CHAPTER 4

GRAPHICIAL ANALYSIS AND STATISTICAL MODELING

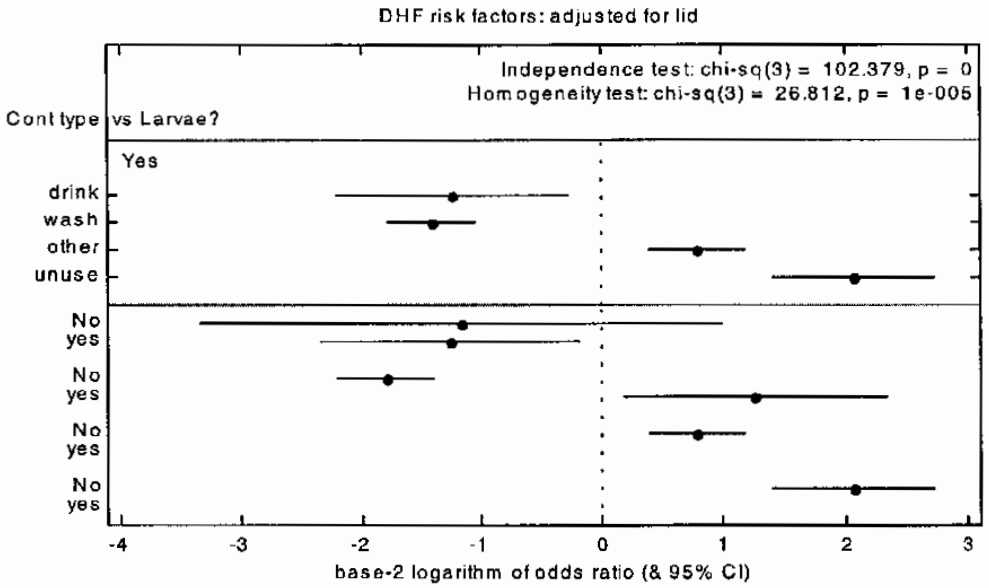
The associations between the DHF transmission factors and the determinant variables are analyzed in this chapter. This analysis is based on the variables collected for the containers and is described in two sections. In the first section, we show graphs of the relevant odds ratios and their 95 percent confidence intervals, after taking into account other variables that could cause confounding. In the second section we use logistic regression modeling to account for the joint effects of the various risk factors.

Odds Ratio Plots

First the risk factors for the presence of dengue vector larvae in the water containers are examined. We consider two risk factors, type of use of container, and whether the container has a lid. Since these factors are strongly associated (as shown in Table 3.3), they need to be considered jointly. Figure 4.1 shows the odds ratios for the association between larval presence and container type, after adjusting for the presence or absence of a container lid.

As explained in Chapter 2, the odds ratios shown in this graph are based on comparisons between each category of the determinant versus all other categories combined. The stratum-specific odds ratios are graphed in the lower panel of Figure 4.1. These show that the odds ratios for the lidded and unlidded containers are similar for the containers used for drinking water, but that the corresponding odds ratios for the washing water containers are quite different. As a result, the test for homogeneity of the odds ratios is rejected (chi-squared = 26.812 with 3 degrees of freedom, p-value = 0). Since none of the containers either used for other purposes or unused have lids, it is not possible to compare the odds ratios within these strata.

Figure 4.1 Association between dengue vector and container type, adjusted for lid

