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REVIEW

# Methodologies for measuring travelers' risk perception of infectious diseases: A systematic review

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**Summary** Numerous studies in the past have stressed the importance of travelers' psychology and perception in the implementation of preventive measures. The aim of this systematic review was to identify the methodologies used in studies reporting on travelers' risk perception of infectious diseases. A systematic search for relevant literature was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. There were 39 studies identified. In 35 of 39 studies, the methodology used was that of a knowledge, attitude and practice (KAP) survey based on questionnaires. One study used a combination of questionnaires and a visual psychometric measuring instrument called the 'pictorial representation of illness and self-measurement" or PRISM. One study used a self-representation model (SRM) method. Two studies measured psychosocial factors. Valuable information was obtained from KAP surveys showing an overall lack of knowledge among travelers about the most frequent travel-associated infections and associated preventive measures. This methodological approach however, is mainly descriptive, addressing knowledge, attitudes, and practices separately and lacking an examination of the interrelationships between these three components. Another limitation of the KAP method is underestimating psychosocial variables that have proved influential in health related behaviors, including perceived benefits and costs of preventive measures, perceived social pressure, perceived personal control, unrealistic optimism and risk propensity. Future risk perception studies in travel medicine should consider psychosocial variables with inferential and multivariate statistical analyses. The use of implicit

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measurements of attitudes could also provide new insights in the field of travelers' risk perception of travel-associated infectious diseases.


## 1. Introduction

Travel medicine is based on the concept of risk reduction. Travelers' risk perception about travel-related infectious diseases is considered a major component of their response to pre-travel advice [1,2]. Travelers' acceptance of vaccination and observance of malaria prophylaxis measures are partly dependent on their perception of the frequency of the threat and its severity and of their own susceptibility to the threat. Consequently, studies specifically addressing risk perception in travelers have been conducted so that the clinician can provide advice that is both meaningful as well as effective in ensuring safe travel [3]. However, the perception of risk by travelers as well as by travel medicine experts is highly subjective, and although this subjectivity suffuses the field of travel medicine, it has rarely been discussed [4] and there has been little formal study on the subject of risk (i.e., risk research) in the context of travel medicine [5].

In this paper, we review the available literature about risk perception for infectious diseases in travelers with the aim to identify the methodologies used in this context and discuss a number of existing methods used in risk perception measurement that could possibly be used in the field of travel medicine. We do not address non-communicable travel-associated disease risk perception.

## 2. Methods

### 2.1. Search strategy and selection criteria

The systematic review was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (http://www.prisma-statement.org). The PubMed database (http://www.ncbi.nlm.nih.gov/pubmed) was searched, attempting to identify all relevant studies published from January 2000 to March 2016. The most recent search was conducted on March 18, 2016. The topic search terms used for searching the databases were as follows:

#1: "travel" OR "traveler" OR "traveller".
#2: "risk perception";
#3: #1 AND #2.

Only articles published in English or French were included, based on common languages shared by the authors.

For inclusion, the article needed to fulfill the following criteria: (1) it needed to be related to international travel, (2) report on risk perception by travelers and (3) to report on travel-associated infectious disease risk perception and (4) to provide quantitative data. The reference lists of papers were screened to identify studies possibly missed by the search. Papers addressing only practices of preventive measures for travel-associated infectious diseases were not included. Studies involving less than 100 participants were not included.

Two researchers (S.S. and P.G.) independently performed the screening of the abstracts. Any discordant result was discussed in consensus meetings. After screening the abstracts, the full text of the articles was assessed for eligibility by the same two researchers and selected or rejected for inclusion in the systematic review.

### 2.2. Data collection process

The following data (if available) were extracted from each article: year, methodology, profile of travelers, number of individuals, focus of the study and key findings.

### 2.3. Data synthesis and analysis

As a result of the nature of the studies and the heterogeneity in patient populations, a formal meta-analysis was not possible. Therefore, the study results were summarized to describe the main outcomes of interest (i.e., methodologies used for the assessment of risk perception of infectious diseases in travelers).

