

Field action report

Surge of Dengue Virus Infection and Chikungunya Fever in Bali in 2010: The Burden of Mosquito-Borne Infectious Diseases in a Tourist Destination

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Received 10 November, 2011 Accepted 20 April, 2012 Published online 27 April, 2013

Abstract: Labor flow and travelers are important factors contributing to the spread of Dengue virus infection and chikungunya fever. Bali Province of Indonesia, a popular resort and tourist destination, has these factors and suffers from mosquito-borne infectious diseases. Using area study approach, a series of fieldwork was conducted in Bali to obtain up-to-date primary disease data, to learn more about public health measures, and to interview health officers, hotel personnel, and other resource persons. The national data including information on two other provinces were obtained for comparison. The health ministry reported 5,810 and 11,697 cases of dengue hemorrhagic fever in Bali in 2009 and 2010, respectively. Moreover, two densely populated tourist areas and one district have shown a particularly high incidence and sharp increases in 2010. Cases of chikungunya fever reported in Bali more than doubled in 2010 from the previous year. Our findings suggest that Bali can benefit from a significant reduction in vector populations and dissemination of disease preventive knowledge among both local residents and foreign visitors. This will require a concerted and trans-border approach, which may prove difficult in the province.

Key words: mosquito-borne infectious disease, tourism, population movements, vector control, Bali

BACKGROUND

Enhanced mobility of travelers and labor flow associated with international travel are important factors causing the spread of infectious diseases in the age of globalization. Epidemics in turn can cause a downturn in tourism and exert a negative effect on the local economy. The island of Bali in the Republic of Indonesia, a well-known international tourist destination, occupies the majority area of Bali Province and recently experienced an increasing incidence of mosquito-borne infectious diseases, namely Dengue virus (DENV) infection and Chikungunya virus (CHIKV) infection.

Female *Aedes* spp., especially *Aedes aegypti* and *Aedes albopictus*, mediate the spread of these two infections, for which neither a specific treatment nor vaccine is available. DENV infection causes a spectrum of diseases ranging from asymptomatic, mild febrile disease such as classic dengue fever (DF) to severe and fatal dengue hemor-

rhagic fever (DHF) and dengue shock syndrome (DSS). These infectious diseases affect the health of both local people and visitors and generate a heavy economic burden. The average expenditure associated with one case of DENV infection in Malaysia was calculated to be US\$ 445, with about 3–7% of the government's healthcare budget being spent on the disease [1]. The estimated average cost of a non-fatal hospitalized case of DENV infection in Thailand in 2005 was US\$ 573, with the total national cost being US\$ 158 million [2]. The clinical symptoms of CHIKV infection or chikungunya fever (CHIKF) occasionally include severe prolonged arthralgia. These symptoms can cause a great economic and social burden when key family members or a significant portion of a community become unable to earn a living and/or provide support for one another [3].

DHF cases are reported on the basis of hospitalized cases in all of the 33 provinces in Indonesia, including DSS. Since the first report of DHF in Indonesia in 1968, the number of DHF cases increased steadily until 2007 and has re-

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mained high since then (Fig. 1). CHIKF was first reported in 1973 from Samarinda, East Kalimantan Province [4]. CHIKF re-emerged in Indonesia in the late 1990s to 2001 after almost two decades of remission [4, 5]. In 2009 and 2010, 17 provinces reported 83,756 cases and 20 provinces, including Bali Province, reported 53,899 cases, respectively [6, 7].

A number of studies on case management, virological surveillance, and vector mosquitoes pertaining to DHF and CHIKF in Indonesia focused on the republic and/or provinces other than Bali [5, 8–11]. Reported DHF cases in Bali (8% of the entire nation in 2010 and the 5th or 6th highest between 2005 and 2010 [6, 7]) stand out, considering the small land area (0.31%) and population (1.6%) of Bali Province relative to the entire nation. However, little research has been dedicated to DHF and CHIKF in Bali. Papers published in the Indonesian language—the majority is contributed by the Ministry of Health, Republic of Indonesia (MOH)—referred to DHF incidence in Bali in 2006 [12]. The lack of knowledge among Japanese travelers to Bali regarding the facts of DENV infection was demonstrated in a Japanese report [13]. Although the media occasionally sound warnings about the prevalence of DHF in Bali [14], the recent status of the two infections in the tourist destination is insufficiently understood. The status of DHF during the first 8 months of 2010 [15] and a brief summary of DHF and CHIKF incidence in 2010 [16] were recently reported in the Japanese language, including preliminary accounts of a part of the present study. These works reported DHF outbreaks in three areas as well as population movements of travelers and workers, urbanization, climate change, improvements needed to achieve mosquito control, and involvement of residential areas near tourist hotels [15,

16].

Conversely, cases imported from Bali have been studied carefully in countries such as Italy [17]. In Japan, more than 20% (51 of 245) of the total annual cases of DENV infection in 2010 (all imported) were identified as possibly being derived from Bali [18]. Among these were 33 patients of 124 cases confirmed by the national laboratory, and the result showed all four serotypes of DENV were circulated in Bali [19]. Since no DENV infections imported from Bali were reported by the same laboratory in 2009, it is likely that there was an increase in the number of Japanese travelers to Bali in 2010. However, the number was lower than in 2009 every month, resulting in an annual decline of 23% [16] (Fig. 2). This paradox implies that the transmission of DENV infection in Bali increased in 2010 especially in tourist areas. An imported CHIKF case returning from Bali was reported in Japan in January 2011 [20].