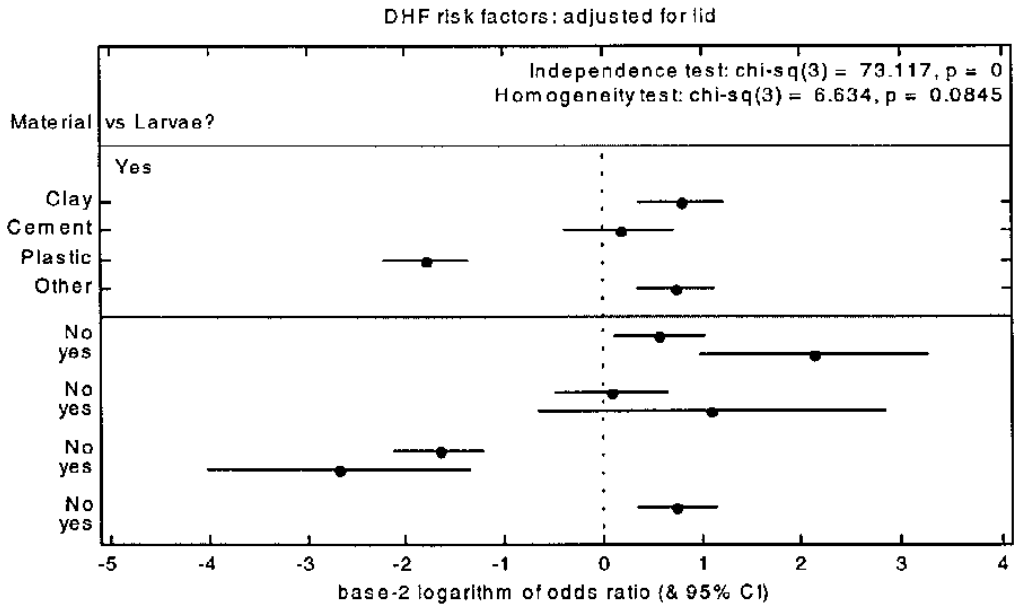


Thus the conclusion is that containers used for storing drinking water, and those used for washing water without lids, have a substantially reduced risk of containing larvae, whilst all other containers have a substantially increased risk. It is interesting to note that for the containers used to store water for washing, those with lids are more likely to contain larvae than those without lids. This may be because those container with lid were less taken care and were renewed seldomly.

Figure 4.2 shows the same comparison as Figure 4.1, using container material instead of container use as the exposure of interest.

Figure 4.2 shows that the association is very strong, with plastic containers having a substantially reduced risk of containing larvae. The cement containers are no more likely to contain larvae than containers made of other materials, but those made of clay (together with those made of unspecified materials) are associated with an increased risk.

Figure 4.2 Association between dengue vector & container material, adjusted for lid



With regard to the containers having lids, it can be seen that having a lid is associated with increased larval risk for the clay and cement containers, but actually appears to reduce the risk even further for those made of plastic.

Figure 4.3 Association between dengue vector & place of containers, adjusted for lid

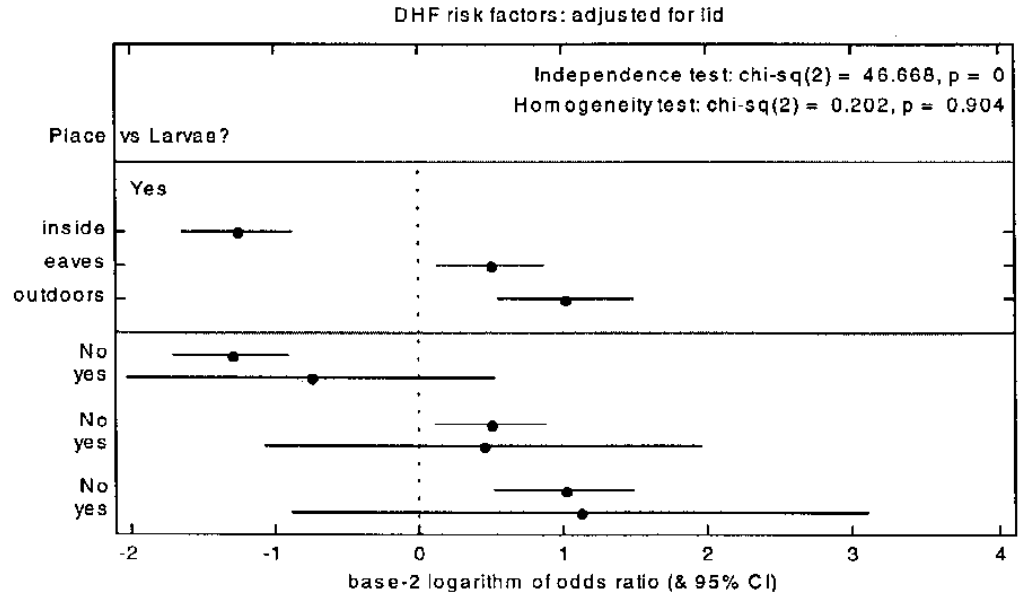


Figure 4.3 uses place of container instead of container use as the exposure of interest and shows the same comparison as Figure 4.1 and 4.2.

