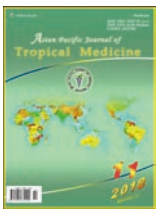

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Knowledge, attitudes and practice survey on Zika virus infection among pregnant women in Brunei Darussalam

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ABSTRACT

Objective: To assess the knowledge, attitudes, and practices (KAP) on Zika virus infection among pregnant women in Brunei Darussalam by a cross-sectional survey. **Methods:** Between February and June 2017, we recruited 234 pregnant women from all government healthcare centres at Brunei-Muara district, using a modified systematic sampling approach. A pre-tested and self-administered questionnaire was used and data analysis was conducted using descriptive statistics and multiple logistic regression analyses. **Results:** The study participants were mainly Malay (87.2%) and their mean age was 28.0 years. The median knowledge score was 13, out of a possible score of 28. Most participants (92.7%) knew that Zika virus was transmitted by mosquito bites whereas some (34.6%) knew that sexual transmission was also possible. Media (radio, television or newspapers) was the preferred source of updated information on Zika virus, followed by healthcare workers (44.0%), government announcements (43.2%), and social media (38.0%). Pregnant women who were 25 years old or older [Adj. *OR*=3.62 (95% *CI:* 1.57, 9.51)], not Malays [Adj. *OR*=3.32 (95% *CI:* 1.35, 8.55)], and had an average monthly household income of more than BND $3 000 [Adj. *OR*=4.06 (95% *CI:* 1.81, 19.44)] were more likely to score higher for knowledge on Zika virus. The median prevention practice score was 23, out of a possible score of 36. Most participants reported wearing covering clothes (98.3%) and kept their living surroundings clean (99.6%). Most participants (88.0%) agreed that Zika is an important issue in their community. **Conclusion:** We found a lack of knowledge on Zika virus infection among pregnant women attending government maternal and child healthcare centres in Brunei Darussalam, in particular that Zika virus can be sexually transmitted. Such information could be well disseminated at the healthcare centre level. Health literacy studies should be conducted to understand the facilitators and barriers of KAP on Zika virus infection among pregnant women.

1. Introduction

Zika virus is a Flavivirus that is transmitted mainly by *Aedes aegypti* and *Aedes albopictus* mosquitoes. While infection tends to be either mild or asymptomatic, those who are symptomatic may exhibit symptoms such as mild fever, skin rash, conjunctivitis, muscle and joint pain, malaise or headache. Despite being a mosquito-borne disease, Zika virus is also transmissible by various non-vector routes, including perinatal transmission[1], sexual transmission[2] and blood transfusion[3]. In 2015, Zika positive cases have drastically surged in northeast Brazil and consequently a global epidemic was declared. There has been a rapid geographical

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expansion of the virus epidemic from 33 countries in early February 2016[4] to 84 countries as of March 2018[5].

It is already established that Zika virus causes microcephaly and other serious brain abnormalities in new-borns[6]. Zika-associated birth defects were identified in 6% of infants among pregnant women with completed pregnancies and laboratory evidence of Zika infection[7]. As of March 2017, the World Health Organization (WHO) has recorded 2 656 congenital syndromes associated with Zika virus infections in 31 countries, out of which 2 653 (99.9%) were in Brazil[8,9]. Hence, women who are either currently pregnant or are planning to get pregnant must be aware about Zika virus and its potential consequences.

Brunei Darussalam is a Southeast Asian country with a crude birth rate of 15.2 births per 1 000 population[10]. It has remained free of the virus as of March 2018[5], even though both *Aedes aegypti* and *Aedes albopictus* has been established in the country[11,12]. Many of its neighbouring countries have reported increasing Zika positive cases[13], for instance a large outbreak in Singapore in 2016[14] and a Zika-associated case of microcephaly reported in Vietnam[15].

The Ministry of Health in Brunei Darussalam have initiated education campaigns since August 2016 to increase public awareness on Zika, through media advertisements, press releases, travel advisories, website coverage, and school cleaning campaigns[16-18]. We conducted this study to assess the levels of knowledge, attitudes and practices (KAP) of Zika virus among pregnant women in Brunei Darussalam and to determine the factors associated with knowledge on Zika virus.

2. Material and methods

2.1. Design and subjects

A cross-sectional paper-based survey was conducted between February to June 2017, at all 8 maternal and child healthcare centres in Brunei-Muara district (where 69.3% of the country's population resides). The inclusion criteria were: (1) women aged 18 years and above who are pregnant at the time of data collection; (2) long- and short-term Brunei residents; and (3) able to read or write in English or Malay (the official and local language in Brunei Darussalam) languages.

