Letter to Editor

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Non-parametric versus parametric methods in environmental sciences

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Dear Editor

I have recently read the short communication by Riaz et al. (2016) published in your journal. In this communication, the authors encouraged the use of nonparametric methods for the case when the background assumptions for the given dataset are violated. The authors investigated the effect of applying parametric versus nonparametric methods by considering real life data from environmental and industrial sectors. In this report, we will only consider the first example related to drinking water that analyzes the microbiological quality of public water supply. In this example, the authors are interested in investigating significant differences among different bacterial types such as Heterotrophic colony count (HC), Total coliform (TC), Fecel coliform (FC), *Citrobacter* (C), *Enterobacter* (E) and *Klebsiella* (K).

The authors reported that (by using the nonparametric Kruskal-Wallis test results) at least one of the bacterial type is contributing significantly different as compared to the other bacterial types. An important question might be to know exactly which of the bacterial types are significantly different from others? For this purpose, we need to extend the analysis by including the nonparametric post hoc pairwise comparisons among the different bacterial types. The Kruskal-Wallis test actually compared the median level of the different bacterial types. Before reporting the formal group comparisons, boxplots of all the bacterial types are presented in Figure 1. In each boxplot the bold horizontal lines indicate the median level whereas a dot represents an extreme observation in that category. From figure 1, we can clearly see the difference in the median levels for the different bacterial types. To know exactly which of the types are significantly different from others, we used two post hoc pairwise comparison procedures. The first procedure uses the Kruskalmc function reported in the pgirmess library and the second uses the dunn.test function reported in the dunn.test library of the R statistical language (Ihaka and Gentleman, 1996). The results are reported in Table 1 and 2.

In Table 1, the pairs which have observed differences higher than a critical value are considered statistically different at the given probability level (0.05 used in this study). The results in Table 1 indicated that only the bacterial type *Citrobacter* is statistically significantly different from Heterotrohic Colony Count and Total Coliform types at the 5% significance level. The rest of the comparisons showed non-significant differences. In Table 2, the test statistic of the Dunn's test are reported in the first row whereas the second rows reports the p-value. Any p-value < 0.05 indicates a significant difference. From Table 2, we can clearly see the significant differences between different bacterial pairs.

Table 1: Pairwise comparisons after Kruskal-Wallis test using Kruskalmc function.

Comparisons	**C-E**	**C-FC**	**C-HC**	**C-K**	**C-TC**
Observed Difference	9.2	10.0	18.4	4.9	18.1
Critical Difference	16.3	16.3	16.3	16.3	16.3
Significance	FALSE	FALSE	TRUE	FALSE	TRUE

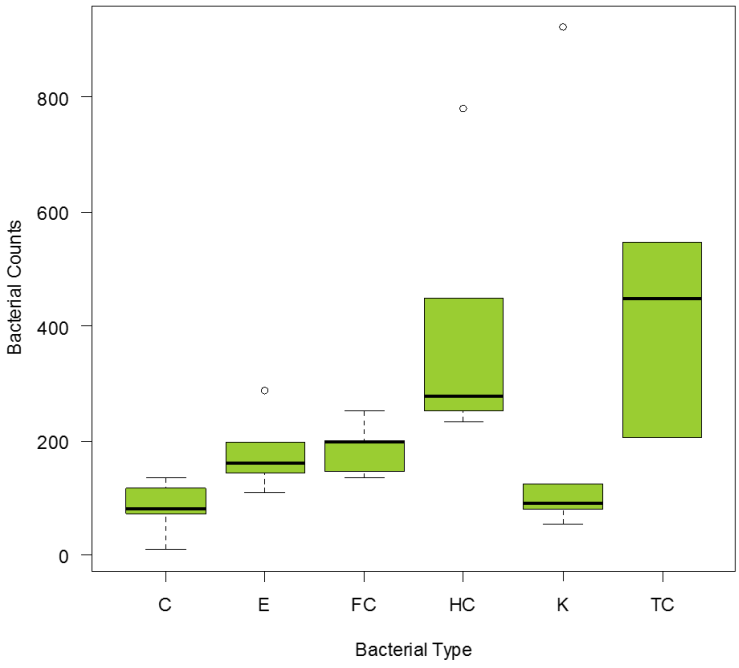
Comparisons	**E-FC**	**E-HC**	**E-K**	**E-TC**	**FC-HC**
Observed Difference	0.8	9.2	4.3	8.9	8.4
Critical Difference	16.3	16.3	16.3	16.3	16.3
Significance	FALSE	FALSE	FALSE	FALSE	FALSE

Comparisons	**FC-K**	**FC-TC**	**HC-K**	**HC-TC**	**K-TC**
Observed Difference	5.1	8.1	13.5	0.3	13.2
Critical Difference	16.3	16.3	16.3	16.3	16.3
Significance	FALSE	FALSE	FALSE	FALSE	FALSE

Table 2: Pairwise comparisons after Kruskal-Wallis test using dunn.test function.

Col Mean - Row Mean	C	E	FC	HC	K
E	-1.654				
	0.049				
FC	-1.798	-0.144			
	0.0361	0.4428			
HC	-3.308	-1.654	-1.510		
	0.0005	0.049	0.0655		
K	-0.881	0.773	0.917	2.427	
	0.1891	0.2197	0.1796	0.0076	
TC	-3.254	-1.600	-1.456	0.054	-2.373
	0.0006	0.0548	0.0726	0.4785	0.0088

Figure 1: Boxplots of different bacterial types.



The results of Dunn test reported in Table 2 are more reliable as can be seen from the median differences shown in the boxplot of bacterial types. Hence we recommend the use of Dunn test for the pairwise comparison of different bacterial types. Similarly the work can be extended for the second example reported in Riaz et al. (2016)

Conflict of Interest

The author declare no conflict of interest.

References

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