

## PRACTICAL EDUCATION OF STATISTICS FOR VETERINARY MEDICINE AND ANIMAL SCIENCE

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*With the emphasis on evidence-based veterinary medicine and policy making in recent years, statistics is becoming an increasingly important tools. The modern veterinarians, research workers and decision makers therefore need to be able to handle numerical data confidently and properly. Nevertheless, it is difficult for them to analyze data since they have had few opportunities to get practical education. There is also a tendency for them to hesitate to study statistics by themselves. Given the above background, we have opened the hands-on training course of statistics in veterinary medicine and animal science using software R. It is our intention to provide a statistical technique underlying study design and data analysis relevant to the study of animal health and diseases.*

### BACKGROUND

The veterinary medicine is following the human medicine in introducing a more objective basis to its practice under the term evidenced-based veterinary medicine (EBVM). Veterinarians are moving towards dependence upon scientific studies to underpin clinical decisions. EBVM implies the basing of clinical judgement not simply on clinical experience but also on the available relevant and valid scientific studies of the conditions. Evidence comes with variable reliability so veterinarians are faced with the task of selecting and critically evaluating the best evidence. The clinician has to know what information is relevant and how to access this evidence, and be able to use rigorous methods to assess it. Generally, this requires an understanding of the principles and technique of statistical analysis. The scientific evidence based on statistical analysis are applied not only in the treatment of clinical disease but also in aspects of production and performance in animal science.

In the animal science there are an increasing number of independent consulting services that will analyze the productivity of livestock for the benefit of health monitoring and maintenance. Those consulting services must always be concerned about data quality and accuracy of statistical analysis for providing expert advice. And it must be able to supply clear guidelines for the interpretation of result obtained in their analysis. Moreover, there is also concern about the disease control for animal infectious disease in livestock. Epidemiology is a science in order to develop effective measures for improving health and disease prevention with observing and recognizing the frequency and distribution of diseases by temporal, spatial and host characteristics, and analyzing the factors which are related to the occurrence of diseases in human and animal populations. Epidemiology is the study of disease in populations and of factors that determine its occurrence. Veterinary epidemiology additionally includes investigation and assessment of other health-related events, notably productivity. All of these investigations involve observing animal populations and making inferences using statistical analysis. In every case, advice and appropriate regulations are established by statistical evaluation.

### THE PROBLEM

Veterinarians and experts of animal science need to be aware of the appropriate statistical procedures in order to play their proper roles. Nevertheless, it is difficult for them to analyze data since they have had few opportunities to get practical education. There is also a tendency for them to hesitate to study statistics by themselves. Most veterinary students and animal science students do not feel the necessity for acquiring statistical analysis. However, in professional life, there are many instances of the relevance of statistics. Given the above background, we have opened the hands-on training course of statistics in veterinary medicine and animal science using software R. It is our intention to provide a statistical technique underlying data analysis relevant to the study of animal health and diseases. For example, we showed how to input data and conduct tests of

significance about therapeutic effects in veterinary science and productivity improvement in the livestock industry.

#### LEARNING OBJECTIVES IN THE EDUCATION PROGRAM

Statistical techniques are an essential part of communicating information about biological phenomena. This seminar will help participants appreciate the proper handling of data and correct how the theory of statistics can be useful to them in veterinary medicine and animal science. To deepen their understandings of the practical technique, various exercises regarding common issues or questions in veterinary medicine and animal science were included in the seminars. We also aim to introduce participants the operating R software, and discuss their study design and analysis. By the end of this seminar, participants should be able to know there are various statistical methods for analysis, and powerful tools and usefulness to work in collaboration with experts.

#### COURSE MATERIALS

- Handout: printed version of a presentation that can include multiple slides per page and space for audience notes.
- Scientific papers: published reports related to veterinary medicine and animal science
- Textbooks (Petrie, 2013, Chikuma, 2012 & Yamada, 2010)
- Computer and software R and RStudio

#### LECTURERS

The seminar were provided by several lecturers who were Statistician, veterinarians and epidemiologists in University of Miyazaki. Three lecturers are necessary to maintain our course and several teaching assistants are helpful for lecturers on each seminar.