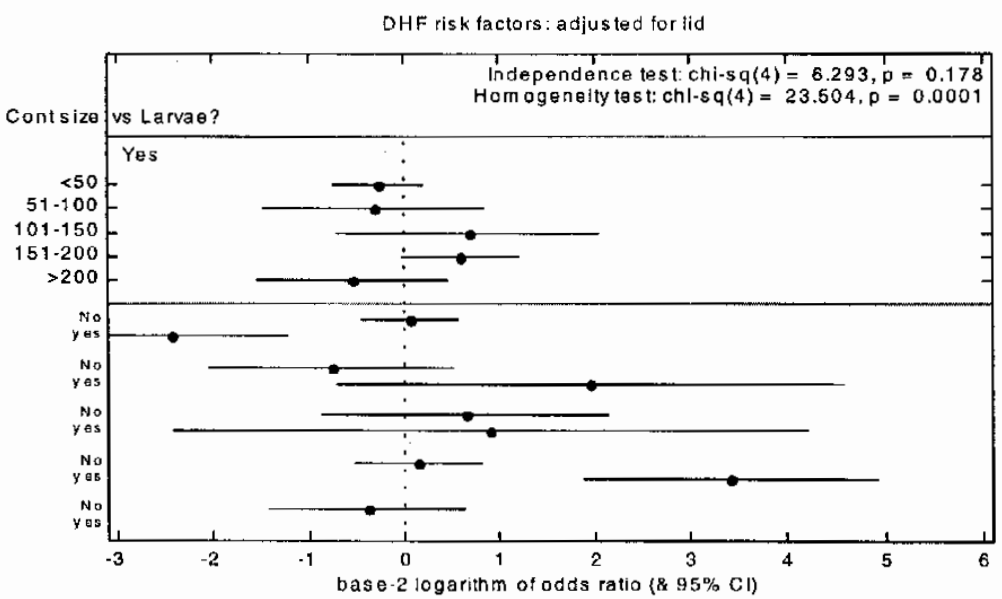
In Figure 4.3, the association is very strong, with containers placed inside the house having a substantially reduced risk of containing larvae. Containers placed under cover and outdoors are associated with an increased risk.

With regard to the containers having lids, it can be seen that having a lid is associated with increased larval risk for the containers placed inside, but there is no difference for containers placed under cover and outdoors.

The association between larval presence and container size, after adjusting for the presence or absence of a container lid, are shown in Figure 4.4. We see that container size is not consistently associated with larval presence or absence in the containers.

With regard to the containers having lids, it can be seen that having a lid is associated with reduced larval risk for containers sized less than 50 liters, but for containers sized more than 150 liters having a lid increases the risk. No containers with capacity exceeding 200 liters had lids.

Figure 4.4 Association between dengue vector & containers size, adjusted for lid



Logistic Regression Analysis of Larvae Outcome

We now consider modeling the larvae outcome, using containers as the case unit for analysis. This analysis is based on the assumption that containers are independent with respect to this outcome. Clearly this is not so. Containers within the same household are likely to be correlated with respect to having larvae in them.

Figure 4.5 is the first step. We fit a model with all variables of interest, consisting of five categories for material (with presence or absence of lid), three for place of container, four for type of container, two for transmission and non-transmission, two for religion and two for District location.

