Media Kesehatan Masyarakat Indonesia
Volume 21 Issue 1 2025
DOI : 10.30597/mkmi.v21i1.36661
Website : http://journal.unhas.ac.id/index.php/mkmi

Infectious Disease Traveler Mobile Application Based on Need Assessment Analysis in Malaysian Students

Farindira Vesti Rahmasari[1*], Wulan Noviani[2], Cahya Damarjati[3], Titih Huriah[4], Ferika Indarwati[4], Umniyyah Agsanie[1], Tesaviani Kusumastiwi[5], Mallika Imwong[6], Chong Mei Chan[7]

[1]School of Medicine, Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia
[2]Community Nursing Department, Master of Nursing, Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia
[3]Department of Information Technology, Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia
[4]School of Nursing, Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia
[5]Department of Psychiatry, Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia
[6]Department of Molecular Tropical Medicine and Genetics, Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand
[7]Department of Nursing Science, Faculty of Medicine, Universiti Malaya, Kuala Lumpur, Malaysia
[*]Authors Correspondence: farindira.vesti@umy.ac.id/08112651397

ARTICLE INFO

Article History:
Received Aug, 26th, 2024
Accepted Mar, 25th, 2025
Published online Mar, 31st, 2025

Keywords:
Infectious Disease;
mHealth;
Need Analysis;

ABSTRACT

Major risks to world health are posed by infectious illnesses such as leptospirosis, hepatitis, malaria, dengue, and tuberculosis. Many diverse measures have been taken to fight infectious disease. However, cases persist despite these efforts, emphasizing the necessity for creative methods of managing and preventing disease. As it integrates mobile health (mHealth) solutions, the research can potentially revolutionize travel medicine. It is vital to give easily accessible and trustworthy health information that can lower the risks of infectious disease while traveling, as the number of students and the general public who travel is increasing. It was qualitative research. Qualitative study explores the potential of mobile health (mHealth) solutions to enhance travel medicine by providing accessible and reliable information to mitigate infectious disease risks among travelers. There 39 informants for the research. The inclusion criteria includes persons with a history of traveling or plans to travel. The data was collected by using questionnaire, FGD, and in-depth interviews for qualitative analysis. Findings from 39 informants, collected through questionnaires, focus group discussions, and in-depth interviews, highlight the need for innovative, user-friendly applications to improve the quality and efficiency of health information for travel-related disease prevention and management. By incorporating mHealth solutions, travelers may receive higher-quality, more useful, and more efficient health information that may be used to manage travel-related health concerns.

INTRODUCTION

Infectious diseases such as malaria, dengue fever, hepatitis, leptospirosis, and tuberculosis continue to be significant global health challenges. Despite advances in medical science, these diseases remain rampant, with malaria alone accounting for an estimated 247 million cases globally in 2021.[1] Dengue fever, with its rapid spread in more than 100 countries, the global burden of hepatitis affecting millions of people, the often underestimated impact of leptospirosis, and the persistent presence of tuberculosis as a leading cause of death all emphasize the ongoing fight against infectious diseases.

The burden of these diseases extends beyond health implications, affect economies and societies worldwide. Indonesia has the second-highest malaria burden in the Southeast Asia region, with around 16 million people living in high-risk areas.[2] Apart from that, malaria is still a public health challenge, especially in cases of pregnancy in several eastern regions of Indonesia.[3] It is estimated that there are 6.3 million pregnancies at risk of contracting malaria, which causes anemia in pregnant women and poor birth outcomes.[4] It is because the provinces of Papua, West Papua, North Maluku, and East Nusa Tenggara contribute more than 60% of the total malaria cases in Indonesia.[5] As a result, the economic burden of malaria is large enough for households to undertake treatment, costing an average of 7% of household income.[6,7] The same thing also happens in Malaysia; malaria still accounts for a large number of cases treated in clinics or hospitals, especially in the urban states of Sabah and Sarawak.[8]

Dengue is an infectious disease that burdens world health, especially in Southeast Asia. Indonesia, the country with the most populous population in Southeast Asia which is susceptible to dengue fever, is consistently projected to be among the top three countries with the highest cases of dengue fever.[9,10] The research results of O'Reilly *et al.* (2019) revealed that the dengue burden in Indonesia is still quite heavy, with a high number of cases.[11] Furthermore, in 2015, an estimated 7.8 million people experienced symptoms; many of these cases did not receive adequate medical care or were not reported. From economic perspective, dengue also poses a significant economic burden for Indonesia, with expenditure reaching US$ 381.15 million consisting of US$ 355.2 million for inpatient care and US$ 26.2 million for outpatient care in 2015.[12] It causes dengue to require a strategic plan to control infection in Indonesia.[13] Dengue is also a major public health challenge in Indonesia, marked by increased dengue-related cases and deaths. During the period from 2014 to 2016, Malaysia recorded approximately 330,891 cases of dengue fever and nearly 788 deaths caused by this disease, emphasizing its severe impact.[14] In 2015, Malaysia recorded a substantial incidence rate of 396.4 cases of dengue fever per 100,000 people, resulting in significant economic and health stress.[15]

Hepatitis B Virus (HBV) and Hepatitis C Virus (HCV) infections represent a significant global health challenge. The greatest prevalence of infection is found in the WHO Western Pacific Region and the WHO African Region, with approximately 97 million and 65 million people chronically infected.[16] In Southeast Asia, 61 million people have been infected with this virus.[16] In Indonesia, it is estimated that 1 in 100 people in the general population have antibodies to hepatitis C virus (HCV), indicating previous exposure to the virus.[17] However, this prevalence increases dramatically among drug users who inject themselves, with 9 out of 10 users having HCV antibodies.[18] With its position as a country with a large population, Indonesia faces major challenges in overcoming the spread of HCV, with estimates that 2.5 million people are infected.[17] In contrast to Indonesia, the prevalence of HBV and HCV in Malaysia has a lighter burden, with a constant HBV incidence of 11 and 15% over the last five years.[19] However, the incidence of HBV in Malaysia is projected to increase between 2010 and 2040, increasing the burden on health services.[20,21]