The two aims of the present field action report are as follows. First, we present the recent spread of both DENV and CHIKV infections in Bali Province, covering the whole period of 2010. Second, we analyze several factors relevant to the spread, incorporating findings gathered through fieldwork, and discuss how public health measures could be improved to reduce the mosquito-borne infectious diseases.

Lying east of Java, Bali Province is about 5,780 km² in area and situated at 8°39' south of the Equator in a tropical climate zone (average temperature: 24–31°C, relative humidity 71–89% in 2009). The east-west length is approximately 140 km, and the main Island of Bali is composed of a chain of volcanic mountains. The fertile soil supports rice cultivation on broad and terraced slopes. The province has one municipality and eight districts (or regencies) which are divided into 57 sub-districts and further divided into villages. A dual structure exist in Bali villages: 715 official ad-

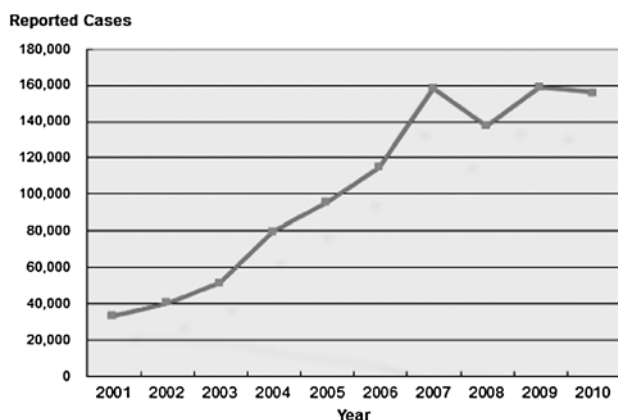


Fig. 1. Number of DHF cases in the Republic of Indonesia between 2001 and 2010.

Source: Constructed from data from the Ministry of Health, Republic of Indonesia [4, 7].

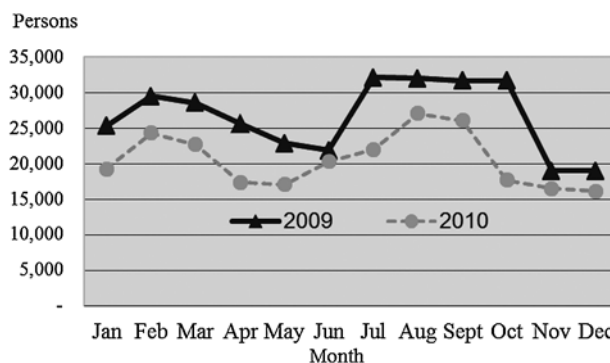


Fig. 2. Monthly Japanese tourists to Bali in 2009 and 2010.

Source: Constructed from data from Bali Government Tourism Office and Municipal Government of Denpasar [22, 29].

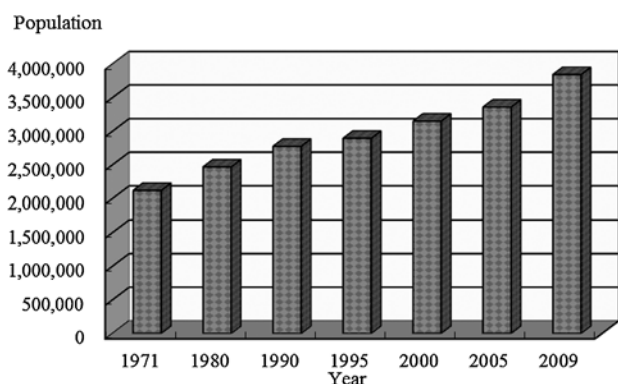


Fig. 3. Population increase in Bali Province since 1971. Source: Constructed from data from Bali Provincial Government (www.bps.go.id/tab_sub/view.php?tabel=1&daftar=1&id_subyek=12¬ab=1, accessed November 27, 2010).

ministrative units [21] partially overlapped by 3,625 informal units as of 2010 [22]. Of the provincial population in 2000, the religious orientation was 87% Hindu, 10% Muslim, and the rest Christian, Buddhist, and others [23] while ethnic composition was 89% Balinese, 7% Javanese, and others [24]. The population has grown rapidly in the new millennium (Fig. 3), the population density (608 per km²) being the 7th highest in the republic as of 2008 [25].

MATERIALS AND METHODS

The majority of data specific to Bali Province was obtained from fieldwork performed by the first author in stages as follows: a one-week feasibility study in May 2009, a one-week pre-survey visit in June 2010 after obtaining approval from the State Ministry of Research and Technology, Indonesia (permit number 106/FRP/SM/VI.2010), and 22-day field activities in September 2010 and February 2011 following ethical clearance from the National Institute of Health Research and Development, the MOH and local approval in Bali.

The number of annual reported cases of the two diseases in the country and provinces was calculated from the annual reports of the MOH [4, 6, 7], the monthly reported DHF cases of DKI Jakarta, East Java, and the national level (unpublished data, MOH) as well as local literature [12, 26, 27] made available by the co-author. The Bali Provincial Health Office provided data on monthly reported DHF cases by district/municipality for the period between 2001 and 2010 and reported CHIKF cases in 2009 and 2010 (unpublished data, Bali Provincial Health Office) in addition to other supplemental materials including provincial statistics [23]. Information concerning epidemiological DHF data



Fig. 4. Map of eight districts and one municipality in Bali Province.

was individually obtained by visiting health offices of the municipality of Denpasar as well as districts of Badung, Buleleng, and Gianyar (unpublished data, Health Offices of Denpasar, Badung, Buleleng, and Gianyar) (Fig. 4).