## 3. Results

### 3.1. Study selection

A total of 134 articles were found after elimination of duplicates, and 20 additional references were found through manual search. After screening of titles and summaries, 44 articles were finally retained for full text-assessment. There were 40 articles corresponding to 39 studies included in the qualitative synthesis of the systematic review (Fig. 1).

### 3.2. Study characteristics

A total of 39 studies were conducted from 1997 to 2015 [6—45] (Table 1). Sample sizes ranged from 119 to 6633 participants. A total of 23 studies were conducted among the general population of travelers [8,12,15—17,20,22—25,28—33,35—39,41—44]; other studies were conducted among specific populations of travelers, including Hajj pilgrims (n = 6) [6,7,9,11,14,24], business travelers (n = 3) [13,21,40], students (n = 2) [19,27], missionary personnel and their families (n = 1) [45], ethnic Africans visiting their country of origin (n = 1) [34], backpackers (n = 1) [26], airline crews (n = 1) [18] and public health professionals (n = 1) [10].

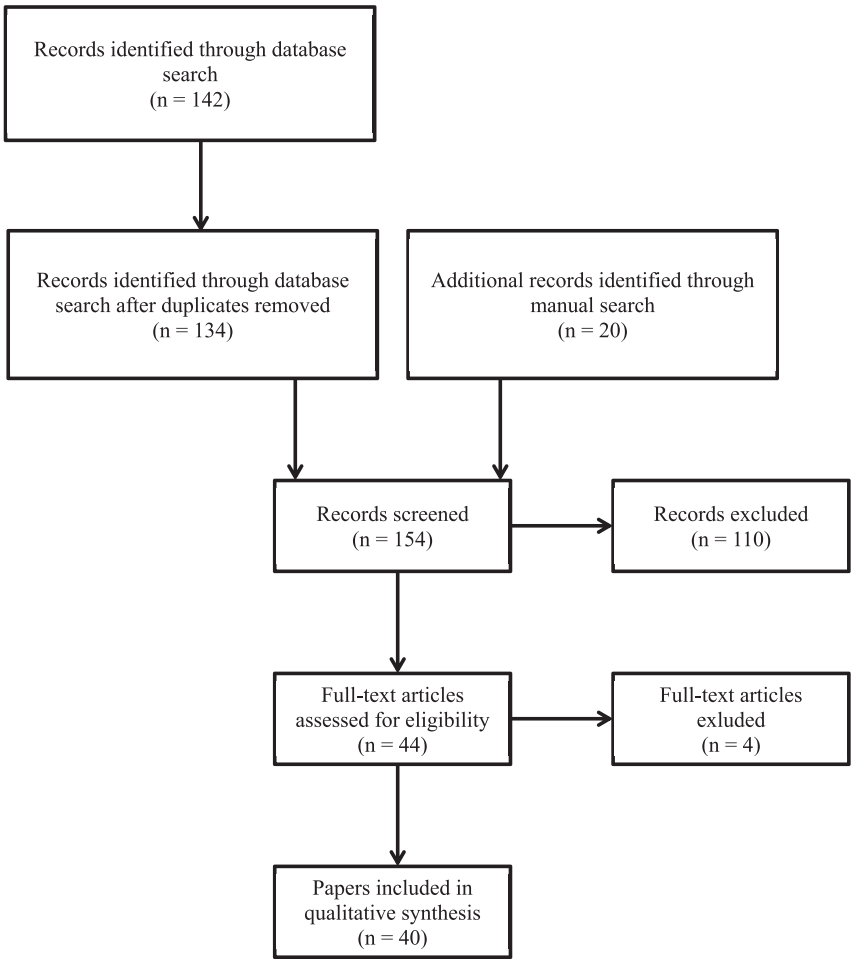


**Fig. 1** Flow diagram of search strategy.

There were 15 studies conducted in travelers recruited at airports [8,15–17,20,22,31–33,35–39,43,44] and one on-board flight [41], in Europe [8,15–17,32,37,39], Asia [20,33,36], Australia [36], US [22,38] and Canada [41] before flying abroad or at airports in Africa [31,35,43,44] and Asia [31] before flying back home. Thirteen studies included travelers recruited at travel clinics when seeking travel advice [7,9–12,14,23,24,28,29,34,40,42] in Europe [7,11,12,14,23,24,28,34,40], Australia [9], US [10], Canada [42] and Asia [29]. Travelers were also recruited through travel agencies (n = 5) [7,25,29,30,34] in Europe [7,25,34] and Asia [29,30], business corporations in Europe (n = 2) [13,21], universities (n = 2) in Australia [19] and the US [27], a commercial airline in the US (n = 1) [18], a Japanese embassy in Africa (n = 1) [29], post-Hajj seminars or social gatherings or randomized trials in Australia (n = 1) [6]; one study was conducted among foreign backpackers recruited in the Khao San Road area, Bangkok, Thailand [26] and another among missionary personnel and their families stationed abroad (n = 1) [45]. Some studies combined several sources of recruitment [7,29,34]. A total of 14 studies focused on a group of selected infectious diseases, including notably malaria, hepatitis A and B and HIV infection [12,13,19,25,27,30,32,35–39,41,42]; 13 focused on malaria only [10,15,16, 18,20,21,26,29,31,33,34, 40,43,44], 2 on respiratory tract infections [9,24], 2 on influenza [22,23], 2 on rabies [28,45], and 1 each on Ebola [6], pneumococcal disease [7], hepatitis A [17], hepatitis B [8], infections transmitted through camel milk consumption [11] and Middle East respiratory syndrome [14]. Key findings are reported in Table 1 and show an overall underestimation of risks.

In 35 of 39 studies, the methodology used was that of the knowledge, attitude and practice (KAP) survey [6–11,13–24,26,28–41,43–45]. Of the 35 KAP surveys, 34 used a cross-sectional design with self-administered questionnaires (n = 26) [6,8–10,13,15–23,26,29–31,33,35–37, 39–41,43–45], four of which were web-based [13,18,19,21], or face-to-face questionnaires (n = 7) [7,11,14,24,28,32,38]. One KAP survey was a prospective cohort survey using face-to-face and telephone questionnaires [34]. Only four studies used a methodology distinct from KAP surveys. One cross-sectional study used a combination of questionnaires and a visual psychometric measuring instrument called the 'pictorial representation of illness and self-measure' or PRISM [12]. One cross-

