical condition (yes, no).

Statistical analysis

Descriptive/univariate statistics

Participant characteristics and KAP domain scores are summarized using descriptive statistics. Categorical variables are reported as frequencies (N) and proportions (%). Continuous KAP domain scores are reported as mean±standard deviation (SD) and median interquartile range (IQR). KAP domain scores are additionally reported as percentage of the domain maximum to facilitate cross-domain comparison. Domain-level KAP categories (adequate, moderate, inadequate) are reported as frequencies and proportions for the total sample and by key sociodemographic subgroups. Associations between categorical sociodemographic and travel-related predictors and KAP category and each binary primary outcome were assessed using Pearson's chi-squared test, or Fisher's exact test where expected cell counts were fewer than five. Differences in continuous KAP domain scores across categorical groups were assessed using the Mann-Whitney U test (two groups) or the Kruskal-Wallis test with Dunn's post-hoc pairwise correction (three or more groups).

Multivariable logistic regression with forward stepwise selection

Before multivariable logistic regression was performed, the following assumptions were formally verified: independence of observations, confirmed by the study design (one record per patient, no repeated measures, no clustering); absence of multicollinearity, assessed by variance inflation factors (VIF) for all candidate predictors (threshold: VIF >10 considered problematic); adequate cell counts, with all dummy-coded predictor categories containing at least 10 observations; absence of complete separation, assessed by inspecting the cross-tabulation of each binary predictor against each outcome; and linearity of the log-odds, which was not applicable as all predictors were categorical and entered as dummy variables.[23] These checks confirmed that all assumptions for logistic regression were met prior to model fitting (all VIF <5.0; no complete separation detected; no sparse cells in dummy variables after category consolidation).

Three separate binary and ordinal logistic regression models were fitted, one for each primary outcome. Final models are presented as adjusted odds ratios (aOR) with 95% Wald confidence intervals (CI). Model significance is reported using the likelihood-ratio chi-squared statistic and associated p value relative to the null (intercept-only) model. Model calibration was assessed using the Hosmer-Lemeshow goodness-of-fit test; $p>0.05$ was interpreted as indicating adequate model fit. All hypothesis tests were 2-sided, and statistical significance was defined as a $p<0.05$. No adjustment was made for multiple comparisons, given the pre-specified nature of the analyses and the exploratory objectives related to implementation domains. All analyses were conducted using SAS (version 9.4).

Ethical considerations

Ethical approval was obtained from the Institutional Review Board (IRB) of Prince Sultan Military Medical City prior to any data collection activity. The study was designed and conducted in full accordance with the ethical principles of the Declaration of Helsinki (2013 revision) and applicable Saudi national regulations governing human subjects research in healthcare institutions.

Written informed consent was obtained from all participants before the questionnaire was distributed. The consent form explained, in plain language accessible to participants with secondary-level education, the study's purpose, its observational nature, the voluntary character of participation, the right to withdraw at any time without consequence to clinical care, and the procedures in place to protect confidentiality. Participation was entirely voluntary; no financial incentive or other inducement was offered. All collected data were anonymous: no personally identifiable information was recorded at any stage, and re-identification from the study dataset is not possible.

RESULTS

Sociodemographic and travel characteristics of participants

A total of 400 international travellers attending travel medicine clinics in Riyadh were included in the analysis. The majority were Saudi nationals (393 (98.2%)), with a predominance of male participants (231 (57.8%)). The largest age group was 26–35 years (141 (35.2%)), followed by individuals older than 45 years (98 (24.5%)) and those aged 18–25 years (82 (20.5%)). Most participants had attained at least a bachelor's degree (162 (40.5%)), while 125 (31.2%) had a high school education or less. All participants reported international travel within the past 12 months.

The most common destinations were Asia (131 (32.8%)) and Europe (128 (32.0%)), followed by the Middle East (100 (25.0%)). Travel was primarily for tourism (322 (80.5%)), with smaller proportions traveling for business (34 (8.5%)) or visiting friends and relatives (31 (7.8%)). Most trips lasted more than one week but less than one month (215 (53.8%)), while 165 (41.2%) reported trips of one week or less (Table 1). Regarding travel arrangements, 172 participants (43.0%) travelled with more than two companions, and most stayed in hotels or resorts (322 (80.5%)).

Approximately one-third (144 (36.0%)) reported preparing for travel at least one month in advance, whereas 99 (24.8%) prepared during the week of travel. Fewer than half of participants (153 (38.2%)) obtained health information prior to travel, most commonly from family or friends (91 (59.5%) of those seeking information), followed by the internet (50 (32.7%)). Chronic medical conditions were reported by 116 participants (29.0%), with

hypertension (51 (44.0%)) and diabetes (33 (28.4%)) being the most common conditions. Monthly household income varied, with the largest proportion earning 5,000–9,999 SAR (113 (28.2%)), followed by 15,000–19,999 SAR (88 (22.0%)) and ≥20,000 SAR (75 (18.8%)).