Face-to-face interviews were conducted in English and the Indonesian language with officers at each health office, physicians at public and private hospitals in Denpasar and Badung, and hotel personnel in Denpasar, Badung, and Gianyar. An information sheet written in English with an Indonesian translation explaining the purpose of the study was presented, and all health officers and physicians signed consent forms. The hotel personnel agreed to participate in the survey on the condition that the accommodation facilities remained unnamed. None of the interviewees granted the authors permission to disclose individual names.

Direct observational research techniques were adopted for the investigation at four accommodation facilities in Denpasar and Badung and at three villages (residential areas) in Denpasar, Badung, and Buleleng. Locally distributed literature analyzing Bali's tourism was obtained from the Bali Government Tourism Office [22, 28].

FINDINGS AND DISCUSSION

Reported cases

In 2010, Bali Province reported 12,490 cases of DHF including 35 fatalities (unpublished data, Bali Provincial Health Office), and the monthly number in April, June, and July was higher than in previous records (Fig. 5). Although figures published by the MOH are slightly lower, i.e. 11,697 cases and 34 fatalities [7], the number of reported DHF cases obviously surged in 2010 in Bali Province (Fig. 6). Three areas of Bali Province accounted for the majority of DENV infection cases between 2006 and 2010, and the increases in Badung and Buleleng were conspicuous in 2010

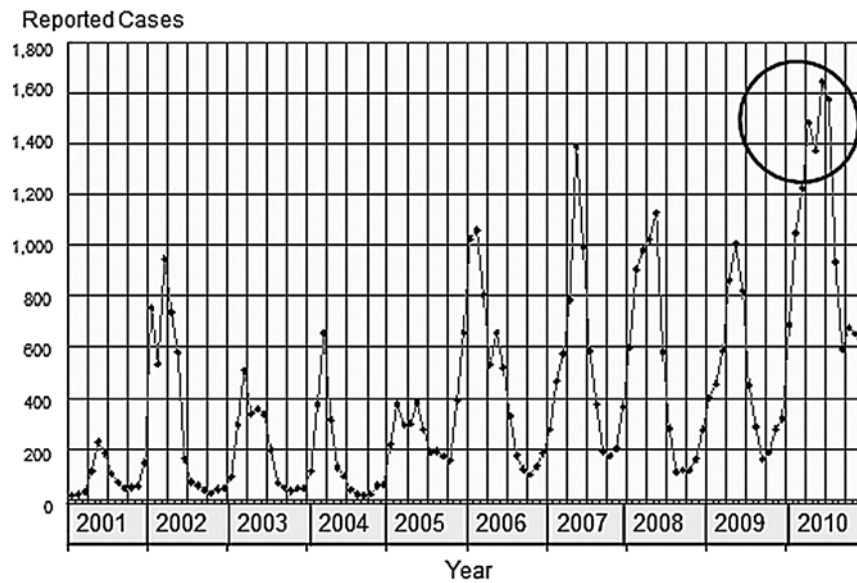


Fig. 5. Monthly reported DHF cases in Bali Province, 2001–2010.

Source: Constructed from unpublished data obtained from Bali Provincial Health Office.

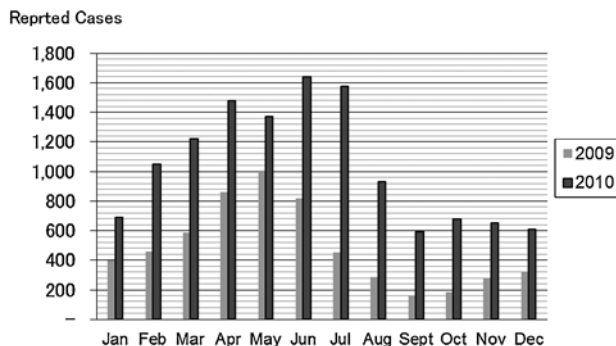


Fig. 6. Monthly reported DHF cases in Bali Province in 2009 and 2010.

Source: Constructed from unpublished data obtained from Bali Provincial Health Office.

(Fig. 7). There are popular tourist spots such as Kuta and Nusa Dua in Badung and Sanur in Denpasar, and Buleleng is undergoing development projects as one of the next tourist spots. While the national reported DHF cases peaked in January, the disease pattern for Bali Province showed peaks in Buleleng, Badung, and Denpasar in March, April, and July, respectively (unpublished data, MOH and Bali Provincial Health Office, Fig. 8).

With regard to the reported cases of CHIKF, limited information was available from the Provincial Health Office, which reported zero in 2008, 193 in 2009, and 1,018 in 2010 when all areas except Badung and Bangli were involved (unpublished data, Bali Provincial Health Office) as shown

in Table 1. The reported cases published by the MOH differ; 103 for 2009 and 246 for 2010 [6, 7].

Movements of people

There appear to be area-specific factors contributing to the spread of DHF and CHIKF, including dense population in tourist areas, daily movement of travelers and workers in and out of the tourist areas, labor flow into the tourist areas, and repeated long-distance travel of the Balinese between current residences and their original communities in other districts within the province.

In 2009, a total of 2,229,945 foreign and 3,521,135 domestic visitors (equivalent to the provincial population in 2008) traveled to Bali [22]. There were 2,473,648 international and 2,300,132 domestic flight passengers recorded at Ngurah Rai Airport in Denpasar. Ketapang Gilimanuk Harbour received 3,161,183 people [22]. Subtracting foreign and domestic visitors from total passengers recorded at the two ports leaves 2,183,883 unaccounted, possibly local and foreign residents, inter-island migrants, and others. Australian nationals (647,872) visited Bali the most frequently in 2010, followed by Japanese (246,465) [29]. Although there were visitors from countries where DENV and CHIKV infections are endemic, estimating the impact of foreign travelers is difficult due to the lack of statistics regarding imported cases in Bali Province.