Leptospirosis is a disease caused by bacteria, causing significant illness and death in tropical areas.[22] In Malaysia, a study reported that there were 3,604 cases and 47 deaths in the Ministry of Health hospitals in Malaysia in 2012 due to leptospirosis.[23] Leptospirosis also has a much higher incidence and mortality rate among other infectious diseases and can be transmitted simultaneously with other diseases. Therefore, greater preventive measures are needed, especially in Southeast Asian countries, including Malaysia, where the climate is humid and floods

occur relatively frequently.[22,24] In Indonesia, it was reported in 2019 that there were 920 cases of leptospirosis in Indonesia.[25] These cases are higher than in 2018, namely 895 cases, with a death rate of 17.8%, according to the official report from the Ministry of Health.[26] However, this number of cases is very low for leptospirosis in Indonesia, considering that the annual morbidity of leptospirosis in the population was recently estimated at 39.2 per 100,000.[27] The striking difference between the number of cases detected and estimated cases shows a lack of understanding of the burden of leptospirosis in Indonesia.[28]

Efforts to combat this infectious disease have been numerous and varied. The World Health Organization's 2030 Sustainable Development Agenda includes a pledge to end epidemics of these diseases.[29] For example, the distribution of Insecticide Treated Nets (ITN), mosquito source reduction, insecticides, and prophylaxis to combat mosquito-borne diseases, such as malaria and dengue, in Indonesia.[30] Apart from that, releasing mosquitoes infected with the intracellular Wolbachia bacteria in Yogyakarta City is also an effort to reduce dengue infections in Indonesia.[31,32] In Malaysia, various efforts have also been made to reduce cases of infection from these diseases, such as using insecticides in Indoor Residual Spray (IRS) and Long-Lasting Insecticide Net (LLIN),[33] and conducting health education based on school.[34] However, despite these efforts, cases continue, highlighting the need for innovative disease management and prevention approaches.

In response to this need, developing customized mobile applications for travelers to manage infectious diseases has emerged as a promising alternative. These applications aim to take advantage of the presence of mobile technology to provide real-time data, disease monitoring, and support for health decision-making.[35] The current research into developing traveler health apps has focused on several key areas. One area of research has been using mobile apps to provide information about mobility, disease connectivity, and individual risk.[36] The application aims to minimize travelers' risk of disease exposure by providing current information. It is achieved by measuring human movement and assessing the origin-destination-specific risks of communicable and non-communicable health issues. Another area of research has been the integration of data visualization into health apps, allowing users to manage and predict their health through graphical representations.[37] Additionally, there has been research into the use of smartphone apps to collect detailed information on health behaviors, clinical symptoms, accidents, and environmental factors during travel. This approach aims to capture real-time data and minimize recall bias. Overall, the research in this field has shown great potential for innovation in travel medicine and has highlighted the importance of reliable and user-friendly apps for travelers.[38] The functions and uses of such mobile applications are diverse, from disseminating public health information to enabling early detection of outbreaks. They serve as an effective tool for travelers to access disease prevalence information, potentially reducing the risk of exposure and assisting in preventive measures.[37]

The importance of this research lies in its potential to transform travel medicine by integrating mobile health (mHealth) solutions. With the increasing mobility of students and the general population, there is a critical need to provide accessible and reliable health information that can reduce the risks associated with infectious diseases during travel. This research is the initial stage for developing a mobile application for travelers to prevent infectious diseases based on needs analysis and assessment of students as potential travelers. The app will be designed to meet the needs of prospective travelers, ensuring that it is easy to use, culturally relevant, and effective in managing travel-related health risks.

MATERIAL AND METHOD

As part of a needs assessment, this study used a qualitative descriptive design to look at the requirements and perspectives of users. It took place at Universiti Malaya with 39 informants chosen by convenience sampling. The people who took part were college students from different semesters who had traveled before or planned to travel in the future. We used a structured questionnaire, Focus Group Discussions (FGDs), and in-depth interviews to gather

data. This allowed us to use methodological triangulation to compare and contrast ideas from different methodologies to make them more credible. The legitimacy also comes from basing judgments on what participants said, giving detailed descriptions of the environment, and keeping track of how the analysis was done. Using NVivo 12 Plus software to help organize and code the data into categories that fit with the study's goals, we followed the Colaizzi method for data analysis. We reviewed transcripts of FGDs and interviews, pulled out important statements, made meanings, and developed themes in an iterative way. This method focused on descriptive breadth over interpretive depth, which suggests that future studies could use more rigorous thematic or grounded theory analysis. The Health Research Ethics Committee of the Faculty of Medicine and Health Sciences at Universitas Muhammadiyah Yogyakarta looked into and approved this study (No. 190/EC-KEPK FKIK UMY/V/2024).

RESULTS

Demographic Data

This initial research was conducted to explore information aimed at developing a mobile traveler application. Most participants in this research were women (79%), and the remaining were men (21%). Participants in this study were aged between 21-49 years, with a mean age of 29,256 (SD = 8,146). Complete demographic information about participants can be seen in Table 1.

Having health facilities close to schools and workplaces is very important. It ensures that medical assistance is quickly available in an emergency and facilitates access to routine services. In addition, health facilities close to schools or workplaces can encourage early intervention and reduce barriers to seeking health services, which can improve public health. The questionnaire analysis showed that most participants (97%) stated that their school or work area was close to health facilities. Most participants (95%) also stated that nearby health facilities met their expectations, such as hospitals, health clinics, and pharmacies. However, adding health facilities, such as vaccination centres or counselling and psychology clinics, is an important input in increasing access to health in the community.

Need Assessment

Based on Table 3, it can be seen that most participants (87%) travelled with a duration of between 1 and 7 days. It suggests that most observed trips are short and may be related to holiday activities or short visits. It can be interpreted as an indication that short trips are more common among participants in this study. However, a small number of participants (3%) also travelled for 8 to 30 days. Although this proportion is smaller, it may indicate variation in the type of travel participants undertake, perhaps including longer business or exploration trips.

Apart from that, several participants (5%) reported traveling between 31 days to 6 months, and (5%) other participants travelled for more than six months. Although small, this proportion indicates the diversity in travel experiences observed in this study. Longer trip durations may reflect long-term travel, such as traveling to pursue studies abroad.