A modification of stratified systematic sampling approach was used whereby (1) a target number of participants was set for each healthcare centre, based on the population size of its catchment area, and then (2) on every researcher's visit to each healthcare centre, every second patient registered for consultation was invited to participate in the study until the targeted number was reached. Trained interviewers explained the study to the potential participants, obtained inform consent, and addressed any queries relating to the questionnaire or study.

Ethical approval was obtained from the Research Ethics Committee of Pengiran Anak Rashidah Saa'datul Bolkiah Institute of Health Sciences (PAPRSB IHSREC), Universiti Brunei Darussalam (Reference no: UBD/IHS/B3/8), following guidelines from the Declaration of Helsinki.

2.2. The data collection instrument

The main data collection tool of the study was a pre-tested self-administered questionnaire, adapted from the WHO Zika KAP survey resource pack[19]. It was initially prepared in English and then translated into Malay language. A pre-test was conducted on 12 individuals and some contextual changes were made on the final version of the questionnaire. It consists of 5 main sections: socio-demographic characteristics, knowledge, attitudes, self-reported prevention practices against mosquito breeding and bites, and sources of information for Zika virus.

The knowledge section consisted of 28 items on the groups of people who can get Zika, mode of transmission, signs and symptoms, whether if it is possible to prevent or treat Zika, if everyone infected exhibits symptoms, population groups at risk of Zika-related complications, and the effect of Zika on unborn foetus. For each question, participants can answer either yes, no, or don't know. During analysis, the correct responses were scored as 1 while incorrect or don't know responses were scored as 0. These scores were totalled up to a maximum of 28 points, where higher scores indicate higher knowledge level. For statistical analysis, these total scores were divided into 2 groups: 0-14 and 15-28 points, using the midpoint as the cut-off point[20]

The attitude section consisted of 8 items on self-perceived risk as well as their reasons and opinions of whether Zika is an important issue, who should be responsible to prevent Zika transmission, whether women should delay pregnancy plans due to Zika, whether pregnant women should postpone unnecessary travel to Zika-affected countries, and whether they would encourage their husbands to practice safe sex or abstinence if he has recently travelled to Zika-affected countries. Attitude questions were measured using a 5-point Likert scale, which ranges from strongly agree to strongly disagree.

The prevention practice section consisted of questions on prevention practices against mosquito bites (4 items) and against mosquito breeding (5 items). Participants were asked to report the frequency of these prevention practices based on 6 options: "Not at all", "Rarely", "Sometimes", "Often", "Always", and "Not available". During analysis, these responses were respectively scored as 0, 1, 2, 3, 4, and 0. These scores were totalled together to give a maximum score of 36 points, with higher scores indicating higher mosquito preventive practice. For statistical analysis, these total scores were divided into 2 groups: 0-18 and 19-36 points, using the

midpoint as the cut-off point[20]. There was 1 questionnaire with incomplete responses in one or more questions, thus it was excluded from the point totalling process and subsequent regression analysis.

Lastly, the information section of the questionnaire included questions on where/from whom they first hear about Zika, and also from where/whom they would like to have updates on Zika. The Cronbach's alpha (a measure of internal consistency and reliability) for knowledge, attitudes and prevention practice sections were 0.87, 0.70, and 0.76, respectively.

2.3. Statistical analysis

Descriptive analyses were carried out and tests (*Chi*-square, Fisher's Exact, independent *t* and Mann-Whitney) were used to determine any group differences for knowledge and prevention practice. Multiple logistic regression analyses were conducted to determine any association between knowledge score groups and socio-demographic factors. Independent variables were first analysed using simple logistic regression, and those with *P*-value < 0.1 were then included into the multiple logistic regression model. All analyses were done using R (ver.3.4.1) statistical software[21]. A *P*-value of < 0.05 was considered statistically significant.

3. Results

3.1. Socio-demographic characteristics

A total of 234 completed surveys were collected and Table 1 summarized their demographic characteristics. Their median age was 28.0 years (range=19-42 years, IQR=7) and most are of Malay ethnicity (87.2%, *n*=204). More than half of the participants (59.8%, *n*=140) have attained at least a tertiary school education. The majority lived in land settlements (94.0%, *n*=220) and a large proportion (43.2%, *n*=101) lived in households with 5 to 8 members. In addition, 32.1% (*n*=75) reported a monthly household income of less than BND $1 000, while 43.2% (*n*=101) reported between BND $1 000 and BND $3 000.