Figure 4.5 Logistic regression model for study of DHF risk factors.

logistic regression analysis: Study of dengue haemorrhagic fever risk factors

factor	coeff	St.Error	p-value	Odds ratio	95% CI	
Larvae?						
Yes / No	-3.6533	0.4534	0	0.0259	0.0107	0.063
material and lid			0			
plastic lid	(0)					
plastic non-lid	1.6421	0.5679	0.0038	5.1661	1.6972	15.725
clay/cem lid	1.7565	0.4967	0.0004	5.792	2.1878	15.3334
clay/cem non-lid	3.0588	0.5542	0	21.3016	7.1888	63.12
others	1.7718	0.5814	0.0023	5.8812	1.8819	18.3802
Place			0.1378			
inside	(0)					
eaves	0.334	0.1741	0.0551	1.3966	0.9927	1.9647
outdoors	0.0667	0.2355	0.7769	1.069	0.6738	1.696
Cont type			0			
drink	(0)					
wash	0.0427	0.3789	0.9103	1.0436	0.4966	2.1929
others	1.5497	0.429	0.0003	4.7099	2.0318	10.918
unused	2.7553	0.5134	0	15.7261	5.7497	43.0126
Transmission						
Non-transmission	(0)					
Transmission	0.6053	0.143	0	1.8318	1.3842	2.4242
Religion						
Muslim	(0)					
Buddhist	0.323	0.1501	0.0315	1.3812	1.0291	1.8538
District						
Kok Pho	(0)					
Panarehk	0.3598	0.1509	0.0171	1.4331	1.0663	1.9261

df: 1188 deviance: 1264.799 number of iterations: 4

As Figure 4.5 shows, all variables are statistically significant except for the place of the containers. The deviance from this model is 1264.799 and the number of degrees of freedom is 1188.

Figure 4.6 presents the result of fitting a reduced model for study of DHF risk factors in which the location variable is omitted.

From Figure 4.6, after reducing the model, it was found that religion has become significant. The deviance and number of degree of freedom have increased from 1264.799 to 1268.76, and 1188 to 1190, respectively.

Figure 4.6 Logistic regression model for study of DHF risk factors after place is omitted

logistic regression analysis: Study of dengue haemorrhagic fever risk factors

factor	coeff	St.Error	p-value	Odds ratio	95% CI	
Larvae?						
Yes / No	-3.6171	0.4527	0	0.0269	0.0111	0.0652
material and lid			0			
plastic lid	(0)					
plastic non-lid	1.656	0.5677	0.0035	5.2383	1.7216	15.9391
clay/cem lid	1.7896	0.4955	0.0003	5.9869	2.2669	15.8114
clay/cem non-lid	3.1136	0.5538	0	22.5017	7.6001	66.6208
others	1.8116	0.5812	0.0018	6.12	1.9588	19.1208
Cont type			0			
drink	(0)					
wash	0.1267	0.3746	0.7352	1.135	0.5447	2.365
others	1.6914	0.4185	0.0001	5.4273	2.3896	12.327
unused	2.8354	0.4756	0	17.037	6.7068	43.2782
Transmission						
Non-transmission	(0)					
Transmission	0.5955	0.1423	0	1.8139	1.3723	2.3976
Religion						
Muslim	(0)					
Buddhist	0.2321	0.1426	0.1037	1.2613	0.9536	1.6682
District						
Kok Pho	(0)					
Panarehk	0.4043	0.1489	0.0066	1.4982	1.119	2.006

df: 1190 deviance: 1268.76 number of iterations: 5

Figure 4.7 shows the result fitting the model after omitting religion. All variables are statistically significant.

Next we test the interactions between variables, and find that type of container and place of container are associated.

Accordingly we put the interactions between type of container and place of container in to the model.

Figure 4.8 shows the result fitting the model with an interaction between type of container and place of container.

In this model, the value of the deviance and the number of degrees of freedom decreased from 1271.48 to 1265.358, and from 1191 to 1188, respectively.