Univariate associations between traveller characteristics and KAP domains

In univariate analyses, vaccination knowledge (D1) was significantly associated with destination region (p<00.001), purpose of travel (p=0.004), duration of stay (p=0.026), number of travel companions (p=0.040), and accommodation type (p=0.008). Food and water safety knowledge (D2) was significantly associated with educational attainment (p=0.003), monthly household income (p<0.001), and purpose of travel (p=0.007). Attitude and preventive behavior (D3) were significantly associated with age group (p=0.011), sex (p=0.004), trip preparation time (p<0.001), and obtaining health information before travel (p<0.001). Overall KAP scores were significantly associated with sex (p=0.013), monthly income (p=0.013), trip preparation time (p=0.004), and seeking pretravel health information (p<0.001) (Table 1).

Self-reported illness history during international travel

Among the 400 participants, self-reported illness during prior international travel was most commonly attributed to traveler's diarrhea, reported by 73 individuals (18.2%). Vector-borne diseases were less frequently reported, with malaria in 19 participants (4.8%), dengue fever in 17 (4.2%), leishmaniasis in 14 (3.5%), West Nile fever in 12 (3.0%), and chikungunya in 8 (2.0%). Overall, any vector-borne disease was reported by 25 participants (6.2%) (Figure 1).

Distribution of travel health knowledge, attitudes, and preventive practices

A large proportion of participants demonstrated suboptimal levels across all domains. For attitude and behavior, nearly half of participants were classified as having poor levels (47.0%), while 39.8% were moderate and only 13.2% achieved good levels. Knowledge levels were more evenly distributed, with 34.0% classified as poor, 34.2% as moderate, and 31.8% as good. Preventive practices showed the most pronounced gap, with the majority of participants categorized as poor (66.2%), compared with 31.5% classified as good and only a small proportion (2.3%) as moderate. These findings indicate a marked deficiency in preventive practices relative to knowledge and attitudes among international travellers (Figure 2).

Multivariable analysis of factors associated with preventive practices, knowledge, and attitude–behavior

In multivariable analyses, preventive practices (D1) were significantly associated with travel to Africa (aOR, 7.69; 95% CI, 2.61–22.63; p<0.001), traveling with two companions (aOR, 5.61; 95% CI, 1.84–17.10; p=0.002), and higher income (10,000–14,999 SAR: aOR, 2.75; 95% CI, 10.09–6.93; p=0.032). Knowledge (D2) was strongly associated with higher education (diploma: aOR, 2.27; 95% CI, 1.26–4.11; p=0.007; postgraduate: aOR, 4.57; 95% CI, 1.79–11.67; p=0.002) and higher income (≥20,000 SAR: aOR, 30.42; 95% CI, 18.31–50.53; p=0.001). Non-hotel accommodation (aOR, 2.46; 95% CI, 1.45–4.20; p=0.001) and earlier trip preparation (1–2 weeks: aOR, 2.80; 95% CI, 1.40–5.60; p=0.004) were also associated with higher knowledge. Attitude and behavior (D3) were associated with age 26–35 years (aOR, 2.31; 95% CI, 1.50–3.54; p<0.001) and 36–45 years (aOR, 2.30; 95% CI, 1.26–4.19; p=0.006), travel to Africa (aOR, 30.08; 95% CI, 1.28–7.41; p=0.012), non-hotel accommodation (aOR, 2.68; 95% CI, 1.47–4.89; p=0.001), obtaining health information before travel (aOR, 5.50; 95% CI, 30.05–9.92; P=0.001), and earlier trip preparation (2–4 weeks: aOR, 3.33; 95% CI, 1.60–6.93; p=0.001) (Table 2 and Figure 3).

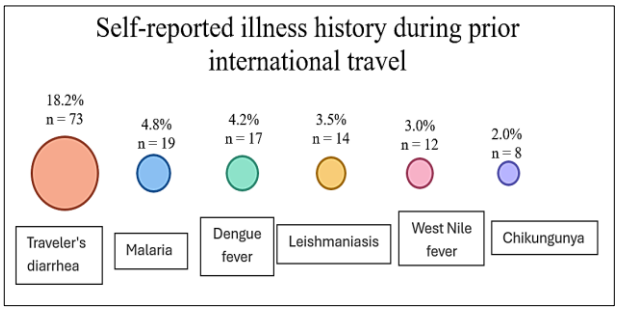

Figure 1: Self-reported illness history for the participants.