3.2. Knowledge

The median knowledge score was 13, out of a possible score of 28 (Table 2). Categorising the sum of knowledge scores into 2 groups (0-14 and 15-28 points) showed that 64.5% of the participants (*n*=151) scored between 0-14 points, while 35.5% (*n*=83) scored between 15-28 points. A large majority of participants were able to answer correctly that Zika is transmitted by mosquito bites (92.7%, *n*=217), fever is a symptom of Zika (88.5%, *n*=207), Zika is preventable (79.9%, *n*=187), pregnant women are at high risk of getting health complications from Zika (90.2%, *n*=211), and Zika affects everyone (75.2%, *n*=176). Also, 64.1% (*n*=150) of the participants answered correctly that pregnant women with Zika are at risk of giving birth to a baby with microcephaly. Only 34.6% (*n*=81) and 15.0% (*n*=35) answered correctly that Zika can be transmitted sexually and that there were no specific treatment for Zika, respectively.

Table 1
Socio-demographic characteristics and differences on knowledge and prevention practices on Zika virus infection among pregnant women in Brunei Darussalam.

Demographic characteristics		*n* (%)	Knowledge score (*n*=234)			Practice score (*n*=233)		
			0–14 [*n* (%)]	15–28 [*n* (%)]	*P*-value	0–18 [*n* (%)]	19–36 [*n* (%)]	*P*-value
Age group (years)	< 25	53(22.6)	46(86.8)	7(13.2)	0.002	17(32.1)	36(67.9)	0.073
	25 – 28	58(24.8)	33(56.9)	25(43.1)		9(15.8)	48(84.2)	
	28 – 32	60(25.6)	36(60.0)	24(40.0)		17(28.3)	43(71.7)	
	⩾32	63(26.9)	36(57.1)	27(42.9)		10(15.9)	53(84.1)	
Racial status*	Malay	204(87.2)	136(66.7)	68(33.3)	0.017	45(22.2)	158(77.8)	0.687
	Others	25(10.7)	10(40.0)	15(60.0)		7(28.0)	18(72.0)	
Highest education attained	Secondary school & below	94(40.2)	71(75.5)	23(24.5)	0.006	21(22.6)	72(77.4)	1.000
	Tertiary school & above	140(59.8)	80(57.1)	60(42.9)		32(22.9)	108(77.1)	
Town^	Water village	14(6.0)	9(64.3)	5(35.7)	1.000	2(14.3)	12(85.7)	0.653
	Land village	220(94.0)	142(64.5)	78(35.5		51(23.3)	168(76.7)	
No. of household members▽	1-4 people	39(16.7)	24(61.5)	15(38.5)	0.447	7(18.4)	31(81.6)	0.597
	5-8 people	101(43.2)	62(61.4)	39(38.6)		22(21.8)	79(78.2)	
	>8 people	92(39.3)	64(69.6)	28(30.4)		24(26.1)	68(73.9)	
Monthly average household income◆	< B$1 000	75(32.1)	58(77.3)	17(22.7)	< 0.001	18(24.0)	57(76.0)	0.371
	B$1 000 – B$3 000	101(43.2)	67(66.3)	34(33.7)		18(18.0)	82(82.0)	
	> B$3 000	55(23.5)	23(41.8)	32(58.2)		15(27.3)	40(72.7)	

*5 were missing, ▽2 were missing, ◆3 were missing; ^ Water settlement is defined as towns that are situated as least partly near a large area of water.

Table 2

Knowledge on Zika virus infection among pregnant women in Brunei Darussalam.

Knowledge questions on Zika virus	Correct response	No. of correct responses (%)
^Median knowledge score (Min-max)		13 (0–27)
0-14 points		151(64.5)
15-28 points		83(35.5)
The following groups can get Zika:		
Only males	False	131(58.0)
Only females	False	124(53.0)
Only pregnant women	False	100(42.7)
Everyone	True	176(75.2)
A person can get Zika by the following ways:		
From mosquito bite(s)	True	217(92.7)
From drinking polluted water	False	70(29.9)
Through sexual intercourse	True	81(34.6)
Through coughing and sneezing	False	80(34.2)
From a blood transfusion	True	70(29.9)
From mother to child transmission	True	135(57.7)
The following are the signs and symptoms of Zika		
Fever	True	207(88.5)
Headache	True	159(67.9)
Rash	True	118(50.4)
Muscle/ joint pain	True	116(49.6)
Conjunctivitis (red eyes)	True	77(32.9)
Convulsions or fits	False	63(26.9)
Bleeding	False	56(23.9)
It is possible to prevent Zika	True	187(79.9)
There is a specific treatment for Zika	False	35(15.0)
Everyone who gets Zika show symptoms	False	31(13.2)
The following group(s) is at high risk of getting health complications from Zika		
Pregnant women	True	211(90.2)
Women who are planning to get pregnant	True	92(39.3)
Males of all ages	False	52(22.2)
Females of all ages	False	65(27.8)
Everyone has equal risk	False	44(18.8)
If a pregnant woman has Zika, her foetus/ baby is at risk of		
Being stillborn	False	52(22.2)
Being born prematurely	False	42(17.9)
Being born with microcephaly	True	150(64.1)

^Interquartile range = 7.