Personal interviews conducted in June and September 2010 with ten Balinese workers originally from Buleleng and other districts revealed that they travel frequently with family members between their original communities and

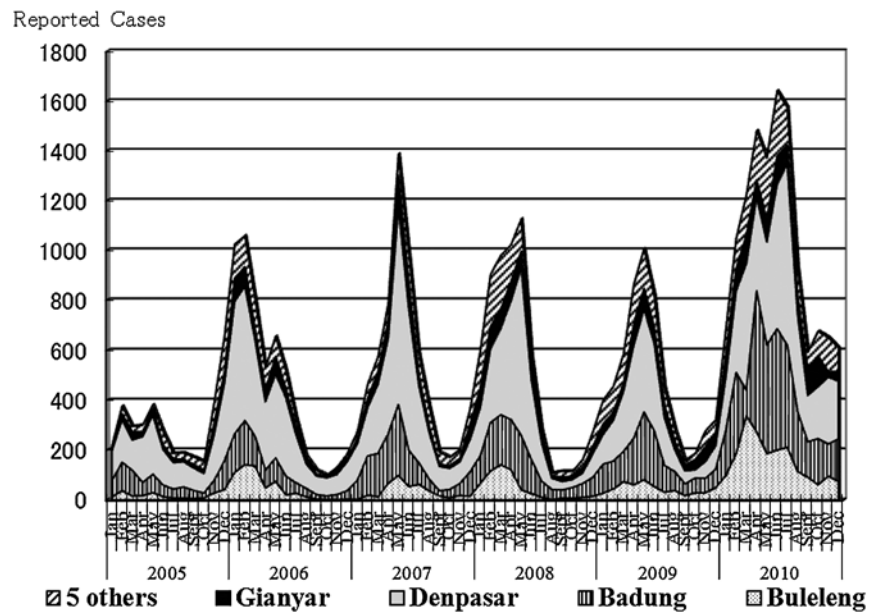


Fig. 7. Reported cases of DHF in Bali by area for the period from 2005 to 2010.
 Source: Constructed from unpublished data obtained from Bali Provincial Health Office.

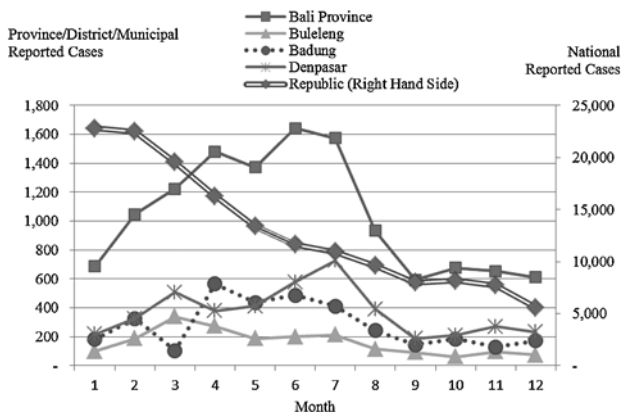


Fig. 8. Comparative DHF disease patterns among the Republic of Indonesia, Bali Province, Buleleng District, Badung District, and Municipality of Denpasar in 2010.
 Source: Constructed from unpublished data obtained from the MOH and Bali Provincial Health Office.

the current residences by motor bicycles and that the main reason for this frequent travel is to fulfill community ritual service obligations [15, 16]. Although the sample size interviewed is small, daily conversations with the local people during the fieldwork confirmed that this movement of Balinese is common.

Additionally, a significant number of job seekers move into tourist-concentrated areas from other parts of the province (intra-island migrants) and from other provinces (inter-island migrants). They apparently remain unrecorded in the

Table 1. Details of reported CHIKF cases in Bali Province in 2010.

| Areas | Reported cases | Dates when outbreak was inspected |
|------------|----------------|--|
| Jembrana | 104 | February 2 |
| Tabanan | 198 | February 22, July 14 |
| Buleleng | 193 | March 9 & 18, June 14, July 8 |
| Klungkung | 255 | June 11 & 17, July 5, 10 & 23 |
| Karangasem | 218 | June 23 & 28, July 29, October 10 & 27 |
| Gianyar | 24 | December 14 |
| Denpasar | 26 | October 12, December 24 |

Source: Modified from unpublished data, Bali Provincial Health Office.

official statistics. It is not rare to find workers from the Special Province of Jakarta (DKI Jakarta) and East Java Province in hotels, restaurants and other establishments in Denpasar, the provincial capital, and Badung District. The Bali Provincial Health Office found that as many as 300,000 inter-island migrants a year arrive in Bali and that about 200,000 people move in and out of Denpasar every day (unpublished data, Bali Provincial Health Office). This movement of people infers that population density in tourism-concentrated areas is much higher than the official records. Hence, the present research focuses on the number of reported cases in Bali instead of incident rates that use population numbers as a denominator.