**Table 1** Summary of articles on risk perception of infectious diseases by travelers (by decreasing year of publication).

| Year of publication | Period of study | Study methodology | Travelers | N | Focus[a] | Key findings | Reference |
|---|---|---|---|---|---|---|---|
| 2015 | 2014—2015 | Cross-sectional self-administered questionnaire survey (KAP) | Australian pilgrims returning from the Hajj recruited at post-Hajj seminars or social gatherings or following participation in a randomized trial | 150 | Perception of risk for Ebola | 38% of participants thought the risk was low, 19% considered it a moderate risk and 21% believed the risk was high. Nevertheless, 45% were not concerned about contracting Ebola during the Hajj | [6] |
| 2015 | 2014 | Cross-sectional face-to-face interview questionnaire survey (KAP) | French Hajj pilgrims recruited at a travel clinic and at a travel agency | 300 | Perception of risk for pneumococcal disease | 22% of participants at risk for pneumococcal invasive disease perceived themselves at risk for pneumococcal disease | [7] |
| 2014 | 2002—2009 | Cross-sectional self-administered questionnaire survey (KAP) | Dutch travelers recruited at Schiphol airport (Amsterdam, The Netherlands) | 3045 | Perception of risk for hepatitis B | 25% of travelers to high risk countries for hepatitis B perceived themselves at risk for hepatitis B | [8] |
| 2014 | 2014 | Cross-sectional self-administered questionnaire survey (KAP) | Australian Hajj pilgrims recruited at a travel clinic | 119 | Perception of risk for respiratory tract infections | 66% of participants perceived themselves at risk for pneumococcal infection, 75% for influenza, 66% for pertussis and 35% were aware of an ongoing Middle East respiratory syndrome epidemic in Saudi Arabia. | [9] |
| 2014 | 2009—2010 | Cross-sectional self-administered questionnaire survey (KAP) | US public health professionals: travelers recruited at a travel clinic | 238 | Perception of risk for malaria | 6% of travelers visiting destinations in high malaria transmission endemic area perceived themselves at high risk for malaria. | [10] |
| 2013 | 2011 | Cross-sectional face-to-face interview questionnaire survey (KAP) | French Hajj pilgrims recruited at a travel clinic | 331 | Perception of risk for infectious diseases following camel milk consumption | 14% of participants knew that unpasteurized camel milk consumption may be responsible for diseases and cited gastrointestinal diseases in the majority of cases | [11] |
| 2013 | 2008—2009 | Cross-sectional questionnaire and PRISM visual psychometric measuring tool survey | Swiss travelers recruited at a travel clinic | 329 | Perception of risk for selected infectious diseases | Participants ranked malaria, rabies and epidemic outbreaks as the most frequent risks. Sexually transmitted infections were ranked last. Men perceived malaria and rabies as higher risks than women and compared to younger participants, travelers aged >40 years considered STIs as | [12] |