As shown in Table 3, most participants (71.4%, *n*=150) first heard about Zika through the media (radio, television or newspapers), followed by social media (9.0%, *n*=19) and SMS/WhatsApp (5.2%, *n*=11). Media remained as the top preference for participants to get updates on Zika (74.4%, *n*=174), with a significant percentage also observed in health workers (44.0%, *n*=103), government announcements (43.2%, *n*=101), social media (38.0%, *n*=89), and SMS/WhatsApp (26.1%, *n*=61). Only 25.2% of the participants (*n*=59) reported that they had enough information about Zika virus.

When comparing socio-demographic variables (Table 1) between the 2 groups based on the sum of knowledge scores (0-14 *versus* 15-28 points), significant differences were detected for age (P<0.001), racial status (P=0.011), and average monthly household income (P<0.001). Multiple logistic regression results (Table 4) show that people who scored 15-28 points were more likely to be 25 years old or older, had an average monthly household income of more than BND$ 3 000[Adj. *OR*=4.06 (95% *CI:* 1.81, 19.44)], and not of Malay ethnicity[Adj. *OR*=3.32 (95% *CI:* 1.35, 8.55)]. When compared with participants who were 18-24 years old, those between 25-27 years old had the highest odds of scoring 15-28 points for knowledge[Adj. *OR*= 4.68 (95% *CI:* 1.80, 13.51)].

Table 3

Access to information on Zika virus infection among pregnant women in Brunei Darussalam.

Questions on information access	*n* (%)
*From where Zika was first heard (*n*=210)	
Family	10(4.8)
Friends or neighbours	0(0.0)
Community meeting/leaders	1(0.5)
Religious leader	0 (0.0)
Health workers	7(3.3)
Private doctor	1(0.5)
Media	150(71.4)
Social media	19(9.0)
SMS/WhatsApp	11(5.2)
Government announcement	9(4.3)
Do not know	1(0.5)
Others	1(0.5)
^ Preferred to get update information from	
Family	35(15.0)
Friends or neighbours	22(9.4)
Community meeting/leaders	10(4.3)
Religious leader	3(1.3)
Health workers	103(44.0)
Private doctor	30(12.8)
Media	174(74.4)
Social media	89(38.0)
SMS/WhatsApp	61(26.1)
Government announcement	101(43.2)
Do not know	4(1.7)
Others	5(2.1)
Have enough information about Zika	
Yes	59(25.2)
No	138(59.0)
Do not know	36(15.4)
Missing	1(0.4)
^Would like to have more information on	
Cause of disease	90(51.7)
Signs and symptoms	102(58.6)
Prevention	110(63.2)
Treatment options	110(63.2)
Consequences of having Zika	112(64.4)
Do not want any more information	1(0.6)
Others	3(1.7)

*Only those who gave one answer was included in this table, ^ Multiple responses were allowed.

3.3. Attitudes

Table 5 shows the participant's attitudes towards Zika virus. A majority of the participants (88.0%, *n*=206) agreed that Zika is an

Table 4

Factors associated with knowledge on Zika virus infection among pregnant women in Brunei Darussalam.

Variable	Overall population (%)	Simple logistic regression		Multiple logistic regression#	
		Crude *OR* (95% *CI*)	*P*-value	Adjusted *OR* (95% *CI*)	*P*-value
Age group (years)					
18–24	53(22.6)	Reference		Reference	
25–27	58(24.8)	4.98(2.01, 13.73)	< 0.001	4.68(1.80, 13.51)	0.002
28–31	60(25.6)	4.38(1.77, 12.06)	0.002	2.93(1.12, 8.42)	0.035
32	63(26.9)	4.93(2.01, 13.47)	< 0.001	3.46(1.33, 9.95)	0.015
Racial status*					
Malay	204(87.2)	Reference		Reference	
Others^	25(10.7)	3.00(1.29, 7.24)	0.011	3.32(1.35, 8.55)	0.010
Average monthly income◆					
< B$1 000	75(32.1)	Reference		Reference	
B$1 000-B$3 000	101(43.2)	1.73(0.89, 3.48)	0.114	1.53(0.75, 3.21)	0.252
> B$ 3 000	55(23.5)	4.75(2.25, 10.37)	< 0.001	4.06(1.81, 19.44)	< 0.001

*5 were missing, ◆ 3 were missing; ^Other races include Chinese (*n*=9) and other nationalities (*n*=16); # All the 3 variables (age-group, racial status & average monthly income) were included in the model.