There are three main purposes for participants to travel: vacation, pursuing education, and work. Most participants have a main goal of vacation when they plan to travel (76.5%). Activities with the main aim of being on holiday have many variations, such as visiting friends/ family, watching sports matches, or going to the beach. Another reason is study (13.7%), and work (9.8%).

Table 1. Participants Demographic Data

Variables	n = 39	%
Sex		
Male	8	21
Female	31	79
Education		
Senior High School	2	5
Bachelor (S1)	37	95
Occupation		
Student	25	64
Civil Servants (PNS)	13	33
Not Answer	1	3
Health Insurance		
Yes	19	49
No	20	51
Ethnicity		
Chinese	8	21
India	2	5
Melayu	28	72
Others	1	3

Source: Primary Data, 2024

Consideration Before Plan to Travel

Travel planning is crucial in ensuring a safe and enjoyable travel experience. When someone plans a trip, there are various factors to consider, from the purpose of the trip to personal health factors. Knowing these factors helps avoid potential risks during travel and improves the overall travel experience. Participants' considerations before traveling are destination areas and risk factors of infectious disease, travel destination, travel time, risk of previous disease, areas with vaccination recommendation, vulnerable age, history of allergies, pregnancy or breastfeeding, vaccine allergy, lastly history of transmission disease.

There is a clear picture of the considerations made by participants before traveling. From this table, it can be seen that the factors most frequently considered were the destination and risk of infectious disease, as well as the purpose of travel, each of which was mentioned by 33 participants. It revealed that participants paid attention to health and safety factors related to their travel destinations and purposes. The following participant statements support these results:

> *"We should know the risk of disease. As we learned before, if we go to Africa, maybe there is a high risk of getting transmitted disease" (HYT, Male)*

In addition, the travel time factor was also an important consideration for most participants, with 30 participants considering this before traveling. It suggests that the travel duration is also considered to significantly impact the risks one may encounter. Furthermore, previous disease risk factors were also taken into account by 18 participants, indicating that previous health experiences may influence participants' decisions to travel. Although in smaller numbers, factors such as vaccination recommendations, vulnerable age range, history of allergies, pregnancy/breastfeeding conditions, and allergies to vaccines were also considered important by some participants before traveling.

Personal Medicine Preparation Before Travelling

Preparing everything before traveling can reduce the risk of spreading infectious diseases. The research results show that all participants prepared clothing appropriate to the travel destination area. It shows that participants are aware of the need to protect themselves from extreme weather, such as cold or unusual heat. Proper clothing preparation can also reflect efforts to reduce the risk of mosquito bites, skin diseases, or even injuries due to environmental conditions that are not usual for them.

Next, participants prepared medicines that can be brought when traveling. It indicates that participants were aware of the need for personal medication that may not be available at their destination or to anticipate possible medication needs during travel. Personal medication preparation can also be part of a strategy to address health risks that may arise during travel. This result is supported by the following statement from one of the FGD participants:

> *"Prepare appropriate clothes, clothing, medication kit, vaccine if possible" (NW, Female)*

The next preparation was to look for information about endemic diseases in the destination area. Some participants searched for information about diseases endemic to their destination areas. It shows that some participants were aware of the potential health risks associated with their travel destination. Information regarding the endemicity of the disease can help participants take appropriate preventive measures, such as vaccination or the use of certain preventive medications before leaving.

Type of Traveler Most Seeking Information

Based on the research results, participants tend to prioritize information related to aspects that directly impact their travel experience, such as tourist attractions, weather, and transportation. However, the participants did not necessarily ignore the health aspect. It indicates they are highly aware of health and safety during travel. Access to vaccine services is not a priority because participants may have received vaccinations before leaving, or the information is more easily accessible through other sources. However, a few participants perceived that information about vaccine services was necessary for travelers. It is supported by the following participant statements:

> *"I think it is important for us to include information about vaccine access. What we do in the list of hospitals is to find where they can easily get the information. So, it will be easier for people to know where to get the vaccine." (KSM, Female)*

Disease Type and Comprehensive Information about the Disease

Travelers need to get comprehensive information about a disease when they travel. It will reduce the risk of contracting the disease. The research results showed that information about tuberculosis, dengue, and malaria (Figure 1) is most expected to be easy for participants to find on a travel application. It is supported by one of the participants who stated that one of the diseases that needs to be shown is diseases that can spread through the air, such as TB.

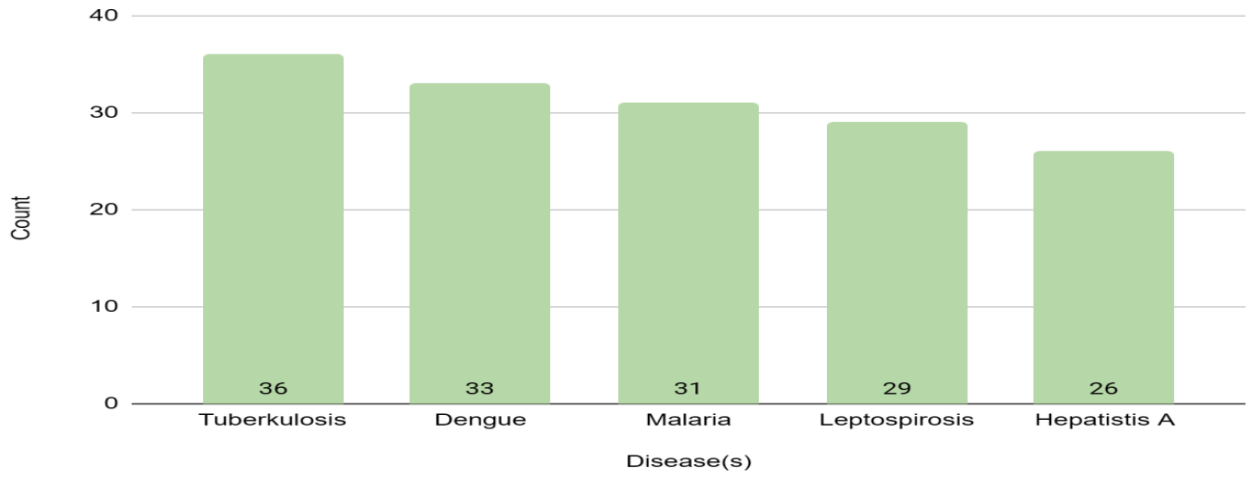
> *"An easy disease like airborne disease, food, which means the infection comes from the food itself. Because we travel, we eat. So, the risk of infections like cholera, hepatitis A, and hepatitis E must be noted there. The patient statistics must be stated in the app, including how much they are. Because we travel, eat, and then do other things like airborne, the droplet is dangerous because it will involve the recipe. So, the high-risk things like that are usually bloodborne. We can put one random thing. Like, the most worried thing is the recipe." (SWD, Female)*