Bubble area is proportional to prevalence. Percentages are of total sample (N=400). Vector-borne disease items: ever diagnosed, binary (yes/no); diseases are not mutually exclusive. Traveller's diarrhea: any episode on a prior international trip. Unduplicated "any vector-borne" count: n=25 travellers with at least one diagnosis

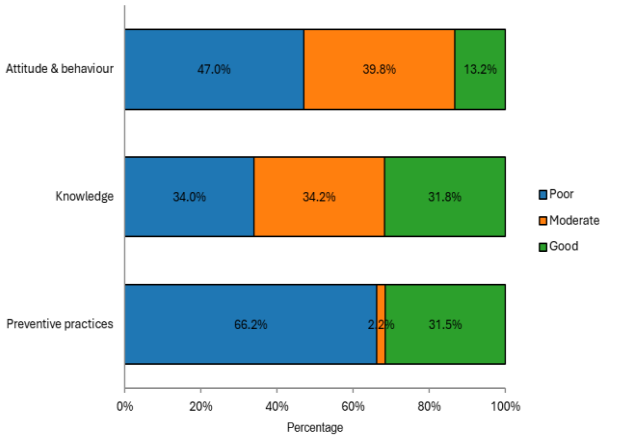

Figure 2: Distribution of travel health knowledge, attitudes, and preventive practices according to Bloom classification.

Table 1: Univariate analysis: KAP domain scores by sociodemographic and travel characteristics among international travellers at PSMMC, Riyadh (n=400).

Character-istic			Domain 1: Vaccination knowledge (0–7)				Domain 2: Food and water safety (0–6)				Domain 3: Attitude and practice (0–9)			
		N	Median (IQR)	Adequate N (%)	Inadequate N (%)	P value	Median (IQR)	Adequate N (%)	Inadequate N (%)	P value	Median (IQR)	Adequate N (%)	Inadequate N (%)	P value
Nationality														
Saudi	98.2	393	1.0 (0.0–7.0)	134 (34.1)	225 (57.3)	0.459	4.0 (3.0–5.0)	259 (65.9)	86 (21.9)	0.815	6.0 (5.0–7.0)	210 (53.4)	34 (8.7)	0.154
Non-Saudi	1.8	7	1.0 (0.0–1.0)	1 (14.3)	6 (85.7)		4.0 (3.0–4.5)	5 (71.4)	2 (28.6)		5.0 (4.5–5.5)	2 (28.6)	1 (14.3)	
Age group (years)														
18–25	20.5	82	2.0 (0.0–6.0)	28 (34.1)	45 (54.9)	0.967	4.0 (3.0–5.0)	52 (63.4)	16 (19.5)	0.157	5.0 (4.0–6.0)	35 (42.7)	15 (18.3)	0.011*
26–35	35.2	141	1.0 (0.0–7.0)	52 (36.9)	82 (58.2)		4.0 (3.0–5.0)	99 (70.2)	30 (21.3)		6.0 (5.0–7.0)	84 (59.6)	10 (7.1)	
36–45	19.8	79	1.0 (0.0–6.0)	26 (32.9)	47 (59.5)		4.0 (2.0–5.0)	48 (60.8)	23 (29.1)		6.0 (5.0–6.5)	43 (54.4)	3 (3.8)	
>45	24.5	98	1.0 (0.0–6.0)	29 (29.6)	57 (58.2)		4.0 (3.0–5.0)	65 (66.3)	19 (19.4)		6.0 (5.0–7.0)	50 (51.0)	7 (7.1)	
Sex														
Male	57.8	231	1.0 (0.0–6.0)	72 (31.2)	141 (61.0)	0.184	4.0 (3.0–5.0)	151 (65.4)	54 (23.4)	0.320	5.0 (4.0–6.0)	115 (49.8)	22 (9.5)	0.004**
Female	42.2	169	2.0 (0.0–7.0)	63 (37.3)	90 (53.3)		4.0 (3.0–5.0)	113 (66.9)	34 (20.1)		6.0 (5.0–7.0)	97 (57.4)	13 (7.7)	
Educational attainment														