#### TARGET PARTICIPANTS

- Someone who needs statistical knowledge in study, research and business for veterinary medicine and animal science
- Someone who wants to learn easily and use it in practice
- Someone who wants to learn the statistical analysis with R

The course information were announced via e-mail or mail to our University students and the related organizations such as governments, veterinary service and animal hospitals. Basically, this program is for beginners, and they enter each seminar on their own judgement referring the course information indicated in e-mail/poster/flyer. Example of the course information is available at the following URL;

<http://www.miyazaki-u.ac.jp/cadic/include/data/article/ja/docs/1497243612-1.pdf>

#### FUNDING

These programs were supported by Center of Animal Disease Control in University of Miyazaki.

#### RESULTS

Most participants joined the program at one period, and some of them joined all periods. The number of participants was about 20 a seminar on average in the first period. In the second and third period, it was about 10 a seminar on average, respectively. In the fourth period, it was about 30 a Japanese seminar on average, and 50 an English seminar (filled to capacity).

- The first period (Table 1)

We gave lectures using Japanese and international scientific paper related to veterinary medicine and animal science (Figure 1A). Participants and lecturers discussed about the topic after the presentation provided by lecturer (Figure 1B).

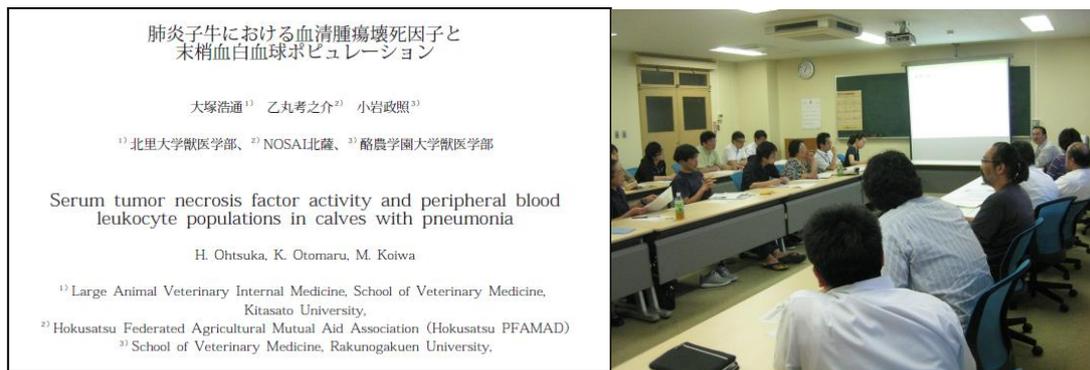


Figure 1. Lectures in the first period. Japanese scientific papers were used as reference materials to learn each topic (left). Participants and lecture were discussed about the statistical analysis in the scientific papers (right).

Table 1. Contents of the first period.

No.	Date	Contents	Type	Materials
1st	28 May, 2012	Learning statistics from case study	Lecture	Scientific paper
2nd	25 June, 2012	Learning multiple comparison and correlation from basic	Lecture	Scientific paper
3rd	30 July, 2012	Learning logistic regression and odds ratio from basic (for intermediate)	Lecture	Scientific paper
4th	24 Sep, 2012	Learning logistic regression and odds ratio from basic (for beginner)	Lecture	Scientific paper
5th	29 Oct, 2012	Case control study (for intermediate)	Lecture	Scientific paper
6th	26 Nov, 2012	Case control study (for beginner)	Lecture	Scientific paper
7th	17 Dec, 2012	The role of statistics in medical research	Lecture	Textbook
8th	28 Jan, 2013	Descriptive statistics	Lecture	Textbook
9th	18 Feb, 2013	Introduction of statistical test	Lecture	Textbook
10th	25 Mar, 2013	Multiplicity and multiple comparison	Lecture	Textbook
11th	22 Apr, 2013	Study design of medical research and analysis	Lecture	Textbook
12th	27 May, 2013	Introduction of odds ratio and logistic regression	Lecture	Textbook
13th	24 June, 2013	Introduction of odds ratio and logistic regression (continued)	Lecture	Textbook
14th	22 July, 2013	Hazard ratio and introduction of survival analysis	Lecture	Textbook
15th	30 Sep, 2013	Announcement of Japan Statistical Society Certificate	Lecture	Textbook
16th	25 Nov, 2013	The points to note about modeling and case study	Lecture	Textbook
17th	10 Mar, 2014	Review of statistic seminar in 2012 and 2013	Discussion	Handout

- The second period (Table 2)

Participants who attended the first period requested to learn more practical method using statistical software. Then, we gave the lectures and exercises using sample data and software R. Participants learned the methodology in the first day, and they practiced statistical analysis using the sample data with R software by themselves in the second day.