In addition, participants need to know important information related to the disease. The results of this study showed that the information most sought by participants when they want to know more about infectious diseases covers various important aspects. According to Table 2, most participants showed a high interest in how the disease is transmitted, which is essential for understanding how the disease can spread and taking appropriate preventive measures. Disease symptoms were also a major focus, with a similar number of participants, indicating the need to recognize early signs of infection to act immediately. Prevention through drugs, or prophylaxis, is almost equally important, indicating an awareness of the importance of medical intervention before infection occurs. Specific seasons or times of year when infectious diseases are common are also a concern, which can help plan and prevent them. Disease definitions, common prevention methods, initial treatment, and information about health and educational facilities all indicate a need for deeper understanding and access to appropriate resources. Although not as popular as other categories, endemicity and drug resistance remain an important part of the overall understanding of infectious diseases.

Table 2. Information Desired by Participants Related to Infectious Diseases

Answer	%
Mode of transmission	12
Symptom	12
Prevention in the form of drugs (prophylaxis)	11
The most frequent season of disease occurrence	11
Definition	10
Prevention	10
Initial treatment	10
Facilities and Education	9
Area endemicity	9
Drug resistance	6

Source: Primary Data, 2024



Source: Primary Data, 2024

Figure 1. Diseases of Concern to Participants

The Most Desirable Feature and Additional Travel Awareness

The ease of use of a travel app is often related to the functionality and effectiveness of the features provided by the developer. As illustrated in Table 2, most participants preferred features that provide user information, particularly the participant's medical history. These findings indicate the need for personalization in travel health management, considering individual medical conditions. As explained by one of the FGD participants below:

> *"I think the application should be applied to people with a disease, such as patients with low immunity when going outside. So, they should know what they should prepare. For example, people who have diabetes are immunocompromised. When they go to the country, they are at high risk of getting an infection such as influenza. So, when declared in the app, the application may allow them to do what they can and cannot." (NGL, Female)*

Furthermore, features that provide information about travel schedules and seasonal periods with a higher risk of infection were also considered important, as indicated by 32 participants. It signals users' desire to understand the best time to travel and the potential health risks they may face. Features related to allergy information and vaccination recommendations also received high priority, with 31 participants identifying them as important, highlighting the importance of precautions and preparation before traveling.

Information regarding the best vacation seasons, travel destinations, and preventive maintenance recommendations receive similar attention, reflecting aspirations for a safe and enjoyable travel experience. Information about the purpose of travel, current health risks, and response to previous vaccinations is also included in the list of needs, demonstrating the importance of access to relevant information to plan travel appropriate to individual health conditions. Personal data and special conditions such as pregnancy or breastfeeding were considered important by 21 participants, highlighting the need for applications that can manage sensitive information securely and provide appropriate recommendations.

In the context of post-travel health management in mobile apps, our research describes the preferences of Malaysian participants regarding desired features in a travel app. A total of 38 participants prioritized the inclusion of guidance on initial non-pharmacological management strategies, underscoring the demand for alternative health solutions that do not rely on medications. Information relating to potential post-travel symptoms was deemed necessary by 37 participants, reflecting a proactive approach to health monitoring. Similarly, a similar number of participants expressed the need for the app to issue alerts for severe symptoms, indicating a need for emergency care functionality. Providing initial pharmacotherapy options was also preferred by 37 participants, indicating a balanced bias toward drug-based interventions. Notifications for mild symptoms were slightly less prioritized, with 36 participants advocating for this feature, which could facilitate timely health interventions. Finally, clear and concise disease definitions were sought by 33 participants, highlighting the importance of educational resources in the app. These findings revealed a comprehensive perspective on desired post-travel health management features in travel mobile apps among Malay community groups. This result is also supported by the following statement from one of the FGD participants:

> *"For me, it's very important after, let's say, we go. We are back from Africa, but we have a few symptoms. I think from the app, we can do post-travel or something so that we can check our health status. If it is not good, the app can suggest that we proceed with a premedical treatment. I think it is very good to have the app to access our help post-travel." (HYT, Male)*

DISCUSSION

This study examined the requirements and preferences of Malaysian visitors for health-related features and information in a proposed mobile travel application. Significant findings indicate that participants prioritize access to individualized health management tools, illness prevention guidance, and health risk information both before to and following travel. This study examined the requirements and preferences of Malaysian travelers about health information and functionalities in a proposed mobile travel application. Participants emphasize the importance of access to health risk information, illness preventive strategies, and tailored health management tools, both before to and following travel.

Table 3. Information Displays Pre and Post Travel

Information Displays Pre-Travel	n	Information Displays Post-Travel	n
Health risks such as a history of previous illnesses	37	Initial management consists of non-pharmacotherapy/non-medication	38
Travel time	32		
Seasons with a greater risk of infectious diseases	32	Symptom	37
Health risks such as allergies	31		
Vaccination recommendations	31	Notification if symptoms are severe	37
The best season during the holidays	31		
Where to travel	30	Initial therapy consists of pharmacotherapy/medication	37
Recommended preventive care (prophylaxis)	29		
Travel purpose	28	Notification if symptoms are mild	36
Health risks such as current treatment, if any	28		
Reaction to previous vaccinations	25	Definition	33
Personal data	21		
Pregnancy/breastfeeding conditions	21		

Source: Primary Data, 2024

Most of participants are reported to be in vacation for travel purpose. Travel to areas where such endemic diseases are present carries a significant risk of infection, especially for individuals from non-endemic countries. The study reported that respondents need information related to health access when travel to another place. It is in line with Sørensen who reported that updated information on health status, diagnoses, treatments, and vaccinations are needed.[39] The risk of being infected with a disease is one of the considerations when traveling to a place or country so as not to cause the disease to spread more widely.[40,41] Various studies have highlighted the impact of travel on the epidemiology of disease infections, emphasizing the need for preventive measures.[42,43] Students need to be aware of the risk factors associated with contracting malaria during travel and take the necessary precautions to prevent transmission.