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**Table 1** (*continued*)

| Year of publication | Period of study | Study methodology | Travelers | N | Focus[a] | Key findings | Reference |
|---|---|---|---|---|---|---|---|
| | | | | | | a lower risk | |
| 2013 | 2005 | Web- based cross-sectional self-administered questionnaire survey (KAP) | Frequent business travelers working for Shell corporation, Netherlands | 608 | Perception of risk for selected infectious diseases | The majority of participants underestimated risk for polio (52%), dengue fever (55%), cholera (57%), and influenza (67%) and overestimated risks for HIV (75%) | [13] |
| 2013 | 2013 | Cross-sectional face-to-face interview questionnaire survey (KAP) | French Hajj pilgrims recruited at a travel clinic | 360 | Perception of risk for Middle-East respiratory coronavirus infection | 65% of participants were aware of an ongoing MERS epidemic in Saudi Arabia | [14] |
| 2013 | 2002—2009 | Cross-sectional self-administered questionnaire survey (KAP) | Dutch travelers recruited at Schiphol airport (Amsterdam, The Netherlands) | 3045 | Perception of risk for malaria | 73% of travelers visiting destinations in high malaria transmission endemic area perceived themselves at high risk for malaria. | [15,16] |
| 2012 | 2002—2009 | Cross-sectional self-administered questionnaire survey (KAP) | Dutch travelers recruited at Schiphol airport (Amsterdam, The Netherlands) | 3045 | Perception of risk for hepatitis A | 35% of travelers to high risk countries for hepatitis A perceived themselves at risk for hepatitis A. Age >60 years was the only significant determinant for improvement of risk perception. | [17] |
| 2012 | Not documented | Web based cross-sectional self-administered questionnaire survey (KAP) | Airline pilots and flight attendants eligible for international travel from a US commercial airline | 437 | Perception of risk for malaria | 31% of participants considered themselves at high risk for malaria because of the job | [18] |
| 2012 | 2010 | Web-based cross-sectional self-administered questionnaire survey (KAP) | Australian university students who had traveled abroad | 829 | Perception of risk for selected infectious diseases | Participants perceived that diarrheal infections, vector borne infections, hepatitis, and respiratory tract infections were significantly more likely to occur while traveling overseas than in Australia, but did not feel overly worried about any of the listed travel threats. | [19] |
| 2011 | 2009—2010 | Cross-sectional self-administered questionnaire survey (KAP | Chinese travelers recruited at airports in Guangzhou, Beijing, Shanghai, Qingdao, and Nanjing, and traveling to malaria endemic countries | 1573 | Perception of risk for malaria | 18% of travelers visiting destinations in high malaria transmission endemic area perceived themselves at high risk for malaria. | [20] |