When the mosquito-borne infectious diseases became

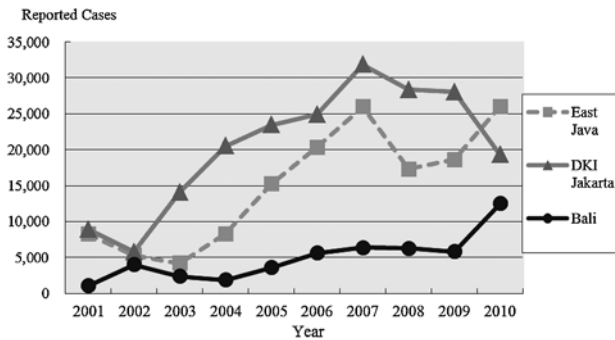


Fig. 9. Yearly reported DHF cases in Bali Province, East Java Province, and DKI Jakarta between 2001 and 2010. Source: Constructed from data from the MOH [4, 7] and unpublished data obtained from Bali Provincial Health Office.

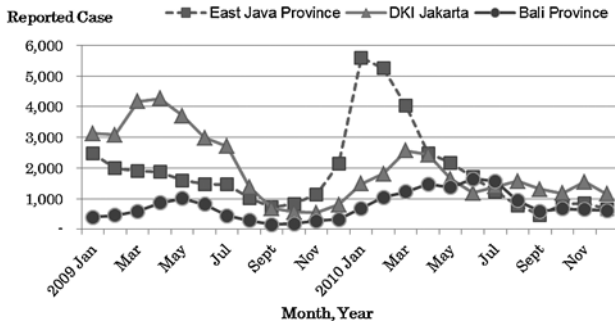


Fig. 10. Monthly reported DHF cases among DKI Jakarta, East Java Province, and Bali Province in 2009 and 2010. Source: Constructed from unpublished data obtained from the MOH and Bali Provincial Health Office.

topics of conversation, many local residents assumed that domestic tourists and inter-island migrants from DKI Jakarta and East Java Province had brought the diseases into Bali Province. However, information on the number, timing and places of population movements, as well as virus information that allow phylogenetic analysis, is unavailable. Therefore, it is difficult to evaluate the association between DHF/CHIKF cases in Bali and those in DKI Jakarta and East Java. Nevertheless, when comparing yearly reported DHF cases in three areas between 2001 and 2010, we found a similar trend between East Java and Bali in 2009 and 2010 (Fig. 9). The monthly reported cases in these years revealed similarities between East Java and Bali from August–November 2009 to August–December 2010 (Fig. 10).

Climate patterns

The data on climate factors (unpublished data, Bali Provincial Health Office) includes only two parameters available at the provincial level, because details by districts/

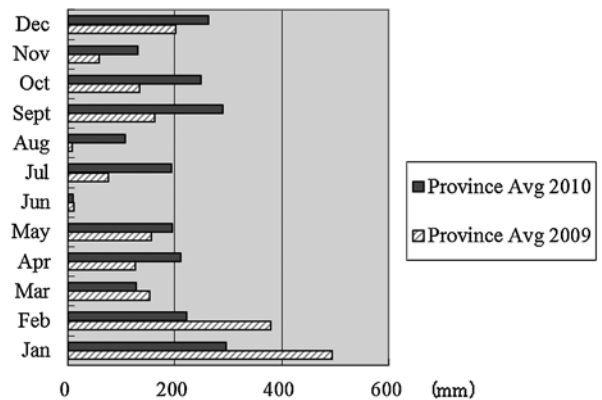


Fig. 11. Monthly rainfall (mm) in Bali Province in 2009 and 2010. Source: Constructed from unpublished data obtained from Bali Provincial Health Office.

municipality and official temperature information for 2010 were not ready. The number of rainy days per month in Bali Province in 2010 revealed unique characteristics: there were 6.9–9.0 rainy days in the usually dry months of June–August (only 1.3–4.4 rainy days for the same period in 2009). Similarly, the monthly rainfall in the province in each month in 2010 exceeded that in 2009 between April and December (Fig. 11). The rain may have influenced the increases in DHF and CHIKF cases, but we need much more detailed monthly (preferably weekly) data from Denpasar and other districts including temperature to evaluate the relationship further.

The impact of decentralization on health authority

The decentralization of the health sector that took place in 2001 is an essential aspect of current public health measures in Bali. The responsibility to implement public services was transferred to local governments, which now have full autonomy in mobilizing local resources and making budget decisions [30]. Hence, the health sector in Indonesia is managed by provinces, districts and/or municipalities following the general policy of the MOH in the central government [31, 32]. MOH has overall responsibility for national health policy and administers teaching-level and specialized hospitals, but there is no longer any hierarchical linkage among health authorities. The provincial health offices report directly to governors and play a role in policy making, coordination of all health programs and training, and overseeing provincial hospitals (Fig. 12). As the heads of provinces, governors are required to guide, monitor and supervise district/municipal health offices, which directly report to heads of districts and mayors of municipalities (Fig. 12). The district/municipal health of-