Pre-travel health preparation involves several important steps. International students must receive professional pre-travel advice, as it helps them understand health risks and preventive measures.[44] Socio-demographic characteristics and past travel history also play a role in determining the uptake of pre-travel health consultation.[45] Seeking pre-travel advice is essential for mitigating the risk of acquiring infections while traveling.[46] For individuals with Cardiovascular Disease (CVD), the pre-travel consultation should address issues such as vaccinations, travel insurance, and necessary medical documents.[47] Pre-travel health preparation should include knowledge about infectious and non-infectious health risks, preventive practices such as condom use and helmet wearing, and understanding the specific health needs of individuals with pre-existing conditions such as CVD.[48] Thus, the need for developing the apps should be on top priority.

In addition, other findings revealed that most participants did not receive or consult a doctor when preparing to travel to a destination. These results are consistent with previous findings that less than 25% of students consulted a doctor or professional to prepare for their trip.[49] It can be caused by the fact that travel medicine is still not common in the Asian region because travel medicine has been developed and cultivated in the Western world for several decades.[50,51] This results in students in the Asian region not being used to making pre-preparations for travel unless required by the destination country to carry out examinations and get certain vaccinations.[44]

The results of this research revealed that the information priorities sought by participants when traveling tend to focus on aspects that directly impact the travel experience, such as tourist attractions, weather, and transportation. It suggests that participants were more interested in information about recreational activities and comfort during their trip. These factors have a significant influence on the quality of the tourism experience, and these findings are consistent with previous research showing that tourists tend to prioritize elements related to their recreation and experience when traveling.[52–54]

However, this research also highlights participants' awareness of health and safety aspects. Despite the low priority placed on information about vaccine services and health facilities compared to tourist attractions or weather, the number of participants seeking information about health facilities and endemic diseases indicates awareness of health risks during travel. It indicates that although not a top priority, health and safety are still a concern for some tourists. This trend may reflect increasing global awareness about public health, particularly in the context of pandemics and infectious disease risks.

Apart from that, the low interest of participants in accessing vaccine services may be caused by several factors. One possible explanation is that participants had been vaccinated before travel and thus felt no need to seek further information.[44] Alternatively, they may perceive that the information is more easily accessible through other channels, such as government recommendations or local health centers.[50] However, the fact that some participants still consider this information important, as stated by one respondent, indicates the need to provide information about access to vaccine services in the context of travel. It is closed the study which developed Mount Bromo android applications as the preventive effort for tourist by giving information the recent condition of Bromo.[55] It could be a consideration for tourism authorities and the travel industry to ensure that information on health and safety is more easily accessible to tourists.

Several mobile applications for travel medicine have been developed to reduce and suppress the spread of disease due to the movement of people from an area. This study's findings revealed that most participants wanted more personalized information on mobile apps, especially during the pre-travel period. Information such as disease history was the most desired information on the mobile app. The author assumed that with the existing disease history information on the smartphone, the app will provide recommendations regarding what they can and cannot do personally so that it becomes a relevant recommendation for users.[56–58] It will result in increased vigilance against endemic diseases of the destination and changes in traveler behavior.[37,58] Mobile health traveler features also need to be expanded, not only to pre-travel but also post-travel. This study's findings also demonstrated a need for a post-travel feature that is useful for screening symptoms or health status after returning to the area of origin. The post-travel symptom-checking feature through the app has the potential to reduce the burden that will be borne by the health system.[59]

The employment of a convenience sampling strategy may have resulted in selection bias, as participants were selected from those who were more accessible and ready to participate, thereby rendering the sample less representative. Secondly, the research exclusively examined college students, the majority of whom were youthful and well educated. This complicates the application of the findings to other demographics of passengers, such as elderly individuals, children, or those from diverse socio-economic situations. Third, qualitative descriptive analysis provided extensive insights into participants' preferences and behaviors; nevertheless, self-reported data may be influenced by memory bias or social desirability bias. The limited sample size and the study's confinement to a single institution (Universiti Malaya) hinder the generalizability of the results to other contexts or locations. To strengthen the argument for the development of mobile health traveler applications, future study should examine more varied and representative groups, as well as employ quantitative data to support these conclusions.

CONCLUSION AND RECOMMENDATION

A needs analysis is required to identify the information and features required by users of an infectious disease mobile app for travelers. Information about the destination and the risk of disease in the area is the main information users consider before traveling to a region. In addition, adding features in the application to detect disease symptoms after traveling to a region is important to reduce the burden of infectious diseases on the health system.

AUTHOR CONTRIBUTIONS

FVR concepting the study. Designing methodology was done by FVR and CD. FI did the formal analysis. WN, TH, UA, TK, MI and CMC did the investigation. All authors read and approved the final manuscript. FVR = Farindira Vesti

Rahmasari; CD = Cahya Damarjati; FI = Ferika Indarwati; WN = Wulan Noviani; TH = Titih Huriah; UA = Umniyyah Agsanie; TK = Tesaviani Kusumastiwi; MI = Mallika Imwong; CMC = Chong Mei Chan.

CONFLICTS OF INTEREST

All authors declare no conflict of interest.

