A Systematic Review of Mosquitoes at International Ports and Points of Entry: Implications of Risks for Migrating Refugees

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INTRODUCTION

- Insect vectors, including mosquitoes, can transmit pathogens to individuals at transit hubs like airports ("airport malaria"), ports, and railway stations
- Recent data on the threat posed by mosquitoes near aircraft, marine vessels, and railcars at these entry points are limited. ***To address this knowledge gap, we conducted a systematic review of studies documenting mosquito presence at international ports and points of entry***

METHODS

- A systematic review of literature reporting studies of mosquitoes identified at international ports for all modes of transportation was conducted according to PRISMA guidelines
- **Databases** were searched from inception to July 2025, without language restrictions

Inclusion Criteria	Exclusion Criteria
• All studies reporting on the identification of mosquitoes identified at international ports and points of entry regardless of the application of a disinsection process	• Studies conducted in putative models of ports that did not fully replicate the conveyance environment • Epidemiological studies of airport malaria where the mechanism of transmission was not unequivocally airport related • Epidemiological studies reporting only on larval surveillance activities as a proxy for vector-competent adult mosquitoes

Table 1: Inclusion and exclusion criteria

DISCUSSION

- Notable detection of ***Aedes albopictus*** at points of entry in **Belgium** and **Germany** where this species is non-endemic underscores the potential for vector conveyance globally
- Included cases of airport malaria were convincingly linked to mosquito exposures in **baggage handling areas** and **via airmail**
- Report of a mosquito surviving outside the **International Space Station** highlights the insect's ability to survive extreme conditions and physiological stressors
- The role that **passenger luggage** plays in conveyance of vectors internationally warrants investigation
- **High priority research agenda:** Determining the extent to which mosquitoes are present in passenger bridges and walkways, vehicles that transport passengers to the aircraft door, and vehicles transporting luggage to the cargo hold