High school or less	30.8	123	1.0 (0.0–7.0)	47 (38.2)	70 (56.9)	0.097	4.0 (3.0–5.0)	83 (67.5)	25 (20.3)	0.003**	6.0 (5.0–6.0)	66 (53.7)	11 (8.9)	0.327
Diploma	19.2	77	1.0 (0.0–6.0)	23 (29.9)	51 (66.2)		4.0 (3.0–5.0)	55 (71.4)	15 (19.5)		5.0 (4.0–7.0)	38 (49.4)	13 (16.9)	
Bachelor's degree	40.5	162	1.0 (0.0–6.0)	51 (31.5)	90 (55.6)		4.0 (3.0–5.0)	96 (59.3)	40 (24.7)		6.0 (5.0–7.0)	87 (53.7)	9 (5.6)	
Postgraduate	9.0	36	3.0 (1.0–7.0)	14 (38.9)	18 (50.0)		5.0 (4.0–5.0)	30 (83.3)	6 (16.7)		6.0 (4.0–7.0)	19 (52.8)	2 (5.6)	
Monthly household income (SAR)														
<5,000	12.8	51	0.0 (0.0–2.5)	12 (23.5)	38 (74.5)	0.080	3.0 (1.0–4.0)	23 (45.1)	24 (47.1)	<0.001***	6.0 (5.0–6.0)	28 (54.9)	7 (13.7)	0.875
5,000–9,999	28.2	113	2.0 (0.0–7.0)	42 (37.2)	57 (50.4)		4.0 (3.0–4.0)	70 (61.9)	25 (22.1)		6.0 (5.0–6.0)	58 (51.3)	8 (7.1)	
10,000–14,999	18.2	73	1.0 (0.0–7.0)	27 (37.0)	41 (56.2)		4.0 (3.0–5.0)	44 (60.3)	15 (20.5)		6.0 (4.0–7.0)	38 (52.1)	3 (4.1)	
15,000–19,999	22.0	88	1.0 (0.0–7.0)	35 (39.8)	48 (54.5)		4.0 (4.0–5.0)	71 (80.7)	12 (13.6)		6.0 (5.0–7.0)	48 (54.5)	13 (14.8)	
≥20,000	18.8	75	1.0 (0.0–4.5)	19 (25.3)	47 (62.7)		5.0 (3.5–5.0)	56 (74.7)	12 (16.0)		6.0 (4.5–7.0)	40 (53.3)	4 (5.3)	
Destination region														
Africa	7.0	28	7.0 (4.0–7.0)	20 (71.4)	6 (21.4)	<0.001***	4.0 (4.0–6.0)	24 (85.7)	3 (10.7)	0.144	6.0 (5.0–6.0)	19 (67.9)	1 (3.6)	<0.001***
Asia	32.8	131	2.0 (0.0–5.5)	37 (28.2)	73 (55.7)		4.0 (3.0–5.0)	84 (64.1)	31 (23.7)		5.0 (4.0–6.0)	63 (48.1)	20 (15.3)	
Middle East	25.0	100	0.0 (0.0–6.2)	31 (31.0)	68 (68.0)		4.0 (3.0–5.0)	69 (69.0)	19 (19.0)		5.0 (5.0–6.0)	49 (49.0)	10 (10.0)	
Europe	32.0	128	1.0 (0.0–6.0)	41 (32.0)	78 (60.9)		4.0 (3.0–5.0)	80 (62.5)	29 (22.7)		6.0 (5.0–7.0)	77 (60.2)	0 (0.0)	
North America	3.2	13	4.0 (2.0–7.0)	6 (46.2)	6 (46.2)		4.0 (1.0–4.0)	7 (53.8)	6 (46.2)		4.0 (1.0–6.0)	4 (30.8)	4 (30.8)	
Purpose of travel														
Tourism	80.5	322	1.0 (0.0–6.8)	104 (32.3)	198 (61.5)	0.004**	4.0 (3.0–5.0)	218 (67.7)	61 (18.9)	0.007**	6.0 (5.0–7.0)	172 (53.4)	26 (8.1)	0.766