REFERENCES

1. WHO. World Malaria Report. Geneva: World Health Organization; 2022. https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2022
2. Surendra H, Supargiyono, Ahmad RA, Kusumasari RA, Rahayujati TB, Damayanti SY, et al. Using Health Facility-Based Serological Surveillance to Predict Receptive Areas at Risk of Malaria Outbreaks in Elimination Areas. *BMC Medicine*. 2020;18 (9). https://doi.org/10.1186/s12916-019-1482-7
3. Paintain L, Hill J, Ahmed R, Umbu Reku Landuwulang C, Ansariadi A, Rini Poespoprodjo J, et al. Cost-Effectiveness of Intermittent Preventive Treatment with Dihydroartemisinin-Piperaquine Versus Single Screening and Treatment for The Control of Malaria in Pregnancy in Papua, Indonesia: A Provider Perspective Analysis from A Cluster-Randomised Trial. *The Lancet Global Health*. 2020;8(12):1524–1533. https://doi.org/10.1016/S2214-109X(20)30386-7
4. Ahmed R, Levy EI, Maratina SS, De Jong JJ, Asih PBS, Rozi IE, et al. Performance of Four HRP-2/pLDH Combination Rapid Diagnostic Tests and Field Microscopy as Screening Tests for Malaria in Pregnancy in Indonesia: A Cross-Sectional Study. *Malaria Journal*. 2015;14(420). https://doi.org/10.1186/s12936-015-0943-5
5. Ipa M, Laksono AD, Astuti EP, Prasetyowati H, Pradani FY, Hendri J, et al. Sub-National Disparities in Accessing Anti-Malarial Drug Treatment in Eastern Indonesia. *BMC Public Health*. 2021;21(1548). https://doi.org/10.1186/s12889-021-11602-1
6. Karyana M, Devine A, Kenangalem E, Burdarm L, Poespoprodjo JR, Vemuri R, et al. Treatment-Seeking Behaviour and Associated Costs for Malaria in Papua, Indonesia. *Malaria Journal*. 2016;15(536). https://doi.org/10.1186/s12936-016-1588-8
7. Assebe LF, Kwete XJ, Wang D, Liu L, Norheim OF, Jbaily A, et al. Health Gains and Financial Risk Protection Afforded by Public Financing of Selected Malaria Interventions in Ethiopia: An Extended Cost-Effectiveness Analysis. *Malaria Journal*. 2020;19(41). https://doi.org/10.1186/s12936-020-3103-5
8. Jiram AI, Ooi CH, Rubio JM, Hisam S, Karnan G, Sukor NM, et al. Evidence of Asymptomatic Submicroscopic Malaria in Low Transmission Areas in Belaga District, Kapit Division, Sarawak, Malaysia. *Malaria Journal*. 2019.18(156). https://doi.org/10.1186/s12936-019-2786-y
9. Bhatt S, Gething PW, Brady OJ, Messina JP, Farlow AW, Moyes CL, et al. The Global Distribution and Burden of Dengue. *Nature*. 2013;496(496):504–507. https://doi.org/10.1038/nature12060
10. Shepard DS, Undurraga EA, Halasa YA, Stanaway JD. The Global Economic Burden of Dengue: A Systematic Analysis. *Lancet Infectious Diseases*. 2016;16(8):935–941. https://doi.org/10.1016/S1473-3099(16)00146-8
11. O'Reilly KM, Hendrickx E, Kharisma DD, Wilastonegoro NN, Carrington LB, Elyazar IRF, et al. Estimating the Burden of Dengue and The Impact of Release of wMel Wolbachia-Infected Mosquitoes in Indonesia: a Modelling Study. *BMC Medicine*. 2019; 17(172). https://doi.org/10.1186/s12916-019-1396-4
12. Nadjib M, Setiawan E, Putri S, Nealon J, Beucher S, Hadinegoro SR, et al. Economic Burden of Dengue in Indonesia. Shepard DS, Editor. *PLoS Neglected Tropical Diseases*. 2019;13(1):e0007038.

https://doi.org/10.1371/journal.pntd.0007038

13. WHO. Ending the Burden of Dengue Infection: Indonesia Launched The 2021-2025 National Strategic Plan for Dengue Control Programme. Geneva: World Health Organization; 2021. https://www.who.int/indonesia/news/detail/15-11-2021-ending-the-burden-of-dengue-infection-indonesia-launched-the-2021-2025-national-strategic-plan-for-dengue-control-programme
14. Liang Y, Ahmad Mohiddin MN, Bahauddin R, Hidayatul FO, Nazni WA, Lee HL, et al. Modelling the Effect of a Novel Autodissemination Trap on the Spread of Dengue in Shah Alam and Malaysia. *Computational and Mathematical Methods in Medicine*. 2019; 2019(1):1–15. https://doi.org/10.1155/2019/1923479
15. Greenhalgh D, Liang Y, Nazni WA, Teoh GN, Lee HL, Massad E. Modeling the Effect of a Novel Auto-Dissemination Trap on The Spread of Dengue in High-Rise Condominia, Malaysia. *Journal of Biological Systems*. 2018;26(04):553–578. https://doi.org/10.1142/S0218339018500250
16. WHO. Hepatitis B. Geneva: World Health Organization; 2025. https://www.who.int/news-room/fact-sheets/detail/hepatitis-b
17. Trickey A, Hiebert L, Perfect C, Thomas C, El Kaim JL, Vickerman P, et al. Hepatitis C Virus Elimination in Indonesia: Epidemiological, Cost and Cost-Effectiveness Modelling to Advance Advocacy and Strategic Planning. *Liver International*. 2019;40(2):286–297. https://doi.org/10.1111/liv.14232
18. Degenhardt L, Peacock A, Colledge S, Leung J, Grebely J, Vickerman P, et al. Global Prevalence of Injecting Drug Use and Sociodemographic Characteristics and Prevalence of HIV, HBV, and HCV in People Who Inject Drugs: A Multistage Systematic Review. *Lancet Global Health*. 2017;5(12): 1192–207. https://doi.org/10.1016/S2214-109X(17)30375-3
19. Muhamad NA, Ab. Ghani RM, Abdul Mutalip MH, Muhammad EN, Mohamad Haris H, Mohd Zain R, et al. Seroprevalence of Hepatitis B Virus and Hepatitis C Virus Infection Among Malaysian Population. *Scientific Reports*. 2020;10(21009). https://doi.org/10.1038/s41598-020-77813-5
20. Rajamoorthy Y, Mohd Taib N, Rahim K, Munusamy S. Trends and Estimation of Hepatitis B Infection Cases in Malaysia, 2003-2030. *Malaysian Journal of Public Health Medicine*. 2016;16(1):113–120. https://www.researchgate.net/publication/319664509_Trends_and_estimation_of_hepatitis_B_infection_cases_in_Malaysia_2003-2030
21. Raihan R, Azzeri A, Shabaruddin FH, Mohamed R. Hepatocellular Carcinoma in Malaysia and Its Changing Trend. *Euroasian Journal of Hepato-Gastroenterology*. 2018;8 (1):54–56. https://doi.org/10.5005/jp-journals-10018-1259
22. Ho JY, Lavinya AA, Kay DSW, Lee CIS, Razmi AH, Walsh CL, et al. Towards an Integrated Approach to Improve the Understanding of the Relationships Between Water-Borne Infections and Health Outcomes: Using Malaysia as a Detailed Case Study. *Frontiers Water*. 2022;4:779860. https://doi.org/10.3389/frwa.2022.779860
23. Benacer D, Thong KL, Verasahib KB, Galloway RL, Hartskeerl RA, Lewis JW, et al. Human Leptospirosis in Malaysia: Reviewing the Challenges After 8 Decades (1925-2012). *Asia Pacific Journal of Public Health*. 2016;28(4):290–302. https://doi.org/10.1177/1010539516640350
24. Mohd Radi MF, Hashim JH, Jaafar MH, Hod R, Ahmad N, Mohammed Nawi A, et al. Leptospirosis Outbreak After the 2014 Major Flooding Event in Kelantan, Malaysia: A Spatial-Temporal Analysis. *American Journal of Tropical Medicine and Hygiene*. 2018; 98(5):1281–1295. https://doi.org/10.4269/ajtmh.16-0922