Table 5

Attitudes towards Zika virus infection among pregnant women in Brunei Darussalam.

Attitude questions on Zika virus	Frequency of responses *n* (%)		
	Agree	Disagree	Neutral
Zika is an important issue in my community	206(88.0)	5(2.1)	23(9.9)
Zika is the personal responsibility	214(91.5)	9(3.8)	11(4.7)
Zika is the community responsibility	143(61.1)	29(12.4)	62(26.5)
Zika is the health worker responsibility	206(88.0)	3(1.3)	25(10.7)
Zika is the government responsibility	203(86.8)	4(1.7)	27(11.5)
Women should avoid getting pregnant due to Zika	88(37.6)	78(33.3)	68(29.1)
Pregnant women should postpone unnecessary travel to Zika-affected countries	211(90.2)	6(2.6)	17(7.2)
If my spouse has rcently traveled to Zika-affected countries, I would encourage him to use condoms during sexual intercourse or consider abstinence for 6 months after the trip	193 (82.5)	12(5.1)	29(12.4)

important issue. When asked about their risk of getting Zika within the next 6 months, the participants reported their risk as did not know (51.7%, *n*=121), high (9.8%, *n*=23), medium (13.3%, *n*=31), low (13.7%, *n*=32) or none (11.5%, *n*=27). Most agreed that it is the responsibility of the individual themselves (91.5%, *n*=214), health workers (88.0%, *n*=206), and the government (86.8%, *n*=203) to prevent their community from getting Zika virus infection. While 90.2% (*n*=211) agreed that pregnant women should postpone unnecessary travel to Zika-affected countries, only 37.6% (*n*=88) agreed that women should avoid getting pregnant in the next 6 months due to Zika. Lastly, 82.5% (*n*=193) agreed that they would encourage their husbands to practice safe sex or consider abstinence for 6 months if their spouse has recently travelled to Zika-affected countries.

3.4. Prevention practices

The median prevention practice score was 23, out of a possible score of 36 (Table 6). Categorising these scores into 2 groups (0-18 and 19-36 points) showed that 77.3% of the participants (*n*=180) scored between 19-36 points, while 22.7% (*n*=53) scored between 0-18 points. Most participants reportedly wore covering clothes (98.3%, *n*=230) and used mosquito repellent or spray on their body (90.6%, *n*=212). Also, a majority reportedly conducted general prevention practices against mosquito breeding (85.9%–99.6%). No significant differences were detected when comparing the socio-demographic variables between the 2 groups of prevention practice scores (0-18 *versus* 19-36 points) (Table 1).

Table 6

Self-reported prevention practices against mosquito bites and breeding among pregnant women in Brunei Darussalam.

Overall prevention practice for Zika virus	*n* (%)
Median overall prevention practice score (min-max)	23(0–36)
0–18 points	53(22.7)
19–36 points	180(77.3)
To prevent mosquito bites	
Used mosquito repellent or spray on your body	212(90.6)
Used mosquito coil/ lit fires to keep mosquitoes away	196(83.8)
Worn covering clothes	230(98.3)
Put screens on windows or doors	116(49.6)
To prevent mosquito breeding	
Removed standing water/ stagnant water	225(96.2)*
Removed garbage and keep the surroundings clean	233(99.6)
Cleaned/ scrubbed water storage container(s) at least once a week	226(96.6)
Put cover(s) over the water storage container(s) at least once a week	221(94.4)
Changed water from flower vase(s) at least once a week	201(85.9)

* There is 1 missing value; Interquartile range =8.