Continued.

Character-istic		N	Domain 1: Vaccination knowledge (0–7) Median (IQR)	Adequate N (%)	Inadequate N (%)	P value	Domain 2: Food and water safety (0–6) Median (IQR)	Adequate N (%)	Inadequate N (%)	P value	Domain 3: Attitude and practice (0–9) Median (IQR)	Adequate N (%)	Inadequate N (%)	P value
Business	8.5	34	3.0 (1.0–7.0)	14 (41.2)	14 (41.2)		3.0 (2.0–4.0)	16 (47.1)	15 (44.1)		6.0 (4.0–7.0)	18 (52.9)	5 (14.7)	
VFR	7.8	31	1.0 (0.0–7.0)	12 (38.7)	18 (58.1)		4.0 (2.0–4.0)	19 (61.3)	12 (38.7)		6.0 (4.0–6.0)	17 (54.8)	4 (12.9)	
Education/ Other	3.2	13	4.0 (3.0–6.0)	5 (38.5)	1 (7.7)		4.0 (4.0–5.0)	11 (84.6)	0 (0.0)		5.0 (4.0–8.0)	5 (38.5)	0 (0.0)	
Duration of stay														
≤1 week	41.2	165	1.0 (0.0–7.0)	56 (33.9)	98 (59.4)	0.026*	4.0 (3.0–5.0)	116 (70.3)	30 (18.2)	0.304	5.0 (5.0–6.0)	81 (49.1)	14 (8.5)	0.255
>1 week–1 month	53.8	215	1.0 (0.0–6.0)	67 (31.2)	127 (59.1)		4.0 (2.0–5.0)	135 (62.8)	55 (25.6)		6.0 (5.0–7.0)	121 (56.3)	19 (8.8)	
>1 month	5.0	20	6.0 (2.0–7.0)	12 (60.0)	6 (30.0)		4.0 (3.0–4.0)	13 (65.0)	3 (15.0)		5.5 (4.0–7.0)	10 (50.0)	2 (10.0)	
Trip preparation time														
≥1 month before	36.0	144	2.0 (0.0–7.0)	53 (36.8)	74 (51.4)	0.097	4.0 (2.0–5.0)	94 (65.3)	38 (26.4)	0.242	6.0 (5.0–6.2)	73 (50.7)	5 (3.5)	<0.001***
2–4 weeks	17.2	69	0.0 (0.0–6.0)	22 (31.9)	40 (58.0)		4.0 (3.0–5.0)	41 (59.4)	13 (18.8)		7.0 (5.0–7.0)	49 (71.0)	3 (4.3)	
1–2 weeks	22.0	88	2.0 (0.0–6.0)	32 (36.4)	47 (53.4)		4.0 (3.0–5.0)	63 (71.6)	14 (15.9)		6.0 (5.0–6.2)	54 (61.4)	4 (4.5)	
During week of travel	24.8	99	0.0 (0.0–7.0)	28 (28.3)	70 (70.7)		4.0 (3.0–5.0)	66 (66.7)	23 (23.2)		5.0 (4.0–6.0)	36 (36.4)	23 (23.2)	
Chronic medical condition														
No	71.0	284	1.0 (0.0–7.0)	92 (32.4)	166 (58.5)	0.333	4.0 (3.0–5.0)	186 (65.5)	64 (22.5)	0.793	6.0 (4.0–7.0)	149 (52.5)	24 (8.5)	0.439
Yes	29.0	116	2.0 (0.0–6.2)	43 (37.1)	65 (56.0)		4.0 (3.0–5.0)	78 (67.2)	24 (20.7)		6.0 (5.0–7.0)	63 (54.3)	11 (9.5)	
Pre-travel health information sought														
No	61.8	247	1.0 (0.0–7.0)	79 (32.0)	151 (61.1)	0.713	4.0 (3.0–5.0)	168 (68.0)	56 (22.7)	0.649	5.0 (4.0–6.0)	101 (40.9)	32 (13.0)	<0.001***
Yes	38.2	153	2.0 (0.0–7.0)	56 (36.6)	80 (52.3)		4.0 (3.0–5.0)	96 (62.7)	32 (20.9)		6.0 (5.0–8.0)	111 (72.5)	3 (2.0)	
Number of travel companions														
None (solo)	9.2	37	1.0 (0.0–6.0)	10 (27.0)	20 (54.1)	0.040*	4.0 (3.0–5.0)	24 (64.9)	8 (21.6)	0.116	6.0 (5.0–6.0)	19 (51.4)	4 (10.8)	0.708
One	30.8	123	0.0 (0.0–6.0)	33 (26.8)	81 (65.9)		4.0 (3.5–5.0)	92 (74.8)	15 (12.2)		6.0 (4.0–7.0)	63 (51.2)	10 (8.1)	
Two	17.0	68	1.5 (0.0–7.0)	31 (45.6)	35 (51.5)		4.0 (2.0–4.2)	37 (54.4)	22 (32.4)		6.0 (5.0–6.0)	36 (52.9)	11 (16.2)	
More than two	43.0	172	2.0 (0.0–7.0)	61 (35.5)	95 (55.2)		4.0 (2.8–5.0)	111 (64.5)	43 (25.0)		6.0 (5.0–7.0)	94 (54.7)	10 (5.8)	
Accommodation type														
Hotel or resort	80.5	322	1.0 (0.0–7.0)	104 (32.3)	188 (58.4)	0.008**	4.0 (3.0–5.0)	209 (64.9)	71 (22.0)	0.181	5.0 (5.0–6.8)	160 (49.7)	27 (8.4)	0.088
Private home	16.2	65	1.0 (0.0–7.0)	21 (32.3)	40 (61.5)		4.0 (3.0–5.0)	47 (72.3)	14 (21.5)		6.0 (5.0–7.0)	44 (67.7)	7 (10.8)	
Other	3.2	13	6.0 (6.0–7.0)	10 (76.9)	3 (23.1)		4.0 (3.0–4.0)	8 (61.5)	3 (23.1)		6.0 (4.0–7.0)	8 (61.5)	1 (7.7)	

Values: median (IQR). Statistical tests: Mann-Whitney U (2 groups), Kruskal-Wallis H (≥3 groups) on continuous scores. Adequate = ≥60% of domain maximum (Bloom's taxonomy). *p<0.05 **p<0.01 ***p<0.001, % = percentage of total sample (N=400), n=number of participants in each subgroup, adequate= ≥60% of domain maximum; Inadequate = <40% (Bloom's taxonomy; Wang et al, 2022), domain 1: vaccination knowledge (max=7): adequate ≥5, inadequate ≤2, domain 2: food & water safety (max=6): adequate ≥4, inadequate ≤2, domain 3: attitude and preventive practice (max=9, attitude 4 items + practice 5 items): adequate ≥6, inadequate ≤3, Mann-Whitney U (2 groups) or Kruskal-Wallis H (≥3 groups) on continuous scores. *p<0.05 **p<0.01 ***p<0.00 and VFR=Visiting friends or relatives. SAR=Saudi Arabian Riyal

Table 2: Multiple logistic regression analysis of factors associated with preventive health practices (D1), food and water safety knowledge (D2), and attitude and preventive behaviour (D3) among international travellers attending travel medicine clinics, Riyadh, Saudi Arabia (n=400).