Figure 4.7 Logistic regression model for study of DHF risk factors after religion omitted

logistic regression analysis: Study of dengue haemorrhagic fever risk factors

factor	coeff	St.Error	p-value	Odds ratio	95% CI	
Larvae?						
Yes / No	-3.4784	0.4436	0	0.0309	0.0129	0.0736
material and lid			0			
plastic lid	(0)					
plastic non-lid	1.6429	0.5668	0.0037	5.1701	1.7023	15.7019
clay/cem lid	1.8059	0.4943	0.0003	6.0855	2.3095	16.035
clay/cem non-lid	3.1146	0.5528	0	22.5247	7.6225	66.5613
others	1.8327	0.5802	0.0016	6.2508	2.0047	19.4903
Cont type			0			
drink	(0)					
wash	0.1387	0.3742	0.711	1.1487	0.5517	2.3917
others	1.65	0.4176	0.0001	5.2072	2.2967	11.8061
unused	2.8576	0.4754	0	17.4201	6.8606	44.232
Transmission						
Non-transmission	(0)					
Transmission	0.5852	0.142	0	1.7953	1.3592	2.3713
District						
Kok Pho	(0)					
Panarehk	0.3817	0.1481	0.01	1.4648	1.0958	1.9582

df: 1191 deviance: 1271.419 number of iterations: 5

When comparing the values of the deviance and degrees of freedom between this and the full model from Figure 4.5, it is found that this value is close to that for Figure 4.5. But we should select this model because all variables are statistically significant (in Figure 4.5 the place of container is non-significant). It is clear that the reduced model is better.

In Figure 4.8, after adjusting for various factors, it is observed that material with presence or absence of lid, container type with place, transmitted areas, and districts are significantly associated with having larvae in the containers. Containers used for other purposes or unused have a higher chance of having larvae in the containers when compared with drinking water container placed inside, with the odds ratios of 4.58 (95% CI: 1.92 - 10.90) and 15.19 (95% CI: 5.74 - 40.25), respectively.

Figure 4.8 Final Logistic regression model for study of DHF fever risk factors.

logistic regression analysis: Study of dengue haemorrhagic fever risk factors

factor	coeff	St.Error	p-value	Odds ratio	95% CI	
Larvae?						
Yes / No	-3.4857	0.4484	0	0.0306	0.0127	0.0738
cont type and place			0			
drink inside	(0)					
drink eaves	-0.9864	1.1227	0.3796	0.3729	0.0413	3.3673
drink outdoors	1.7684	1.6576	0.286	5.8616	0.2275	150.9989
wash inside	-0.1736	0.4158	0.6764	0.8407	0.3721	1.8992
wash eaves&outdoors	0.2655	0.4084	0.5158	1.304	0.5856	2.9038
others	1.5207	0.443	0.0006	4.5755	1.9204	10.9016
unused	2.7211	0.497	0	15.1973	5.7378	40.2522
material and lid			0			
plastic lid	(0)					
plastic non-lid	1.7873	0.5874	0.0023	5.9734	1.8888	18.891
clay/cem lid	1.8534	0.5032	0.0002	6.3814	2.38	17.1102
clay/cem non-lid	3.2367	0.5714	0	25.4503	8.305	77.9907
other	1.9737	0.5998	0.001	7.1971	2.2211	23.3208
Transmission						
Non-transmission	(0)					
Transmission	0.6143	0.1434	0	1.8483	1.3955	2.4481
District						
Kok Pho	(0)					
Panarehk	0.3527	0.1499	0.0186	1.4229	1.0607	1.9088

df: 1188 deviance: 1265.358 number of iterations: 5

Containers made of plastic without lids, clay/cement with or without lids, and other materials, have a higher chance of having larvae in the containers when compared with those made of plastic and having lids, with odds ratios of 5.97 (95% CI: 1.89 - 18.89), 6.38 (95% CI: 2.38 - 17.11), 25.45 (95% CI: 8.31 - 77.99), and 7.19 (95% CI: 2.22 - 23.32), respectively. We can see that transmission villages have almost a two fold higher chance of having larvae in containers than those in non-transmission villages (OR=1.85, 95% CI: 1.39 - 2.45). And Panarehk Districts have 1.42 times the risk of having larvae in containers than Kok Pho Districts (OR=1.42, 95% CI: 1.06 – 1.91).