**Table 1** (*continued*)

| Year of publication | Period of study | Study methodology | Travelers | N | Focus[a] | Key findings | Reference |
|---|---|---|---|---|---|---|---|
| 2011 | 2005 | Web- based cross-sectional self-administered retrospective cohort study (KAP) | Frequent business travelers working for Shell corporation, Netherlands who traveled to malaria endemic areas | 328 | Perception of risk for malaria | 92% of travelers visiting destinations in high malaria transmission endemic area perceived themselves at high risk for malaria. | [21] |
| 2010 | 2008 | Cross-sectional self-administered questionnaire survey (KAP) | US travelers departing to Asia and recruited at 4 airports in the US. | 1301 | Perception of risk for influenza | 65% of travelers considered themselves at risk for influenza but 75% were not worried about acquiring influenza. | [22] |
| 2010 | 2009—2010 | Cross-sectional self-administered questionnaire survey (KAP) | Swiss travelers recruited at a travel clinic | 868 | Perception of risk for influenza | 8% of travelers considered themselves at high risk for influenza | [23] |
| 2009 | 2008 | Cross-sectional face-to-face interview questionnaire survey (KAP) | French Hajj pilgrims recruited at a travel clinic | 528 | Perception of risk for respiratory tract infections | 37% of participants perceived high risk for respiratory tract infection and 20% some risk | [24] |
| 2009 | 2004 | Cross-sectional self-administered questionnaire survey Psychosocial factors. | Finnish travelers who visited Asia, selected from a tour operator database | 338 | Perception of risk for selected infectious diseases | 69% of travelers considered themselves at high or very high risk for influenza, 3% for SARS 2% for HIV, 2% for tuberculosis, 1% for avian flu | [25] |
| 2009 | 2007 | Cross-sectional self-administered questionnaire survey (KAP) | Foreign backpackers recruited in Khao San Road area, Bangkok, Thailand | 434 | Perception of risk for malaria | 94% of participants were aware of the risk of malaria in Southeast Asia; 46% felt that they had very low risk, while 6% felt that they had high risk for malaria | [26] |
| 2009 | Not documented | Cross-sectional web based SRM survey | US university students studying abroad | 318 | Perception of risk for selected infectious diseases | Participants ranked diarrhea, vector borne diseases and respiratory tract infections as the most frequent infectious disease risks | [27] |
| 2009 | 2007 | Cross-sectional face-to-face interview questionnaire survey (KAP) | French travelers recruited at a travel clinic | 300 | Perception of risk for rabies | 47% of travelers to rabies-risk countries were aware of rabies risk | [28] |
| 2008 | 2006 | Cross-sectional self-administered questionnaire survey (KAP) | Japanese travelers recruited at travel clinics, at the Japanese embassy in Guinea, at an organized tour in Sri-Lanka and at a travel agency, and traveling to malaria endemic countries | 212 | Perception of risk for malaria | 42% of travelers visiting destinations in high malaria transmission endemic area perceived themselves at high risk for malaria. | [29] |
| 2008 | 2007—2008 | Cross-sectional self-administered | Japanese travelers recruited through travel | 302 | Perception of risk for | 33% of travelers perceived themselves at | [30] |

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**Table 1** (*continued*)

| Year of publication | Period of study | Study methodology | Travelers | N | Focus[a] | Key findings | Reference |
|---|---|---|---|---|---|---|---|
| | | questionnaire survey (KAP) | operators | | selected infectious diseases | high risk for rabies, 25% for malaria and 24% for HIV. | |
| 2008 | 2004 | Cross-sectional self-administered questionnaire survey (KAP) | German travelers flying back to Germany from Mombasa (Kenya), Dakar (Senegal), and Bangkok (Thailand) | 1001 | Perception of risk for malaria | 43% of travelers to Kenya and Senegal perceived themselves at high risk for malaria. Travelers with pre-travel advice were significantly more likely to correctly perceive a high risk than travelers without any pre-travel advice (51% vs 32%). | [31] |
| 2007 | 2004 | Cross-sectional face-to-face interview questionnaire survey (KAP) | Spanish travelers departing from Madrid and Barcelona airports (Spain) | 1212 | Perception of risk for infectious diseases | Travelers spontaneously cited yellow fever (45%), typhoid fever (45%), malaria (37%), hepatitis (34%), HIV (19) as most frequent risk | [32] |
| 2007 | 2006 | Cross-sectional self-administered questionnaire survey (KAP) | Korean travelers recruited at airport and departing to India | 188 | Perception of risk for malaria | 49% of travelers perceived themselves at risk for malaria | [33] |
| 2007 | 1998 | Observational prospective cohort study (face-to-face and telephone questionnaire interview (KAP) | Travelers of African ethnicity living in Paris and visiting their country of origin in sub-Saharan Africa, recruited at two travel clinics and in 2 travel agencies | 191 | Perception of risk for malaria | 17% of travelers visiting destinations in high malaria transmission endemic area perceived themselves at high risk for malaria. Perception was higher in travelers enrolled at travel agencies (33%) compared to those enrolled at travel clinics (7%). | [34] |
| 2004 | 2003 | Cross-sectional self-administered questionnaire survey (KAP) | Departing travelers recruited at Johannesburg airport, South Africa | 419 | Perception of risk for selected infectious diseases | 80% of travelers visiting destinations in high malaria transmission endemic area perceived themselves at high risk for malaria. Participant ranked yellow fever, hepatitis A and B, and HIV as the most frequent risks | [35] |
| 2004 | 2003 | Cross-sectional self-administered questionnaire survey (KAP) | Departing travelers recruited at airports in Singapore, Kuala-Lumpur, Taipei, Melbourne and Seoul | 2101 | Perception of risk for selected infectious diseases | 35% of travelers visiting destinations in high malaria transmission endemic area perceived themselves at high risk for malaria. Participants ranked hepatitis A and B, rabies and varicella as the most frequent risks | [36] |