Variable (reference category)	Model 1 D1 preventive practices		Model 2 D2 knowledge		Model 3 D3 attitude and behavior	
	aOR (95% CI)	P value	aOR (95% CI)	P value	aOR (95% CI)	P value
Age group (ref: 18–25 years)						
26–35	1.10 (0.56–2.14)	0.780	1.38 (0.89–2.14)	0.151	2.31 (1.50–3.54)	<0.001***
36–45	0.79 (0.37–1.69)	0.543	1.23 (0.63–2.38)	0.544	2.30 (1.26–4.19)	0.006**
>45	0.61 (0.28–1.30)	0.197	0.97 (0.58–1.61)	0.905	1.49 (0.82–2.72)	0.193
Sex (ref: male)						
Female	1.25 (0.76–2.08)	0.378	1.07 (0.75–1.52)	0.710	1.38 (0.46–4.14)	0.572
Education (ref: high school or less)						
Diploma or technical certificate	0.95 (0.45–2.02)	0.900	2.27 (1.26–4.11)	0.007**	1.15 (0.17–7.52)	0.886
Bachelor's degree	0.71 (0.38–1.34)	0.295	0.89 (0.52–1.51)	0.659	0.98 (0.14–6.84)	0.982
Postgraduate degree (Master's/ PhD)	2.13 (0.80–5.66)	0.131	4.57 (1.79–11.67)	0.002**	1.16 (0.50–2.70)	0.732
Destination region (ref: Middle East)						
Africa	7.69 (2.61–22.63)	<0.001***	2.01 (0.83–4.86)	0.123	3.08 (1.28–7.41)	0.012*
Asia	0.85 (0.44–1.66)	0.643	0.92 (0.53–1.60)	0.776	0.75 (0.46–1.25)	0.270
Europe/N. America	0.94 (0.43–2.01)	0.865	0.48 (0.26–0.89)	0.020*	0.96 (0.52–1.77)	0.885
Purpose of travel (ref: tourism)						
Business	2.21 (0.87–5.59)	0.095	0.19 (0.11–0.31)	0.001**	0.74 (0.29–1.94)	0.545
Other	1.12 (0.47–2.67)	0.795	0.69 (0.36–1.31)	0.251	0.76 (0.37–1.56)	0.451
Duration of stay (ref: ≤1 week)						
>1 week to 1 month	0.69 (0.39–1.24)	0.217	0.59 (0.36–0.96)	0.032*	1.05 (0.70–1.58)	0.819
>1 month	3.56 (0.97–13.10)	0.056	0.50 (0.18–1.38)	0.182	0.57 (0.13–2.55)	0.462
Number of travel companions (ref: none/solo)						
One	2.05 (0.72–5.80)	0.178	1.63 (0.98–2.71)	0.058	1.14 (0.55–2.37)	0.734
Two	5.61 (1.84–17.10)	0.002**	0.75 (0.34–1.62)	0.461	0.81 (0.38–1.70)	0.572
More than two	2.68 (0.99–7.30)	0.053	0.86 (0.46–1.58)	0.624	0.89 (0.47–1.67)	0.713
Accommodation type (ref: hotel or resort)						
Non-hotel	1.14 (0.53–2.44)	0.738	2.46 (1.45–4.20)	0.001**	2.68 (1.47–4.89)	0.001**
Time of trip preparation (ref: during week of trip)						
1–2 weeks before	1.80 (0.85–3.79)	0.122	2.80 (1.40–5.60)	0.004**	2.24 (1.06–4.74)	0.035*
2–4 weeks before	1.43 (0.62–3.31)	0.406	1.09 (0.70–1.69)	0.697	3.33 (1.60–6.93)	0.001**
≥1 month before	2.01 (0.98–4.11)	0.056	1.55 (0.91–2.65)	0.109	1.61 (0.94–2.77)	0.084
Obtained health information before travel (ref: no)						
Yes	1.26 (0.76–2.08)	0.363	1.16 (0.69–1.96)	0.571	5.50 (3.05–9.92)	0.001**
Chronic medical condition (ref: no)						
Yes	1.55 (0.86–2.81)	0.147	0.62 (0.39–0.99)	0.046*	1.52 (0.89–2.61)	0.128

Continued.

Variable (reference category)	Model 1 D1 preventive practices		Model 2 D2 knowledge		Model 3 D3 attitude and behavior	
	aOR (95% CI)	P value	aOR (95% CI)	P value	aOR (95% CI)	P value
Monthly household income (ref: <5,000 SAR)						
5,000–9,999	1.62 (0.67–3.93)	0.289	2.46 (1.56–3.87)	<0.001***	0.53 (0.19–1.47)	0.220
10,000–14,999	2.75 (1.09–6.93)	0.032*	2.90 (1.65–5.09)	<0.001***	0.81 (0.39–1.67)	0.569
15,000–19,999	2.12 (0.85–5.29)	0.107	8.49 (5.27–13.66)	0.001**	0.70 (0.24–2.07)	0.523
≥20,000	1.53 (0.57–4.11)	0.402	30.42 (18.31–50.53)	0.001**	1.50 (0.77–2.91)	0.230

Model fit — M1 Binary logistic: Cox-Snell R^2=0.143, Nagelkerke R^2=0.199 | M2 Ordinal logistic: Cox-Snell R^2=0.269, Nagelkerke R^2=0.303 | M3 Ordinal logistic: Cox-Snell R^2=0.242, Nagelkerke R^2=0.280, aOR = adjusted odds ratio. 95% CI=95% confidence interval. N=400 for all models. Model 1: binary logistic regression; outcome=D1 good/moderate versus poor (Bloom's cutpoint ≥60%). Models 2 and 3: cumulative proportional odds logistic regression; outcome ordered poor < moderate < good. Reference categories in parentheses. *p<0.05, **p<0.01, ***p<0.001.