RESULTS

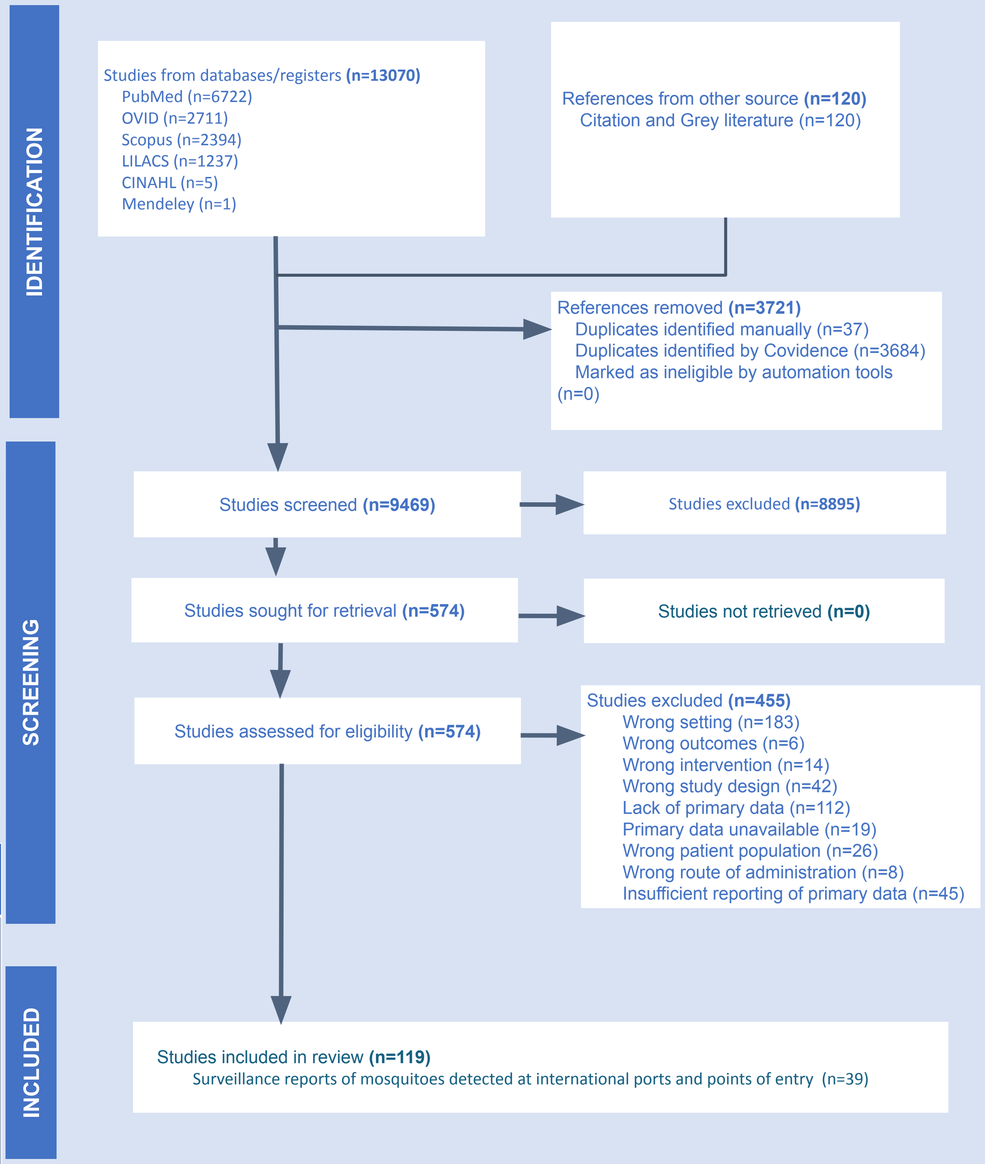

Figure 1: PRISMA Flow Chart with modification

Author (Year)	Study Design	Country Setting	Point / Port of Entry	Seasonality / Surveillance Period	Number of Ports Surveyed	Species Detected (N)[a]
Airports						
Bakran-Lebl (2021)	Surveillance Report	Austria	Vienna International Airport	Weekly from June 13 to October 31, 2018, and May 2 to October 30, 2019	1	Endemic *Anopheles claviger (2), Anopheles hyrcanus (1), Anopheles maculipennis* complex *(9), Anopheles* spp. *(4), Aedes caspius (9), Aedes cinereus/geminus (9), Aedes geniculatus (2), Aedes japonicus (1), Aedes sticticus (81), Aedes vexans (452), Aedes* spp. *(126), Culex hortensis (1), Culex modestus (14), Culex pipiens/torrentium, Culex territans (1), Culex* spp. *(674), Culiseta annulate (15), Culiseta longiareolata (1), Culiseta* spp. *(10), Coquillettidia richiardii (6),* and *Uranotaenia unguiculata (1),* as well as *undefined species (4).* **Total** *(4850)*
D'Ambrosio (1951)	Surveillance Report	Italy	Airports in Chinisia, Castelvetrano, Milo, Trapani, Marsala	June 1947 - November 1950	5	*Anopheles (Maculipennia) labranchiae Fni (718), Anopheles claviger Meig. (333).* **Total** *(1051)*
Furumizo (2005)	Surveillance Report	USA (Hawaii)	Honolulu International Airport	December 8, 2003	1	Novel *Anopheles (Anopheles) punctipennis* (Say) **Total** *(1)*
Guillet (1998)	Surveillance Report	Senegal, Benin, Ivory Coast, and Cameroon	Airports in Senegal, Benin, Ivory Coast, and Cameroon	July to September 1995.	4	*Anopheles arabiensis, Anopheles pharoensis, Culex quinquefasciatus, Anopheles gambiae* s.s., *Anopheles gambiae* s.l., *Anopheles moucheti,* and *Anopheles funestus.* **Total** *(3383)*
Ibanez-Justicia (2017)	Surveillance Report	Netherlands	Schiphol International Airport	Sampling was done from June to October 2016	1	Endemic *Anopheles maculipennis (sensu lato) (17), Culiseta annulate (15), Culex pipiens/torrentium (1316),* and *Aedes aegypti (6).* **Total** *(1354)*
Laird (1956)	Review	Singapore	Paya Lebar International Airport	March to August 1954; February to April 1955; and July 1955	1	*Aedes albopictus, Aedes aegypti,* and *Culex pipiens fatigans.* **Total** *(ND)*
Larish (2005)	Surveillance Report	USA (Hawaii)	Hilo and Waimea airports	November 2003 and June to December 2004	NA	Novel *Aedes (Finlaya) japonicus japonicus* (Theobald). **Total** *(29)*
Macdonald (1956)	Surveillance Report	Malaysia	Kuala Lumpur Airport	ND	1	*Aedes albopictus (6), Aedes lineatopennis (5), Aedes vexans (1), Aedomyia venustipes (4), Culex fatigans (242), Culex gelidus (8), Culex bitaeniorhynchus (1), Culex vishnui* spp. 'a' *(30), Culex vishnui* spp. 'b' *(31), Culex tritaeniorhynchus (12), Culex fuscanus (1), Culex nigropunctatus (4), Mansonia uniformis (31), Mansonia annulifera (2), Anopheles hyrcanus (49), Anopheles karwari (1), Anopheles aconitus (1),* and *Anopheles philippinensis (2).* **Total** *(435)*
Macdonald (1958)	Surveillance Report	Malaysia	Kuala Lumpur International Airport	September 1955 to March 1956	1	*Culex, Mansonia, Anopheles,* and *Aedes albopictus.* **Total** *(1054)*[b]
Ong (2018)	Experimental Trial	Australia	Australian international airports	April	8	Novel *Aedes aegypti.* **Total** *(79)*
Sukehiro (2013)	Surveillance Report	Japan	Narita International Airport	Routine surveillance-January to November 2012 Intensive surveillance-August to October 2012	1	Routine surveillance: *Culex tritaeniorhynchus (92), Culex pipiens* gr., *(39), Aedes vexans nipponii (6), Anopheles sinensis (5),* and *Armigeres subalbatus (2).* **Total** (*144*) Intensive surveillance: Novel *Aedes aegypti (27)*[c] *Culex tritaeniorhynchus (105), Culex .pipiens* gr. *(94), Aedes albopictus (12), Anopheles sinensis (2),* and *Armigeres subalbatus (2).* **Total** (*242*)

Table 2: Preliminary summary of findings of characteristics of included empirical studies of mosquitoes with potential for international conveyance identified at international ports and points of entry. NA = not applicable; ND = No data; NR: not reported.

Table 2 (continued): Preliminary summary of findings of characteristics of included empirical studies of mosquitoes with potential for international conveyance identified at international ports and points of entry.NA = not applicable; ND = No data; NR: not reported.

CONCLUSIONS

This evidence synthesis affirms the need for:

- Comprehensive surveillance to unravel the **causal** relationship between local and introduced populations of vectors at ports, and global emerging infectious diseases
- **Inclusion** of systematic and largescale pathogen detection initiatives within port-related surveillance programs

REFERENCES