4. Discussion

We found a lack of knowledge on Zika virus infection among pregnant women attending government maternal and child healthcare centres in Brunei-Muara district, Brunei Darussalam. This finding is similar to other studies conducted among pregnant women[22-25]. On one hand, a high percentage of our study participants knew that Zika virus is transmitted through mosquito bites (92.7%), when

compared to those from other similarly Zika-unaffected areas (90.5% in Greece[26] and 66.9% in Northern Nigeria[27]. Also, 64.1% of the participants knew of the relationship between Zika infection during pregnancy and microcephaly, which is within the range of that reported in Greece (47.1%)[26] and Northern Nigeria (80.7%)[27]. However, on the other hand, only 34.6% answered correctly that Zika virus could be transmitted sexually. This finding is similar to that reported in numerous other studies in countries where documented Zika virus transmission was either absent[26,27] or present[22,24,28]. The WHO has recommended that areas with no active Zika virus transmission (such as Brunei Darussalam) should ensure that men and women returning from areas with known Zika virus transmission adopt safer sex practices or consider abstinence for at least 6 months upon return, in order to prevent Zika virus transmission through sexual transmission[29]. This highlights the need to promote awareness on Zika virus for pregnant women, in particular on the possible transmission modes.

Our findings showed that knowledge on Zika virus were associated with age, household income and race. In agreement, one study found that knowledge on Zika virus was negatively associated with younger pregnant women in the United States[24]. This could possibly be due to less exposure or access to health-related information. Also, our results for household income suggest a role of socio-economic status (SES). Several studies have shown that SES correlates positively with knowledge scores[30,31] and this was also observed in similar surveys on dengue[32]. People with higher SES could have better access and comprehension of information on Zika virus. Lastly, we found that knowledge scores were positively associated with non-Malays. Malays constitute 65.7% of Brunei Darussalam's population, while Chinese (10.3%) and other races (24.0%) form the minority of the population[10]. Foreign expatriates, in particular, could be more knowledgeable on Zika virus and possibly more interested on the topic than locals, as no Zika cases have been reported at the time of writing this article. Thus, our findings suggest that future education campaigns on Zika should target on pregnant women who are younger, Malays and those of lower SES status.

Also, we observed that only 25.2% of the participants reported having enough information on Zika virus, in agreement to that reported in another similarly Zika-unaffected country (13.1%) [26]. Also, a significant percentage of participants would like to get updates on Zika virus from healthcare professionals. Other studies have shown that recommendations from healthcare providers are an important factor for pregnant women[33,34], and this has been also reported for Zika virus[22,35]. Hence, Zika virus education and awareness among pregnant women could be done more effectively through disseminating information via healthcare workers at antenatal clinic settings. As face-to-face clinic time with patients can be limited, other effective ways include using providing educational brochures and updating websites with information endorsed by organisations (such as the Ministry of Health or WHO)[35]. Importantly, providing information to the public would only increase their knowledge level for a particular disease, only if the members of the public understand and is able to make decisions based on the information. As it is known that the health literacy level of an individual plays a major role in his/her ability to assess and apply health information given to them[36]. Future studies involving health literacy assessment on Zika virus should thus be conducted at the community level[37].

When compared to knowledge scores, we observed a higher level of self-reported prevention practices against mosquito bites and breeding. Our reported percentages are higher than that of a similar study in Greece[26]. Brunei Darussalam has a hot and wet climate throughout the year, and Aedes mosquitoes can be detected locally[11,12]. Dengue, another mosquito-borne disease, is also endemic in the country. Hence, Zika virus transmission through mosquitoes can be considered as the main transmission mode in Brunei Darussalam. Our findings may reflect the existing prevention practices against existing mosquito-borne diseases.

This study has several limitations. Firstly, the low sample size of this study could potentially lead to lack of study power to identify true associations and also generalizability issues to all pregnant women in the Brunei-Muara district. The former can be seen in the wide confidence level ranges for the regression analysis results. Data collection for this study was carried out concurrently with a similar study on the general adult population (submission under review) and it was a post-hoc decision to analyse the pregnant women dataset separately. Hence, the study results should be interpreted with caution. Secondly, it should be noted that the choice of cut-off points for the 2 groups in the regression analysis could have an effect on the results. As there were no known criteria to categorize the responses, we decided to use the mid-point as the cut-off point, following a similar study on dengue[20]. Separate sensitivity analyses using different cut-off points were also conducted separately (results not shown), yielding similar results. Future studies could be conducted to determine a suitable cut-off point for similar KAP questionnaires. Lastly, as the prevention practices were all self-reported, there could potentially be a certain degree of bias.

In conclusion our study observed on lack of knowledge on Zika virus infection among pregnant women attending government maternal and child healthcare centres in Brunei Darussalam, in particular that Zika virus could be sexually transmitted. Providing Zika education to pregnant women at the maternal and child healthcare centres (such as through posters and brochures), would be a feasible step to increase their knowledge on the virus. Our study findings are useful for policy makers and health professionals to plan, implement and evaluate specifically Zika awareness programmes both at local and regional levels. Such programmes, emphasizing on transmission modes and prevention among pregnant women, is warranted. Qualitative research could complement this study in exploring the facilitators and barriers of KAP on Zika virus infection among pregnant women.