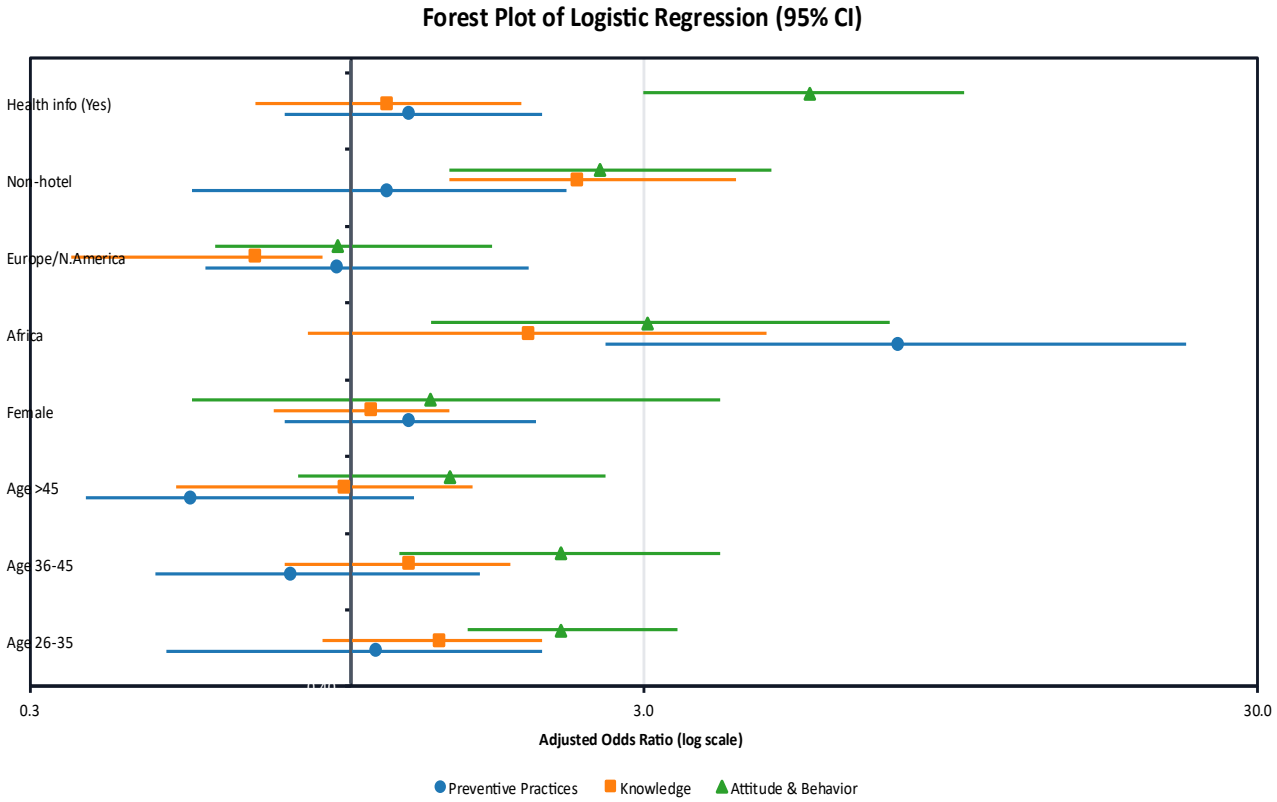

Figure 3: Forest plot for significant factors associated with preventive health practices, food and water safety knowledge, and attitude and preventive behaviour.

DISCUSSION

This cross-sectional study of international travellers attending primary health care clinics in Riyadh identified notable gaps in preventive practices despite moderate levels of knowledge and attitudes, and highlighted distinct sociodemographic and travel-related determinants across domains. Overall, two key findings emerge: first, preventive practices lag considerably behind knowledge and attitudes; and second, engagement in preventive behaviors appears to be driven more by contextual and behavioral factors than by knowledge alone. A central finding is the marked disparity between knowledge and practice. While approximately one-third of participants demonstrated adequate knowledge, two-thirds exhibited poor preventive practices. This disconnect is consistent with prior travel medicine literature suggesting that knowledge alone is insufficient to drive behavioral change. Rather, translation of knowledge into action is influenced by perceived risk, convenience, and situational factors.[24,25] In the present study, fewer than 40% of participants reported seeking pre-travel health information, reinforcing the notion that awareness does not necessarily translate into engagement. The marked discrepancy between knowledge and preventive practices suggests that travel health behavior may follow a behavioral-intention pathway rather than a purely informational pathway. Individuals may recognize travel-related risks yet fail to engage in preventive measures because of perceived inconvenience, low susceptibility, competing priorities, or limited access to services. This finding supports emerging evidence that behavioral determinants may exert greater influence on preventive engagement than knowledge alone. These findings align with global evidence indicating that travellers often underestimate personal risk or defer preventive actions unless prompted by external triggers such as healthcare provider recommendation or prior illness experience.[26-28]