25. WHO. Leptospirosis Prevention and Control in Indonesia. Geneva: World Health Organization; 2020. https://www.who.int/indonesia/news/detail/24-08-2020-leptospirosis-prevention-and-control-in-indonesia
26. Kemenkes RI. Profil Kesehatan Indonesia Tahun 2018. Jakarta: Kementerian Kesehatan RI; 2019. https://kemkes.go.id/id/profil-kesehatan-indonesia-2018
27. Costa F, Hagan JE, Calcagno J, Kane M, Torgerson P, Martinez-Silveira MS, et al. Global Morbidity and Mortality of Leptospirosis: A Systematic Review. *PLoS Neglected Tropical Diseases*. 2015;9(9): e0003898. https://doi.org/10.1371/journal.pntd.0003898
28. Gasem MH, Hadi U, Alisjahbana B, Tjitra E, Hapsari MMDEAH, Lestari ES, et al. Leptospirosis in Indonesia: Diagnostic Challenges Associated with Atypical Clinical Manifestations and Limited Laboratory Capacity. *BMC Infectious Diseases*. 2020;20 (179). https://doi.org/10.1186/s12879-020-4903-5
29. WHO. Accelerating Progress on HIV, Tuberculosis, Malaria, Hepatitis and Neglected Tropical Diseases. Geneva: World Health Organization; 2015. https://www.who.int/publications/i/item/accelerating-progress-on-hiv-tuberculosis-malaria-hepatitis-and-neglected-tropical-diseases
30. Bandzuh JT, Ernst KC, Gunn JKL, Pandarangga S, Yowi LRK, Hobgen S, et al. Knowledge, Attitudes, and Practices of Anopheles Mosquito Control Through Insecticide Treated Nets and Community-Based Health Programs to Prevent Malaria in East Sumba Island, Indonesia. *PLoS Global Public Health*. 2022;2 (9):e0000241. https://doi.org/10.1371/journal.pgph.0000241
31. Anders KL, Indriani C, Ahmad RA, Tantowijoyo W, Arguni E, Andari B, et al. The AWED Trial (Applying Wolbachia to Eliminate Dengue) to Assess the Efficacy of Wolbachia-Infected Mosquito Deployments to Reduce Dengue Incidence in Yogyakarta, Indonesia: Study Protocol for A Cluster Randomised Controlled Trial. *Trials*. 2018;19 (302). https://doi.org/10.1186/s13063-018-2670-z
32. Brady OJ, Kharisma DD, Wilastonegoro NN, O'Reilly KM, Hendrickx E, Bastos LS, et al. The Cost-Effectiveness of Controlling Dengue in Indonesia Using wMel Wolbachia Released at Scale: a Modelling Study. *BMC Medicine*. 2020;18(186). https://doi.org/10.1186/s12916-020-01638-2
33. Rohani A, Fakhriy HA, Suzilah I, Zurainee MN, Najdah WMAW, Ariffin MM, et al. Indoor and Outdoor Residual Spraying of a Novel Formulation of Deltamethrin K-Othrine® (Polyzone) for The Control of Simian Malaria in Sabah, Malaysia. *PLoS One*. 2020;15(5):e0230860. https://doi.org/10.1371/journal.pone.0230860
34. AhbiRami R, Zuharah WF. School-Based Health Education for Dengue Control in Kelantan, Malaysia: Impact on Knowledge, Attitude and Practice. *PLoS Neglected Tropical Diseases*. 2020 Mar 27;14(3): e0008075. https://doi.org/10.1371/journal.pntd.0008075
35. Ahn J. Unequal Loneliness in The Digitalized Classroom: Two Loneliness Effects of School Computers and Lessons for Sustainable Education in the E-Learning Era. *Sustainability*. 2020;12(19). https://doi.org/10.3390/su12197889
36. Lai S, Farnham A, Ruktanonchai NW, Tatem AJ. Measuring Mobility, Disease Connectivity and Individual Risk: A Review of Using Mobile Phone Data and mHealth for Travel Medicine. *Journal of Travel Medicine*. 2019; 26(3). https://doi.org/10.1093/jtm/taz019
37. Meankaew P, Lawpoolsri S, Piyaphanee W, Wansatid P, Chaovalit P, Lawawirojwong S, et al. Cross-Platform Mobile App Development for Disseminating Public Health Information to Travelers in Thailand: Develop-

ment and Usability. *Tropical Diseases, Travel Medicine and Vaccines*. 2022;8(17). https://doi.org/10.1186/s40794-022-00174-6