**Table 1** (*continued*)

| Year of publication | Period of study | Study methodology | Travelers | N | Focus[a] | Key findings | Reference |
|---|---|---|---|---|---|---|---|
| 2004 | 2003 | Cross-sectional self-administered questionnaire survey (KAP) | Departing travelers recruited at airports in Belgium (Zaventem, Brussels), Germany (Franz Joseph Strauss, Munich), Greece (Hellinikon, Athens), Italy (Malpensa, Milan), Netherlands (Schiphol, Amsterdam), Spain (Barajas, Madrid), Sweden (Arlanda, Stockholm), Switzerland (Zurich), and the UK (Heathrow, London) | 5465 | Perception of risk for selected infectious diseases | 77% of travelers visiting destinations in high malaria transmission endemic area perceived themselves at high risk for malaria. Participant ranked HIV, hepatitis A and B as the most frequent risks | [37] |
| 2004 | 2003 | Cross-sectional face-to-face interview questionnaire survey (KAP) | Departing travelers recruited at a New York airport, US | 404 | Perception of risk for selected infectious diseases | 73% of travelers visiting destinations in high malaria transmission endemic area perceived themselves at high risk for malaria. Participants ranked HIV, hepatitis A and B and typhoid as the most frequent risks | [38] |
| 2003 | 2002 | Cross-sectional self-administered questionnaire survey (KAP) | Departing travelers recruited at British, German and French airports (pilot study) | 609 | Perception of risk for selected infectious diseases | 64% of travelers visiting destinations in high malaria transmission endemic area perceived themselves at high risk for malaria. Participants at British and German airports ranked hepatitis A and B and typhoid as the most frequent risks. Participants at a French airport ranked HIV and hepatitis A as the most frequent risks. | [39] |
| 2003 | 2000 | Cross-sectional self-administered questionnaire survey (KAP) | Business travelers recruited at travel clinics in Switzerland | 401 | Perception of risk for malaria | 53% of travelers visiting destinations in high malaria transmission endemic area perceived themselves at high risk for malaria | [40] |
| 2002 | 1999 | Cross-sectional self-administered questionnaire survey (KAP) | Travelers going to Mexico and Dominican Republic from Quebec, recruited on-board during the flight | 1724 | Perception of risk for selected infectious diseases | 49% of travelers considered themselves at greater risk for infectious diseases overall, 81% for diarrhea, 42% for hepatitis A and 41% for hepatitis B, than in Quebec. Hepatitis was considered severe by a majority of travelers. Risk perception was | [41] |