Conbflict of interest statement

We declare that we have no conflict of interest.

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References

[1] Besnard M, Lastere S, Teissier A, Cao-Lormeau V, Musso D. Evidence of perinatal transmission of Zika virus, French Polynesia, December 2013 and February 2014. *Euro Surveill* 2014; **19**(13). PubMed PMID: 24721538.

[2] Russell K, Hills SL, Oster AM, Porse CC, Danyluk G, Cone M, et al. Male-to-female sexual transmission of Zika virus-United States, January–April 2016. *Clin Infect Dis* 2016; **64**(2): 211-213.

[3] Musso D, Nhan T, Robin E, Roche C, Bierlaire D, Zisou K, et al. Potential for Zika virus transmission through blood transfusion demonstrated during an outbreak in French Polynesia, November 2013 to February 2014. *Euro Surveill* 2014; **19**(14). PubMed PMID: 24739982.

[4] Maurice J. The Zika virus public health emergency: 6 months on. *Lancet* 2016; **388**(10043): 449-450.

[5] World Health Organization. *Zika virus and complications: 2016 public health emergency of international concern 2018.*[Online]. Available at: http://www.who.int/emergencies/zika-virus/en/[Accessed on 28 April 2018].

[6] Rasmussen SA, Jamieson DJ, Honein MA, Petersen LR. Zika virus and birth defects-reviewing the evidence for causality. *NEJM* 2016; **374**(20): 1981-1987.

[7] Honein MA, Dawson AL, Petersen EE, Jones AM, Lee EH, Yazdy MM, et al. Birth defects among fetuses and infants of us women with evidence of possible Zika virus infection during pregnancy. *JAMA* 2017; **317**(1): 59-68.

[8] World Health Organization. *Situation report on Zika virus, microcephaly and Guillain–Barre syndrome, 10 March 2017.* [Online]. Available at: http://www.who.int/emergencies/zika-virus/situation-report/10-march-2017/en/[Accessed on 8 May 2018].

[9] Baud D, Gubler DJ, Schaub B, Lanteri MC, Musso D. An update on Zika virus infection. *Lancet* 2017; **390**(10107): 2099-109.

[10]Ministry of Health Brunei Darussalam. *Health information booklet 2016 (Revision 2) 2018* [Online]. Available from: http://moh.gov.bn/SitePages/Health Information Booklet.aspx [Accessed on 1 April 2018].

[11]Macdonald WW, Rajapaksa N. A survey of the distribution and relative prevalence of *Aedes aegypti* in Sabah, Brunei, and Sarawak. *Bull World Health Organ* 1972; **46**(2):203-209.

[12]Idris FH, Usman A, Surendran SN, Ramasamy R. Detection of *Aedes albopictus* pre-imaginal stages in brackish water habitats in Brunei Darussalam. *J Vector Ecol* 2013; **38**(1):197-199.

[13]Lim SK, Lim JK, Yoon IK. An update on Zika virus in Asia. *Infect &Chemother* 2017; **49**(2): 91-100.

[14]Ho ZJM, Hapuarachchi HC, Barkham T, Chow A, Ng LC, Lee JMV, et al. Outbreak of Zika virus infection in Singapore: An epidemiological, entomological, virological, and clinical analysis. *Lancet Infect Dis* 2017; **17**(8): 813-821.

[15]Moi ML, Nguyen TTT, Nguyen CT, Vu TBH, Tun MMN, Pham TD, et al. Zika virus infection and microcephaly in Vietnam. *Lancet Infect Dis* 2017; **17**(8): 805-806.

[16]Ministry of Health Brunei Darussalam. *Stay informed, stay protected against ZIKA 2016* [Online]. Available from: http://www.moh.gov.bn/SitePages/Zika.aspx [Accessed on 14 February 2018].

[17]Brunei News gazette. *Meragang national housing scheme cleaning campaign 2016* [Online]. Available from: https://www.bruneinewsgazette.com/17193/meragang-national-housing-scheme-cleaning-campaign [Accessed on 14 February 2018].

[18]Deputy Sultan urge whole nation approach to tackle Zika virus: Brudirect.com; 2016 [Online]. Available from: https://www.brudirect.com/news.php?id=15838 [Accessed on 14 February 2018].