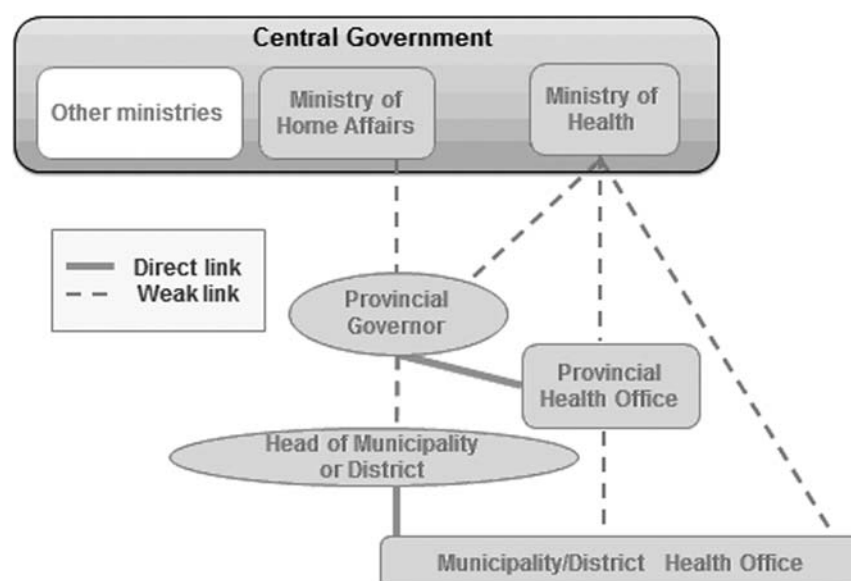


Fig. 12. Linkages in health services after the decentralization in Indonesia.

fices receive funding for health development from various sources such as central, provincial, municipal and district level budgets in addition to income generated by fees for services [33].

For DHF and CHIKF, the Vector Borne Diseases Control Directorate of the MOH formulates and executes technical policy as well as standard procedures, and provides technical assistance to local governments in districts/municipalities [26]. To raise awareness regarding DHF, the MOH implemented a national control program calling for “PSN” (eradication of mosquito breeding) and “3M” representing three action verbs in the Indonesian language (meaning drain/clean, seal/cover, and bury [items which can collect rain water]). The larvae-free rate is monitored as an indicator of community participation [26].

The reporting and feedback system related to DHF in the decentralized health sector is presented in Fig. 13. Except for health centers, the healthcare setting that finds either suspicious cases or patients immediately sends a KD/RS-DBD form to the district/municipality health office within 24 hours with a copy to the health center covering the area (Step 1 in Fig 13). The form includes information on name, age, sex, home address, date of onset/diagnosis (classified as suspicious cases, DF, DHF and DSS), start/end date of treatment, and blood test data with comments. Each health center sends five forms including the KD/RS-DBD form to the district/municipal health offices. A DP-DBD form lists details of individual patients for the month; a K-DBD form reports monthly DF/DHF/DSS cases and progress of vector control; a W2-DBD form shows DF,

DHF, DSS cases broken down by sex and by week in a month; and a W1 form records extraordinary incidents such as outbreaks of major infectious diseases including DHF. Nationally, a DHF outbreak is defined as an increase in the number of DHF/DSS patients in a village (or larger area) within one week/month that is greater than two times compared to earlier weeks/months or to the same month the previous year [27]. Then, the district/municipal health office uses all four forms (DP-DBD, K-DBD, W2-DBD, and W1) to report to the provincial health office, which in turn uses the same four forms to report to the central government, i.e. the MOH [27].

With the assistance of the provincial health authority, the first author conducted interviews at health offices in Denpasar, Badung, Buleleng, and Gianyar that has another famous tourist spot called Ubud. Although each health office analyzed data differently, all maintained similar organizational structures, reporting procedures, vector control measures and outbreak investigation methods despite the decentralization. They also seemed to adhere stringently to the guidelines and strategies set by the MOH. The vector control measures include general cleaning, fogging, “abate” application (larvicide with temephos as an active ingredient) and PSN. Also, 3M and sometimes “3M Plus” are promoted, adding extra actions. Differences were noted in details regarding vector surveillance, definition of an outbreak, and outbreak investigation (Table 2). Denpasar and Gianyar, in particular, are assisted by an NGO called *Jumantik* (skilled larva monitoring workers), which conducts larvae surveillance in residential areas.

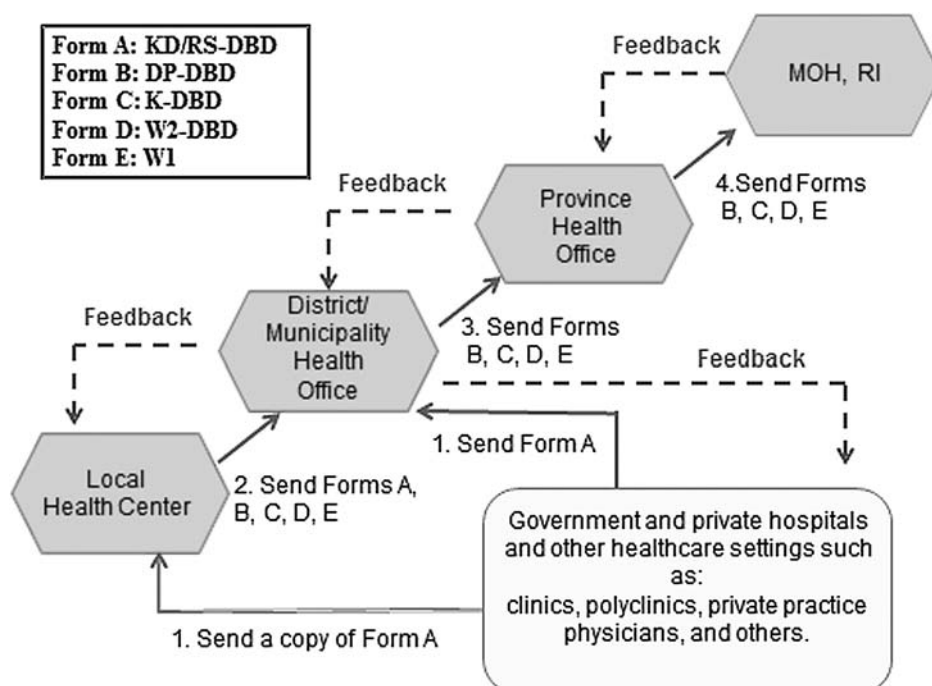


Fig. 13. Reporting procedures and feedback system of DENV infection in Indonesia.

