Cairo University
Faculty of Veterinary Medicine

Scientific Research Skills & Ethics (NDC 1000)

Data Presentation

(Data visualization)

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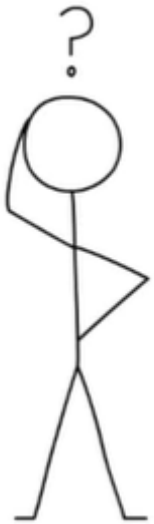
December 10th, 2019

From my previous lecture
Nov. 19th, 2019

Study

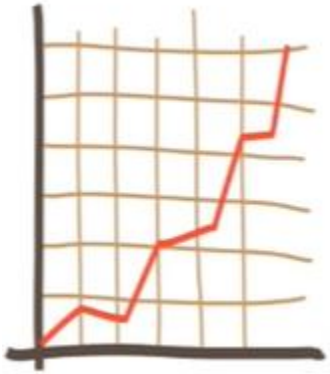
Is a scientific process of answering a question using data from a population

Study question



Select a study type

Collect and analyze data

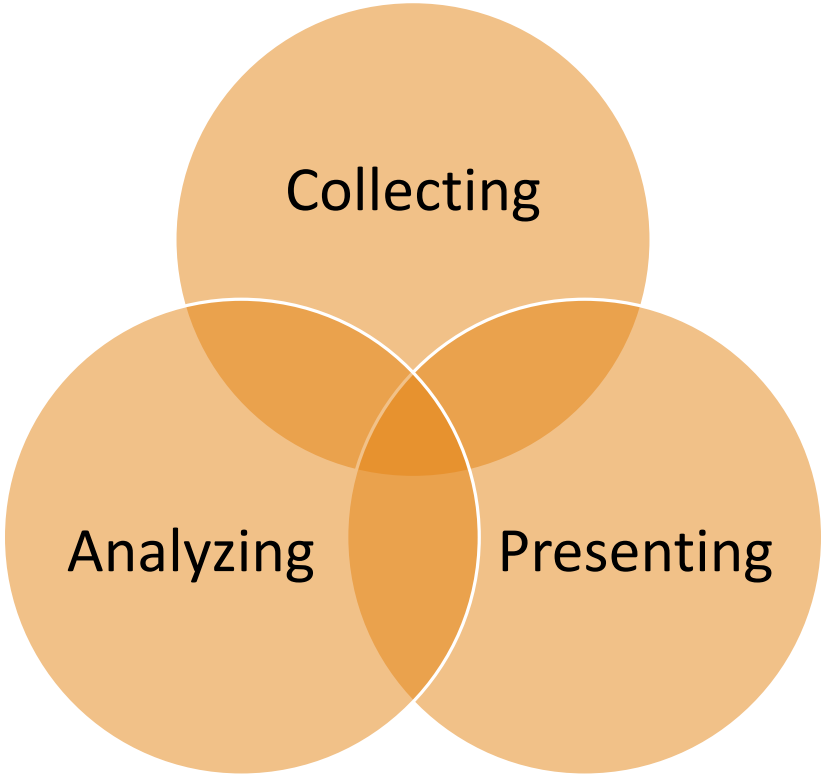


Interpret and report results

From the previous lecture
by Dr. Elshaimaa Ismael
Dec. 3rd, 2019

Statistics = Dealing with data

Data are measurements or observations that are collected as a source of information.



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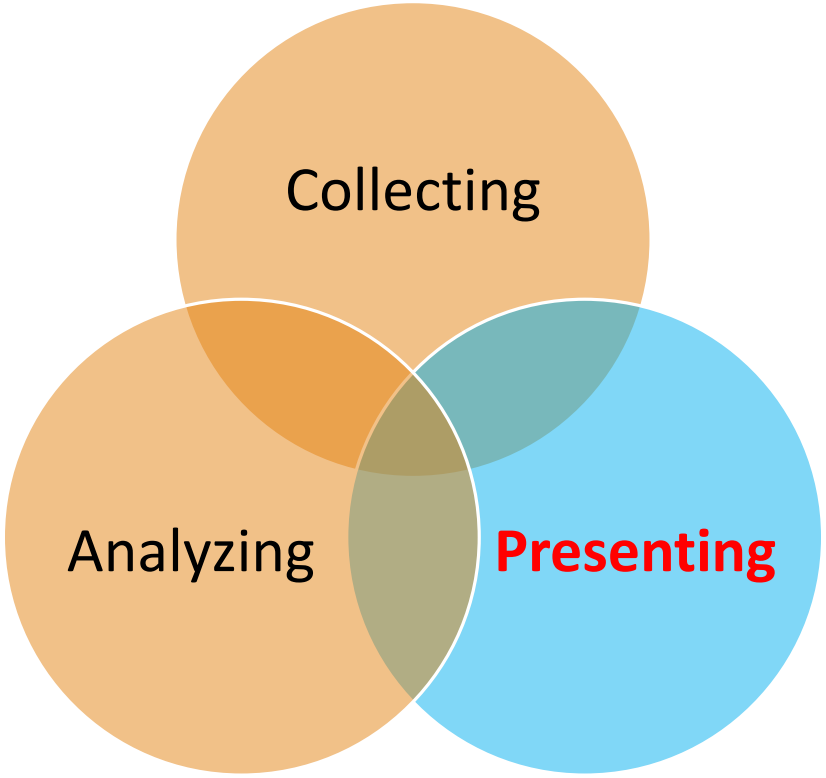

Data

- Set of facts
- Provide a partial picture of reality
- The end products of research

Data are collected in a raw format (difficult to understand).