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**Table 1** (*continued*)

| Year of publication | Period of study | Study methodology | Travelers | N | Focus[a] | Key findings | Reference |
|---|---|---|---|---|---|---|---|
| | | | | | | higher among travelers who experienced a health problem during previous trip. | |
| 2001 | 1999 | Cross-sectional self-administered questionnaire survey Health belief model & Theory of reasoned action | Travelers from Quebec going to Mexico and Dominican-republic recruited at a travel clinic | 449 | Perception of risk for selected infectious diseases | 78% of travelers considered themselves at greater risk for infectious diseases overall, 90% for diarrhea, 74% for hepatitis A and 58% for hepatitis B than in Quebec. Hepatitis was considered severe by a majority of travelers. Risk perception was higher among travelers who experienced a health problem during previous trip. | [42] |
| 2001 | 1997 | Cross-sectional self-administered questionnaire survey (KAP) | Travelers leaving Kenya from Nairobi and Mombasa airports | 6633 | Perception of risk for malaria | 97% of travelers were aware of the risk of malaria in Africa. | [43] |
| 2001 | 2000 | Cross-sectional self-administered questionnaire survey (KAP) | Travelers leaving Zimbabwe from Harare and Victoria Falls airports. | 595 | Perception of risk for malaria | 75% of travelers cited malaria as the most serious risk during their trip and 28% cited HIV | [44] |
| 2000 | Not documented | Cross-sectional self-administered questionnaire survey (KAP) | US missionary personnel and their family stationed in rabies-endemic countries | 308 | Perception of risk for rabies | 50% of travelers were aware of rabies risk. | [45] |

KAP: knowledge, aptitude and practice, PRISM: pictorial representation of illness and self-measure, SRM: self-representation model, HIV: human immunodeficiency virus.

[a] Most studies addressing knowledge and practice about preventive measures against infectious diseases also addressed the non-communicable disease risk perception. Only data related to infectious disease risk perception are reported here.

sectional study used a self-representation model (SRM) method [27]. Two cross-sectional studies measured psychosocial factors [25,42].

## 4. Discussion

In this review paper about the methodology used in studies addressing the risk perception of travelers about infectious diseases, we show that almost all have been conducted using the KAP method. In 2002—2003, the European Travel Health Advisory Board (ETHAB) conducted a multicenter, cross-sectional study to determine the KAP for travel health matters in passengers traveling to developing countries [35—39]. The questionnaire included demographic and travel data, source of travel advice, perceived risk of specific infectious diseases, perception and status of vaccinations, perception and practice of malaria prophylaxis. This questionnaire (or adapted versions) has been used in many studies in different populations of travelers to date. With this method, the studies were able to quantitatively define three components: travelers' actual knowledge of a given disease (symptoms, transmission, preventive measures, etc.), their attitudes (negative, positive, or neutral) toward preventive measures or in terms of intended risk taking/avoidance behavior, and their practices (protection rate). As is typically the case for the KAP method [46], measurements were obtained using either self-report questionnaires or structured interviews. A large amount of descriptive data can be collected from a single survey, revealing quantitative as well as qualitative information [47]. Valuable information was obtained from the above KAP surveys showing an overall lack of knowledge among travelers about the most frequent travel-associated infections and associated preventive measures. These findings have led researchers to outline the need for efficient communication strategies in order to improve travelers'

risk knowledge and their adherence to safety measures [6—17,19,20,23—37,45]. Although the KAP method has been widely advocated, it is not without limitations. One shortcoming is that this methodological approach is mainly descriptive. Estimates in percentages are typically provided for knowledge, attitudes, and practices separately, but the interrelationships between these three components are hardly examined. However, knowing whether and how safety behaviors can be predicted by risk knowledge and attitudes is important information. Descriptive statistics alone can be misleading. This is the case in the KAP studies reviewed here, where high percentages of knowledge have been found to coexist with either high [6] or low [18,22,38,40] percentages of protective behavior, while other studies reported low percentages in both knowledge and protective behavior [17,19,20,23—37,45]. The use of multivariate statistical analyses is thus necessary to assess the respective and real contribution of each key variable. In addition, repeated descriptions of how poor the risk knowledge of travelers is do not inform about efficient measures likely to promote healthy behavior. Travel medicine would benefit at present from experimental studies designed to test different interventions for improving adherence to safety behaviors [48].