Source: Modified from the MOH [27].

Table 2. Area, population, and DHF public health measures of health offices in a municipality and three districts in Bali Province.

| | Denpasar | Badung | Buleleng | Gianyar |
|--|---|--|--|---|
| Area (km ²) | 124 | 419 | 1,366 | 368 |
| Population* | 788,445 | 543,681 | 624,079 | 470,380 |
| Manpower allocated to the disease (persons) | 4 | 6 | 12 | 1 |
| Details of regular vector control and surveillance | Do PSN and Jumantik monitors larvae and applies abate | Cleaning, fogging plus doing PSN | Monitor larvae, apply abate, provide counseling, and conduct ultra-low volume fogging at the start and end of rainy season (April/October) | Implement PSN and surveillance by Jumantik |
| Definition of an outbreak | Cases increase > x2 | > 10 cases | n/a | Cases increase > x3 |
| An outbreak investigation by: | 3 to 4 persons | 2 persons | 2 to 3 persons | n/a |
| Details of an outbreak investigation | To interview patients to find their activities, and monitor the neighborhood within a radius of 100 m | To visit patients' houses; check if the patients are febrile and larvae can be found around the premises | To track cases, provide counseling and apply abate selectively. If > 3 febrile persons with no clear reason and larvae within a radius of 100 m are found, do PSN with fogging | To inquire, conduct epidemiology surveillance, detect larvae, and implement PSN |
| Advices given to the residents near an outbreak investigation site | To do 3M once a week and keep environment hygienic | To do 3M by explaining importance of environmental health | To do PSN every week on Friday; apply abate in stagnant water; and put fish in the pond | n/a |

*As of year 2010 according to Bali Provincial Health Office

Although information on viruses and vector mosquitoes responsible for the transmission of CHIKV was unavailable in Bali, CHIKV with A226V mutation in the genome might be in circulation. The increasing number of CHIKF cases in Bali indicates that preventive measures may have to include aggressive control of *Ae. albopictus* mosquitoes in addition to *Ae. aegypti* mosquitoes.

Larvae surveillance in residential areas

The municipality of Denpasar promotes public health education and community outreach programs by hosting competitions and involving school children. Furthermore, the municipal budget is used to purchase a motor bicycle for each *Jumantik* NGO worker in Health Centre A in South Denpasar. The NGO plays a role in managing larvae surveillance in residential areas. Two teams of seven technicians separately visit target villages in the territory covered by the health center, record houses with larvae, and instruct the residents to eliminate larvae breeding habitats. Some villages have their own guidelines for reducing plastic waste and even collecting funds from the residents to eliminate mosquito breeding, and some (4.88 percent as reported in Bali Province in 2010 representing the poor [23]) are assisted by the NGO. The first author accompanied one team and observed the activities in Village A. According to the workers, frequent monitoring is necessary to ensure compliance among residents in so-called urban slum areas. We actually found a number of existing and potential mosquito breeding habitats (Photo 1–3). The workers collected larvae and took them to the Denpasar Health Office for investigation. An officer at the health office confirmed that the majority were *Ae. aegypti* larvae (personal interview on Sept 27, 2010).

Other findings

In and around houses in Bali, there are additional sites that were not inspected by the NGO but may be ideal for female mosquitoes to lay eggs. Ceramic and glass jars are used to store holy water for prayers by the Balinese Hindu, and, left open in and near premises, these could serve as breeding habitats for mosquito larvae. However, the investigation of holy water is a cultural and religious taboo. Therefore, interviews with local residents and observational research were carried out in Badung and Buleleng in an effort to gain insights into the vector population in residential areas. The results, including preventative actions of the local people, descriptions of personal experiences with DHF, analysis of epidemiological DHF data in the two districts and results of interviews with physicians in tourist areas, will be reported in a separate paper.



Photo 1. Detection of larvae in a stone container by a *Jumantik* worker.



Photo 2. Detection of larvae in reserved water.



Photo 3. Detection of larvae in a receptacle of a water dispenser in a kitchen.

SUGGESTIONS FOR IMPROVEMENT

The public sector

Decentralization has been implemented in Indonesia to empower local governments and communities and improve efficiency and effectiveness in addressing a variety of issues such as poverty, environment and education. However, the division of responsibilities among health authorities may actually create difficulties in administering time-sensitive and often large-scale operations to control outbreaks. In other words, decentralization may adversely affect the public health response to infectious diseases.

To control emerging and re-emerging infectious diseases spreading across borders, whether international or local, we must apply knowledge and countermeasures that also go beyond political and social borders. Forming inter- and intra- linkages is essential among government agencies, sectors, laboratories, field officers, policy makers and communities [34]. These linkages not only ensure the sharing of knowledge and coordination of efforts but also generate economies of scope in expenses required for research and implementation of public health measures.

One way to complement the fragmented health authority would be to explore ideas in using a real-time database accessible at all levels of health offices. Sharing relevant information including the number of reported cases and results of vector surveillance across borders on a timely basis may augment planning measures and resource deployment. Reducing manual paperwork, as shown in Fig. 13, by the introduction of a database could both motivate officers and prevent communication delays. Currently, health officers in Bali occasionally use telephones and short messaging systems to expedite notification prior to sending time-consuming paper forms. Additionally, officers search for timely information by visiting hospitals and health centers. For example, the Bali Provincial Health Office conducts case surveillance at Sanglah General Hospital in Denpasar (the central hospital of the province) and a military hospital.