Raw data

summarized,
organized,
and analyzed

information derived from the raw data should be

presented in an effective format

Data

- Should be **presented** in a certain way depending on **what it is used for**.

- Planning how the data will be presented is essential **before** appropriately **processing raw data**.

- You should present representative data rather than endlessly repetitive data.

John Wesley Powell - geologist, professor at Illinois Wesleyan University
The president of the American Association for the Advancement of Science in 1888

**"The fool collects facts;
the wise man selects them."**

1834 - 1902

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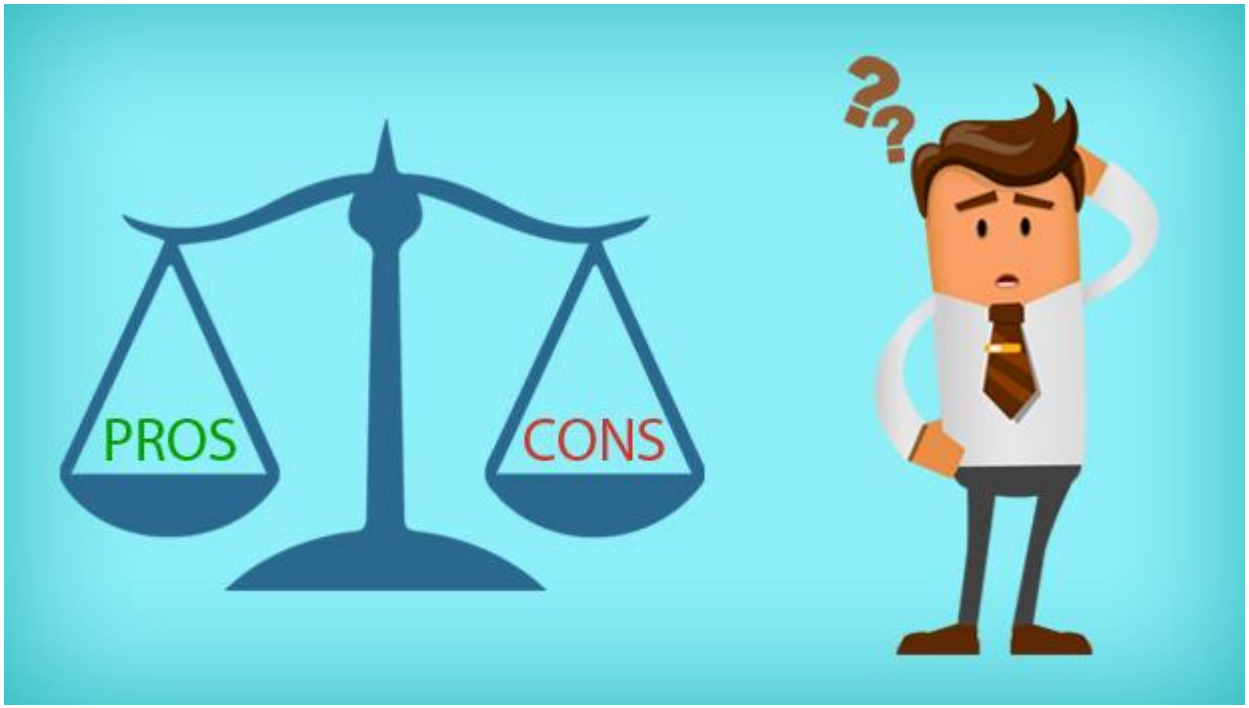
Data Presentation

- Data can be presented in one of the three ways:
  1. **Text**
  2. **Tables**
  3. **Graphs** (graphs, plots, or charts)

- Methods of presentation must be determined according to:
  - **Data format**
  - **Method of analysis**
  - **Information to be emphasized**

Data Presentation

- Choosing the method of data presentation must be **after** carefully weighing the **advantages** and **disadvantages** of different methods of presentation.



1) Text Presentation

- Used to **explain** results and trends
- Data are fundamentally presented in **paragraphs** or **sentences**.
- Text can be used to provide interpretation or emphasize certain data.

❑ **If quantitative information to be conveyed consists of one or two numbers**

✓ more appropriate to use written language (text) than tables or graphs

"The incidence rate of hallucination following anesthesia was **11% in 2016** and **15% in 2017**; no significant difference of incidence rates was found between the two years."