Another limitation of the KAP method is that it overlooks psychosocial variables that have proven to be influential in health related behaviors. For example, the health belief model [49,50] states that the adoption of safety behaviors will not only depend on individuals' perceptions of the likelihood and seriousness of the disease (often measured with the KAP method), but also on their perceived balance between benefits and costs of preventive measures. In line with this, a meta-analysis of 18 studies [51] showed that low perceived barriers and high perceived benefits were consistently the strongest predictors of various healthy behaviors such as tuberculosis screening, quitting smoking, taking medication, dental care, condom use, or attending programs. The theory of planned behavior [52,53] also proposes that subjective norms (perceived social pressure from important others like friends, family, general and specialized practitioners) and perceived personal control over the behavior are direct predictors of intentions to engage in healthy behavior, which in turn predict behavior. Findings provided support for this model across various health-related behavior categories such as addictive behaviors, automobile-related behavior, clinical and screening behavior, eating behavior, and safe sex behaviors [54—56]. At least one other psychosocial factor is worth mentioning that can help understand why low adherence to safety behaviors can be observed despite high risk knowledge: positive illusions. Social and cognitive psychology has demonstrated that individuals tend to exhibit unrealistically positive self-evaluations [57], which can make them overconfident in their decisions and unrealistically optimistic. Of particular interest here, unrealistic optimism (the tendency to think that bad events are more likely to happen to others than to oneself) [58,59] has been documented in over a thousand studies and for various undesirable events such as diseases and natural disasters [60]. Findings show that unrealistic optimism leads to overestimating the ability to quit smoking [61], neglecting risk information [62], and hindering precautionary behaviors [63] to the point that unrealistic optimism has been found to be positively associated with higher levels of subclinical atherosclerosis [64]. In sum, the perceived costs and benefits of safety behaviors, social pressure, personal behavioral control, and unrealistic optimism are key variables that should receive attention in travel medicine, in order to provide a fairer picture of travelers' risk perception about infectious diseases and their likelihood to adopt safety behaviors (See Table 2).

Finally, the KAP method is also vulnerable to the limitations of self-reporting, with participants being either unwilling or unable to report their true feelings, intentions, and behaviors [65]. Some individuals may indeed report their intention to use chemoprophylaxis for social desirability purposes. Others may honestly report their intention to adopt healthy behaviors while finally failing to adopt them for reasons beyond their awareness. Implicit measurements of attitudes such as the Implicit Association Test (IAT) [66] have been proposed to complement the information provided by self-reports. The IAT is a 10-min computer-based task that assesses the degree to which people associate some target categories (e.g., "smoking, " "not smoking") with specific attributes (e.g., "positive, " "negative"). The relative strength of these associations (as indexed by reaction times) reflects individuals' automatic or implicit attitudes. For instance, an IAT designed to assess individual risk propensity uses the categories "me" and "not me" and attributes "risky" and "secure" [67]. Individuals with high risk propensity are typically quicker to associate "me" with "risky" than "me" with "secure, " and these implicit attitudes predict higher risk-taking behavior. Several IATs have been developed in the health domain to

**Table 2** Summary of major models and methods for studying risk perception in the health domain.

| Models | Key Attitude Variables | Method | Statistical analyses |
|---|---|---|---|
| Knowledge, Attitude, Practice (KAP) | Perceived likelihood<br>Perceived seriousness | Explicit measures (Self-reports) | Descriptive statistics |
| Health belief model (HBM) | Perceived benefits and costs of preventive measures | | Inferential and multivariate statistics |
| Theory of planned behavior (TPB) | Behavioral intentions<br>Perceived social pressure<br>Perceived personal control | | |
| Positive illusions | Unrealistic optimism | | |
| Implicit cognition | Impulsive (automatic) risk propensity | Implicit measures (implicit association test-IAT) | |

measure implicit attitudes towards addiction (e.g., alcohol, smoking, drug abuse), diet (tendency to a eat high fat diet), or suicidal ideation/attempt, and these implicit attitudes have proved significant predictors of risky behaviors above and beyond the effects of explicit attitudes [68—70]. Travel medicine could benefit from such implicit measurements. New IATs adapted to travelers and infectious disease need to be developed and evaluated. They might help identify travelers likely to engage in risky behaviors, and thus provide a more appropriate pre-travel consultation.

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## Conflicts of interest

None.

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