[19]World Health Organization. *Knowledge, attitudes and practice surveys Zika virus disease and potential complications: Resource pack 2016 15 Oct 2016* [Online]. Available from: http://www.who.int/csr/resources/publications/zika/kap-surveys/en/ [Accessed on 15 Oct 2016].

[20] Wong LP, Shakir SMM, Atefi N, AbuBakar S. Factors affecting dengue prevention practices: nationwide survey of the Malaysian Public. *Plos One* 2015; **10**(4): e0122890.

[21]R Core Team. *R: A language and environment for statistical computing.* Vienna: R Foundation for Statistical Computing; 2017.

[22]Berenson AB, Trinh HN, Hirth JM, Guo F, Fuchs EL, Weaver SC. Knowledge and prevention practices among U.S. pregnant immigrants from Zika virus outbreak areas. *Am J Trop Med Hyg* 2017; **97**(1): 155-162.

[23]Samuel G, DiBartolo-Cordovano R, Taj I, Merriam A, Lopez JM, Torres C, et al. A survey of the knowledge, attitudes and practices on Zika virus in New York City. *BMC Public Health* 2018; **18**(1): 98.

[24]Heitzinger K, Thoroughman DA, Porter KA. Knowledge, attitudes, and practices of women of childbearing age testing negative for Zika virus in Kentucky, 2016. *Prev Med Rep* 2018; **10**: 20-23.

[25]Whittemore K, Tate A, Illescas A, Saffa A, Collins A, Varma JK, et al. Zika virus knowledge among pregnant women who were in areas with active transmission. *Emerg Infect Dis J* 2017; **23**(1): 164.

[26]Mouchtouri VA, Papagiannis D, Katsioulis A, Rachiotis G, Dafopoulos K, Hadjichristodoulou C. Knowledge, attitudes, and practices about the prevention of mosquito bites and Zika virus disease in pregnant women in Greece. *Int J Environ Res Public Health* 2017; **14**(4). doi: 10.3390/ijerph14040367.

[27]Michael GC, Aliyu I, Grema BA, Ashimi AO. Knowledge of Zika virus disease among reproductive-age women attending a general outpatient clinic in Northern Nigeria. *S Afr FamPrac* 2017; **59**(4): 148-153.

[28]Borges ALV, Moreau C, Burke A, dos Santos OA, Chofakian CB. Women's reproductive health knowledge, attitudes and practices in relation to the Zika virus outbreak in northeast Brazil. *Plos One* 2018; **13**(1): e0190024.

[29]World Health Organization. Prevention of sexual transmission of Zika virus: interim guidance update 2016 [Online]. Available from: http://www.who.int/iris/handle/10665/204421 [Accessed on 8 May 2018].

[30]McArthur L, Peña M, Holbert D. Effects of socioeconomic status on the obesity knowledge of adolescents from six Latin American cities. *Int J Obesity* 2001; **25**: 1262.

[31]Castro M, Sánchez L, Pérez D, Sebrango C, Shkedy Z, Van der Stuyft P. The relationship between economic status, knowledge on dengue, risk perceptions and practices. *Plos One* 2013; **8**(12): e81875.

[32]Harapan H, Rajamoorthy Y, Anwar S, Bustamam A, Radiansyah A, Angraini P, et al. Knowledge, attitude, and practice regarding dengue virus infection among inhabitants of Aceh, Indonesia: A cross-sectional study. *BMC Infect Dis* 2018; **18**(1): 96.

[33]Grimes HA, Forster DA, Newton MS. Sources of information used by women during pregnancy to meet their information needs. *Midwifery* 2014; **30**(1): e26-e33.

[34]Bödeker B, Walter D, Reiter S, Wichmann O. Cross-sectional study on factors associated with influenza vaccine uptake and pertussis vaccination status among pregnant women in Germany. *Vaccine* 2014; **32**(33): 4131-4139.

[35]Ellingson MK, Bonk CM, Chamberlain AT. A survey-based study of Zika virus communication preferences among pregnant women in Georgia, United States. *BMC Pregn & Childb* 2017; **17**(1): 325.

[36]Sørensen K, Van den Broucke S, Fullam J, Doyle G, Pelikan J, Slonska Z, et al. Health literacy and public health: A systematic review and integration of definitions and models. *BMC Public Health* 2012; **12**(1): 80.

[37] Thompson EL, Vamos CA, Liggett LG, Griner SB, Daley EM. Using a health literacy analytic framework to explore Zika virus and reproductive health. *Health Liter Res & Prac* 2018; **2**(2): e78-e87.