Systematic disclosure of information to both public and private healthcare settings in addition to the current feedback system may also prove to be a useful tool. Physicians in Bali could benefit from more frequent and timely disease information across the island by knowing when and where to be more vigilant.

Individuals and the private sector

Educating two other segments of people in addition to the residents of Bali may contribute to improvements in the disease situation. First, there are foreign residents of Bali who may not benefit from the information intended to raise awareness in the community. Messages regarding DHF are

aired, over television, radio and other media, and health centers provide 3M brochures. However, these messages only reach people with a good command of the Indonesian language. Aside from brochures in English and Japanese (typically found at private clinics and hospitals), no visible/audible anti-DHF/CHIKF warnings are recognizable for foreigners in Bali. Revealingly, a MOH officer discovered a mosquito breeding site in the house of a foreigner who used water as an interior decoration.

Second, it is a reality that susceptible and unsuspecting foreign visitors come to Bali with insufficient knowledge of local disease patterns, current outbreaks, high-risk areas, and personal protective measures to prevent mosquito bites. A study published in 2007 remarked that none of the CHIKV patients who returned to Europe from areas including Southeast Asia was given “any information about the disease from their travel agencies or from local authorities during their stay” [35]. Although much greater efforts to educate travelers in home countries is required, engaging tourists in health risk communication is essential to ensure repeat visits to Bali, where tourism is extraordinarily important for the local economy.

Some tourist brochures and magazines distributed locally in Bali caution against diarrhea but not against mosquito bites. This situation does not help tourists in Bali to understand the risk of mosquito-borne infectious diseases. Even though hotels may provide repellent and/or insecticides, the decision to use them depends on personal preference and knowledge of health risks among guests [15]. A possible practical step, then, may be to develop an appropriate communication method to proactively provide information pertaining to public health risks including mosquito-borne infectious diseases. Since tourists tend to spend large portions of their time in accommodation facilities, a pilot study may be useful to determine the role that the hotel industry can play in disseminating information that leads to visitor behavioral change in terms of personal protection against mosquito bites and watchfulness not to create mosquito breeding sites.

As the authors pointed out, some accommodation facilities in tourist areas required a review of mosquito control procedures to improve effectiveness in reducing the vector population [15]. Additional interviews at two other hotels in February 2010 revealed encouraging developments. While insecticide fogging operations are carried out at 4-star and 5-star hotels typically once or twice weekly, some guests occasionally denounce fogging as a nuisance. One solution is shown by a hotel in Denpasar that places letters in guestrooms to provide information about regular fogging operations on the hotel grounds. The letter not only promotes understanding but also raises awareness about the mosquito

problem inherent to the environment of tropical resorts. The general manager of another hotel in Badung advises guests proactively to use mosquito repellent lotion. If other hotels followed these examples, fewer travelers might inadvertently create mosquito breeding habitats by actions such as improper disposal of open containers in the resort island of Bali or unwittingly export mosquito-borne infectious diseases abroad.

CONCLUDING REMARKS

This field action report revealed possible factors contributing to the transmission of DENV and CHIKV infections in Bali. Construction works related to tourism development tends to supply attractive places for mosquito breeding and may account for the surging number of reported DHF cases in the Buleleng District. The influx of people, including inter-island migration and both domestic and foreign visitors, might explain why areas popular with tourists such as Denpasar and the Badung District report a high number of DHF cases. Frequent intra-island movement of the Balinese people may offer a partial explanation as to why DHF peaked in Buleleng and was followed several weeks later by peaks in Denpasar and Badung in 2010. Moreover, the number of rainy days and total rainfall may be related to the increase in both mosquito-borne viral infectious diseases in 2010 in Bali. The decentralization which has affected the health authority may also complicate the recent struggle with infectious diseases. Educating visitors to the island who might otherwise remain ignorant or indifferent to anti-mosquito measures could contribute to the efforts being made by the health authority and the local people to halt the emergence of mosquito-borne infectious diseases.

Our evaluations were affected by the size of the samples, which were small due to the time available for interviews during fieldwork, as well as the lack of data on inter- and intra-island population movements, number of imported cases (with possible areas of infection), vector density, virus information, and the limited availability of meteorological data. Given these constraints, it was not possible to draw clear causality between each potential factor and the spread of DENV and CHIKV infections in Bali Province. Nevertheless, our findings from field activities enhance understanding of the recent situation regarding mosquito-borne infectious diseases in the tourist destination, especially in the year 2010. Our findings also shed light on factors such as the difficulty in coordinating public education and vector control, which might hinder disease prevention in the tropical resort of Bali, Indonesia. Further research is necessary to reduce the incidence of DHF and CHIKV for

the benefit of both local residents and tourists in Bali, including vector studies, virological investigation, affordable laboratory diagnosis, public education, and methods of communication with foreign residents and visitors.

ACKNOWLEDGEMENTS

This research was supported by International Program of Collaborative Research FY2012 IV-7 from Center for Southeast Asian Studies Kyoto University and a Grant-in Aid for Scientific Research (KAKENHI 19101010) from the Japan Society for the Promotion of Science. While it is impossible to name all the contributors in Bali, we thank Dr. Ida Sri Iswari of Sanglah General Hospital, Denpasar for obtaining local research permission and facilitating some of the field activities as well as Dr. I Ketut Subrata of the Bali Provincial Health Office and his staff for invaluable assistance during the fieldwork in Bali.

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