38. Farnham A, Baroutsou V, Hatz C, Fehr J, Kuenzli E, Blanke U, et al. Travel Behaviours and Health Outcomes During Travel: Profiling Destination-Specific Risks in A Prospective mHealth Cohort of Swiss Travellers. *Travel Medicine and Infectious Disease*. 2022;47(102294). https://doi.org/10.1016/j.tmaid.2022.102294
39. Sørensen HT. Patients with Chronic Diseases Who Travel: Need for Global Access to Timely Health Care Data. *Clinical Epidemiology*. 2022;14:513–519. https://doi.org/10.2147/CLEP.S360699
40. Muresu N, Sotgiu G, Are BM, Cossu A, Cocuzza C, Martinelli M, et al. Travel-Related Typhoid Fever: Narrative Review of the Scientific Literature. *International Journal of Environmental Research and Public Health*. 2020;17(2). https://doi.org/10.3390/ijerph17020615
41. Allen V, Longley N. Infections in Immunosuppressed Travellers with Autoimmune Inflammatory Diseases-A Narrative Review and Advice for Clinical Practice. *Rheumatology*. 2021;60(9):3969–3976. https://doi.org/10.1093/rheumatology/keab445
42. Ahmed AM, Mohammed AT, Vu TT, Khattab M, Doheim MF, Ashraf Mohamed A, et al. Prevalence and Burden of Dengue Infection in Europe: A Systematic Review and Meta-Analysis. *Reviews in Medical Virology*. 2020; 30(2). https://doi.org/10.1002/rmv.2093
43. Agudelo Higuita NI, White BP, Franco-Paredes C, McGhee MA. An Update on Prevention of Malaria in Travelers. *Therapeutic Advances in Infectious Disease*. 2021;8. https://doi.org/10.1177/20499361211040690
44. Jaita S, Pisutsan P, Lawpoolsri S, Kitro A, Kittitrakul C, Kusolsuk T, et al. International University Students' Pre-Travel Preparation, Knowledge and Practices Towards Travel Health in Thailand: A Nationwide Cross-Sectional Study. *Tropical Medicine and Infectious Disease*. 2023;8(6). https://doi.org/10.3390/tropicalmed8060322
45. Ariawan IGN, Swedarma KE, Yanti NPED. A Normative Behavior of Pre-Travel Health Consultation and the Associated Factors Among Travelers. *Jurnal Ners*. 2021;16(1): 26–34. https://doi.org/10.20473/jn.v16i1.21443
46. Nemhauser J. Preparing International Travelers. In: Nemhauser JB, editor. CDC Yellow Book 2024 [Internet]. 1st ed. New York: Oxford University Press; 2023. https://academic.oup.com/book/45769/chapter/399173231
47. Kain D, Findlater A, Lightfoot D, Maxim T, Kraemer MUG, Brady OJ, et al. Factors Affecting Pre-Travel Health Seeking Behaviour and Adherence to Pre-Travel Health Advice: A Systematic Review. *Journal of Travel Medicine*. 2019;26(6). https://doi.org/10.1093/jtm/taz059
48. Liew CH, Flaherty GT. Pre-travel Health Advice for Patients with Cardiovascular Disease. *International Journal of Travel Medicine and Global Health*. 2019;7(3):79–85. https://www.ijtmgh.com/article_92589.html
49. Ma T, Heywood A, MacIntyre CR. Travel Health Risk Perceptions of Chinese International Students in Australia – Implications for COVID-19. *Infection, Disease & Health*. 2020;25(3):197–204. https://doi.org/10.1016/j.idh.2020.03.002
50. Leder K, Borwein S, Chanthavanich P, Chatterjee S, Htun K, Marma ASP, et al. Travel Medicine Perspectives of Select Travel Medicine Experts Practicing in The Asia-Pacific Region. *Journal of Travel Medicine*. 2017;24(4). https://doi.org/10.1093/jtm/tax012
51. Sohail A, Akritidis J, McGuinness S, Leder K. Perceptions of Travel-Related Health Risks and Pre-Travel Health-Seeking Behaviour Among Students: A Qualitative Analysis.

Travel Medicine and Infectious Disease. 2023;52(102532). https://doi.org/10.1016/j.tmaid.2022.102532

52. Sastre RP, Phakdee-Auksorn P. Examining Tourists' Push and Pull Travel Motivations and Behavioral Intentions: The Case of British Outbound Tourists to Phuket, Thailand. *Journal of Quality Assurance in Hospitality & Tourism*. 2017;18(4):437–464. https://doi.org/10.1080/1528008X.2016.1250242
53. Brandano MG, Osti L, Pulina M. How Motivations and Satisfaction Influence Wine Tourists' Loyalty? An Analysis of The Italian Case. *International Journal of Culture Tourism and Hospitality Research*. 2019;13(1):55–69. https://doi.org/10.1108/IJCTHR-04-2018-0054
54. Shi X, Day J, Gordon S, Cai L, Adler H. An Exploratory Study of Visitors' Motivations at A Heritage Destination: The Case of The South Luogu Alley in China. *Journal of Hospitality and Tourism Insights*. 2019;2(2):186–202. https://doi.org/10.1108/JHTI-07-2018-0041
55. Fathoni M, Usman F, Hariyani S, Kurniawan EB, Yusuh A, Waloejo CS. Health Disaster Preparedness Using Android Mobile Based Application Case Mount Bromo Eruption. *Jurnal Ners*. 2020;15(1Sp):173–177. https://doi.org/10.20473/jn.v15i1Sp.19005
56. Felkai P. Analysis of Prevention in Travellers Diseases on The Basis of Latest Results in Travel Medicine. *Orvosi Hetilap*. 2008;149(36):1707–1712. https://doi.org/10.1556/oh.2008.28434
57. Gu D, He J, Sun J, Shi X, Ye Y, Zhang Z, et al. The Global Infectious Diseases Epidemic Information Monitoring System: Development and Usability Study of an Effective Tool for Travel Health Management in China. *JMIR Public Health and Surveillance*. 2021;7(2):e24204. https://doi.org/10.2196/24204
58. Kytö M, Koivusalo S, Ruonala A, Strömberg L, Tuomonen H, Heinonen S, et al. Behavior Change App for Self-Management of Gestational Diabetes: Design and Evaluation of Desirable Features. *JMIR Human Factors*. 2022;9(4):e36987. https://doi.org/10.2196/36987
59. Aboueid S, Meyer SB, Wallace JR, Mahajan S, Nur T, Chaurasia A. Use of Symptom Checkers for COVID-19-Related Symptoms Among University Students: A Qualitative Study. *BMJ Innovations*. 2021;7(2):253–260. https://doi.org/10.1136/bmjinnov-2020-000498