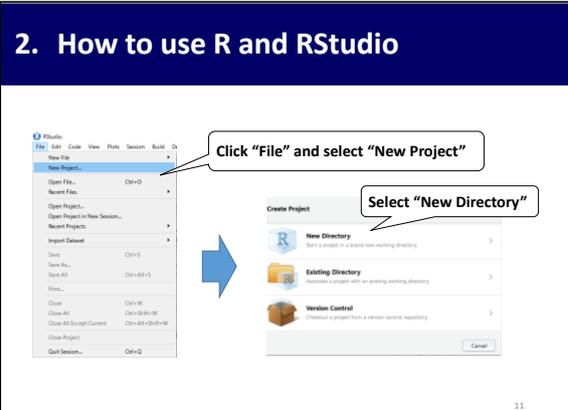
Table 2. Contents of the second period.

No.	Date	Contents	Type	Materials
18th	28 Apr, 2014	Descriptive statistics	Lecture	Textbook
19th	26 May, 2014	Descriptive statistics	Exercise	Computer & Handout
20th	30 June, 2014	Introduction of statistical test	Lecture	Textbook
21st	28 July, 2014	Introduction of statistical test	Exercise	Computer & Handout
22nd	29 Sep, 2014	Multiplicity and multiple comparison	Lecture	Textbook
23rd	27 Oct, 2014	Multiplicity and multiple comparison	Exercise	Computer & Handout
24th	10 Nov, 2014	Study design of medical research and analysis	Lecture	Textbook
25th	22 Dec, 2014	Study design of medical research and analysis	Exercise	Computer & Handout
26th	26 Jan, 2015	Introduction of odds ratio and logistic regression	Lecture	Textbook
27th	23 Feb, 2015	Introduction of odds ratio and logistic regression	Exercise	Computer & Handout
28th	23 Mar, 2015	Hazard ratio and introduction of survival analysis	Lecture	Textbook

- The third period (Table 3)

In the second period, participants learned the technique of statistical analysis using R, but the exercise used in each seminar were focused on the specific topic and fragmentary knowledge. To overcome this issue, we have revised our handout and its contents so that participants could learn systematically the methods of statistical analysis in the third period. For example, participants learned how to choose appropriate test for numerical or ordinal variables. We also gave exercises using sample data and software R from basic to applied analysis. Participants learned the way to use R and RStudio, and practiced statistical analysis using the sample data by themselves (Figure 2).

### 2. How to use R and RStudio



Click "File" and select "New Project"

Select "New Directory"

### 3. Input data and loading external data

✳Basic format of data input

When using Excel to input data, 1<sup>st</sup> line should be Variable name, and 2<sup>nd</sup> line and after should be individual data.

1<sup>st</sup> line: Variable name

2<sup>nd</sup> line and after: individual data

ex) dataset\_20170530\_1

ID	group	weight	height	length	chest
1	A	580	167	178	211
2	A	534	83	153	199
3	A	555	98	179	172
4	A	554	151	115	229
5	A	552	101	161	219
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
146	C	671	116	127	176
147	C	509	153	103	170
148	C	487	125	159	120
149	C	540	176	122	182
150	C	588	91	149	178

Figure 2. Sample of the hand out used in the third period. The explanation of the way to use RStudio (left) and loading external data into RStudio (right).