The significant association between destination risk and preventive practices further supports the role of perceived susceptibility. Travellers to Africa had higher odds of engaging in preventive practices and demonstrating appropriate attitudes, suggesting that risk salience may act as a key driver. The strong association observed among travellers to Africa may reflect heightened risk salience. Travellers may perceive Africa as a destination requiring special precautions because of widespread public awareness regarding malaria, yellow fever, and other travel-associated infections. Consequently, engagement may be driven less by objective knowledge and more by perceived vulnerability, highlighting the importance of risk communication strategies. This pattern is consistent with health behavior theory, particularly the Health Belief Model, where perceived severity and susceptibility influence preventive action.[29] In contrast, travel to regions perceived as lower risk, such as Europe or North America, was associated with lower knowledge levels, highlighting potential complacency in lower-risk settings. Socioeconomic factors on the other hand, particularly education and income, were strongly associated with knowledge outcomes. Higher educational attainment and income demonstrated a clear gradient with improved knowledge, consistent with established literature linking health literacy and access to information with socioeconomic status.[30] However, these factors were less consistently associated with preventive practices, reinforcing the observation that structural and behavioral determinants may outweigh purely informational factors in shaping behavior.[31] The high odds observed for higher income groups in relation to knowledge suggest that access to resources, including private healthcare and information channels, may play a large role in shaping awareness. Behavioral and planning-related factors emerged as important determinants of both knowledge and attitudes. Earlier trip preparation was consistently associated with improved knowledge and more favorable attitudes and behaviors, suggesting that timing is a critical window for intervention. Travellers who prepare earlier are more likely to seek information, access healthcare services, and adopt preventive measures. Similarly, obtaining health information prior to travel was one of the strongest predictors of positive attitudes and behaviors, underscoring the importance of information-seeking behavior as both a marker and facilitator of engagement. Accommodation type also demonstrated consistent associations, with non-hotel stays linked to higher knowledge and better attitudes. This may reflect differences in travel style, with individuals staying in private homes or non-traditional accommodations potentially perceiving higher exposure risk or engaging more actively in trip planning. Additionally, group travel patterns, particularly traveling with two companions, were associated with improved preventive practices, possibly reflecting shared decision-making, peer influence, or greater logistical planning.

The findings also highlight important gaps in health system engagement. Despite the availability of primary care support travel medicine services, a majority of participants did not seek pre-travel health information. This suggests underutilization of existing services and potential missed opportunities for preventive intervention. Given the strategic emphasis on preventive care within Saudi Arabia's Vision 2030 framework, strengthening the integration of travel medicine services within primary care represents a critical opportunity.[32,33] The low proportion of travellers seeking pre-travel health information despite the availability of healthcare services suggests that travel medicine remains underrecognized within routine primary care practice. This finding highlights an implementation gap rather than an availability gap and suggests that increasing awareness of existing services may be as important as expanding service provision. From a public health perspective, the observed burden of self-reported travel-related illness, particularly traveler's diarrhea, further underscores the need for improved preventive engagement. Although less frequent, the presence of vector-borne diseases among travellers highlights ongoing

exposure risks that could be mitigated through appropriate counseling and prophylaxis.

This study has several implications for practice and policy. First, interventions should move beyond knowledge-based education to address behavioral and structural barriers to preventive engagement. Second, primary care clinics should adopt proactive strategies, including systematic travel screening and targeted counseling, particularly for high-risk destinations. Third, promoting earlier travel preparation and facilitating access to pre-travel information may enhance uptake of preventive measures. Finally, leveraging digital health platforms and trusted information sources may help bridge the gap between awareness and action.

Limitations

Several limitations should be considered. The cross-sectional design precludes causal inference, and associations should be interpreted as correlational. The use of self-reported data introduces potential recall and social desirability bias. The study was conducted in a single institutional setting with a predominantly Saudi population, which may limit generalizability to other populations or healthcare systems.

CONCLUSION

This study demonstrates that preventive practices among international travellers remain suboptimal despite moderate knowledge levels, with engagement driven primarily by behavioral, contextual, and structural factors. Future interventions should focus on behavioral activation strategies, earlier travel planning, and proactive integration of travel medicine services into routine primary care workflows. Improving preventive engagement will likely require addressing behavioral and structural barriers in addition to enhancing traveller knowledge.

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