Table 3. Contents of the third period

No.	Date	Contents	Type	Materials
29th	25 May, 2015	R and statistics	Exercise	Computer & Handout
30th	26 June, 2015	Special lecture of epidemiology	Lecture	NA
31st	29 July, 2015	Descriptive statistics	Exercise	Computer & Handout
32nd	28 Sep, 2015	Statistical test	Exercise	Computer & Handout
33rd	26 Oct, 2015	Comparison of two groups	Exercise	Computer & Handout
34th	30 Nov, 2015	Comparison of multiple groups	Exercise	Computer & Handout
35th	21 Dec, 2015	Comparison of multiple groups (continued)	Exercise	Computer & Handout
36th	25 Jan, 2016	Regression analysis	Exercise	Computer & Handout
37th	29 Feb, 2016	Regression analysis (continued)	Exercise	Computer & Handout
38th	25 Apr, 2016	R and statistics	Exercise	Computer & Handout
39th	25 May, 2016	R and statistics	Exercise	Computer & Handout
40th	27 June, 2016	Comparison of multiple groups	Exercise	Computer & Handout
41st	27 July, 2016	Comparison of multiple groups	Exercise	Computer & Handout
42nd	26 Sep, 2016	Count data analysis	Exercise	Computer & Handout
43rd	26 Oct, 2016	Count data analysis	Exercise	Computer & Handout
44th	26 Nov, 2016	Workshop of EZR	Exercise	Computer & Handout
45th	14 Dec, 2016	Statistical consulting	Exercise	Computer & Handout
46th	30 Jan, 2017	Regression analysis	Exercise	Computer & Handout
47th	22 Feb, 2017	Regression analysis	Exercise	Computer & Handout

- The fourth period (Table 4)

Participants who attended the third period suggested that it was difficult to attend the seminar frequently. They preferred more intensive lecture to short time and frequent seminar. Foreign students also requested to give them lecture in English. In response to their request, we gave exercises twice a year (basic course and applied course) in Japanese and English, respectively (Figure 3).

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graph TD
    A[Compare between two groups] --> B[Independent]
    A --> C[Paired]
    B --> D[Normal distribution]
    B --> E[Non-normal distribution (unknown)]
    C --> F[Normal distribution of the difference between the paired values]
    C --> G[Non-Normal distribution of the difference between the paired values (unknown)]
    D --> H[Equal variance]
    D --> I[Unequal variance]
    E --> J[Wilcoxon rank sum test]
    F --> K[Paired t-test]
    G --> L[Wilcoxon signed rank test]
    H --> M[Two sample t-test]
    I --> N[Welch's test]
    
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Figure 3. Statistical analysis (left). Participants including foreign students practiced statistical analysis using the sample data with R software by themselves (right).

Table 4. Contents of the third period

No.	Date	Contents	Type	Materials
48th	30 May, 2017	Basic biostatistics in Japanese	Exercise	Computer & Handout
49th	4 July, 2017	Basic biostatistics in English	Exercise	Computer & Handout
50th	3 Oct, 2017	Applied biostatistics in Japanese	Exercise	Computer & Handout
51st	21 Oct, 2017	Special lecture: Analysis of repeated measures data	Lecture	Computer & Handout
52nd	5 Dec, 2017	Applied biostatistics in English	Exercise	Computer & Handout

#### PARTICIPANTS' OUTCOMES

1. Veterinarians understood the way to use R software and employed it for EBVM in practice. They published scientific papers and presented in the academic meetings about those results of therapeutic efficacy.
2. Veterinary officers were able to evaluate the efficacy of preventive measures of animal infectious disease in livestock, and make science-based decision-making. They also presented those results in academic meetings.
3. More than 100 students who participated in our program graduated and received bachelor's degree, master or doctorate so far.
4. Two participants have challenged Japan Statistical Society Certificate (JSSC) test and both successfully passed it.

#### DISCUSSION

Most veterinarians and people who are engaged in animal science are interested in practical technique rather than theoretical knowledge of statistics. We have provided hands-on training course of statistics in veterinary medicine and animal science using software R. The topics taken up in the seminar were requested from participants. This "demand-oriented" approach is very practical and motivates participants to learn initiatively. In addition, we have received many suggestions to improve the seminar from participants. Following the feedback, we have evolved the seminar style and approach. We could say that one of the most important things for statistical educators is to understand what participants need or what they have trouble with in their workspace. We are continually improving our education program by utilizing the PDCA (Plan-Do-Check-Act) cycle.

#### CONCLUSION

Demand for statistical analysis in the workplace is growing. Nevertheless, it is difficult for veterinarians and research workers to analyze data since they have had few opportunities to get practical education. We have produced postgraduate education system with the hands-on training course of statistics in veterinary medicine and animal science. We hope our activities could contribute greatly towards promoting statistics education in the workplace.

#### REFERENCES

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