✓ If **more data** are to be presented, or other information such as that regarding **data trends** are to be conveyed ➔ a table or a graph would be more appropriate

✓ Data **take longer to read** when presented as texts

✓ If the main text includes **a long list of information**

➔ readers and reviewers may have *difficulties in understanding* the information.

1) Text Presentation

Crystal Clear

Verbiage	No Verbiage
Are you going to be ✗ attending?	Will you attend? ✓

- ✓ should be short and sweet, without verbiage
- ✓ clearly and simply stated

because it constitute the new knowledge that you are contributing to the world

Avoid Redundancy

The **most common fault** is the repetition in words of what is already apparent to the reader from examining the figures and tables

2) Table Presentation

- Information has been converted into **words or numbers** in **rows and columns**.
- Anyone with a sufficient level of literacy can **easily understand** the information presented in a table.
- The most appropriate for **presenting individual information**
- Can present both **quantitative and qualitative** information.

2) Table Presentation

- Example of **quantitative** information:

TABLE 2 Monthly averages, standard deviations (*SD*) and coefficient of variation (CV) for water temperature during the 2012, 2013 and 2015 growing seasons in 21 ponds at an inland, low-salinity shrimp farm in Alabama. The letter S designated that ponds were stocked in May and could not be used in average. The letter H designated that ponds were harvested in September

	May			June			July			August			September			October			Mean[a]		
Pond	2012	2013	2015	2012	2013	2015	2012	2013	2015	2012	2013	2015	2012	2013	2015	2012	2013	2015	2012	2013	2015
N–1	29.95	26.77	25.17	29.94	30.57	30.01	31.38	30.58	31.51	29.82	30.65	30.46	27.58	29.51	27.65	H	H	H	29.71	29.89	29.32
N–2	–	25.66	25.20	–	28.95	29.37	–	29.58	30.65	–	30.24	29.98	–	29.94	27.60	–	H	23.34	–	29.08	28.64
N–3	27.91	26.31	26.03	29.98	30.28	30.47	31.37	30.25	31.49	29.92	30.64	30.43	28.25	29.51	29.64	H	H	H	29.60	29.69	29.97
N–4	27.52	26.91	S	29.86	30.24	29.39	31.12	29.83	31.25	29.60	30.27	30.32	27.17	28.54	27.89	23.92	25.28	21.78	29.03	29.13	28.60
N–5	–	27.05	–	–	30.12	–	–	29.91	–	–	30.55	–	–	28.87	–	–	H	–	–	29.49	–
N–6	26.83	25.94	S	29.62	30.04	29.73	31.24	29.99	31.68	29.77	30.40	30.50	27.11	28.52	27.97	22.34	24.37	26.32	28.52	28.85	29.99
N–7	28.06	–	S	29.73	–	28.61	31.18	–	31.63	29.88	–	30.37	27.39	–	27.74	22.88	–	20.86	28.69	–	29.26
N–8	27.11	25.58	25.93	29.70	29.80	30.19	31.29	30.13	31.58	30.03	30.71	30.52	28.79	28.95	28.09	H	25.35	22.20	29.45	28.97	29.36
N–9	26.93	–	–	29.39	–	–	31.06	–	–	29.81	–	–	27.57	–	–	H	–	–	29.00	–	–
N–10	26.87	25.22	24.98	29.37	29.07	29.07	30.86	29.79	31.10	29.48	30.37	29.89	28.46	28.73	28.27	H	25.33	H	29.13	29.27	29.04
N–11	28.40	22.85	24.70	30.12	29.80	28.89	31.30	30.15	31.07	29.71	30.52	30.06	28.23	28.77	27.91	H	25.97	H	29.88	28.76	28.89
N–12	28.08	S	23.44	29.52	27.98	29.68	31.15	29.31	31.06	29.65	29.87	30.23	27.10	30.35	29.63	H	H	H	29.53	29.24	29.25
N–14	–	–	26.49	–	–	30.15	–	–	31.39	–	–	30.43	–	–	27.95	–	–	22.55	–	–	28.98
S–1	27.68	27.69	26.37	29.36	30.04	29.85	31.03	29.96	31.44	29.57	30.42	30.16	27.38	30.02	27.65	H	H	20.80	29.07	30.02	28.93
S–2	27.30	–	S	29.72	–	29.99	31.26	–	31.73	29.73	–	30.45	27.23	–	27.94	22.75	–	21.53	28.71	–	28.77
S–3	29.16	27.85	–	29.97	28.89	–	31.18	29.75	–	29.72	30.35	–	27.26	28.47	–	22.56	24.23	–	28.85	28.59	–
S–4	29.76	–	S	29.82	–	28.05	30.45	–	30.84	29.22	–	29.74	27.17	–	27.61	22.77	–	22.31	28.52	–	28.29
S–5	27.56	27.50	–	29.56	29.55	–	31.20	29.73	–	29.96	30.12	–	27.49	28.73	–	22.94	25.15	–	28.60	29.00	–
S–6	26.54	–	–	29.23	–	–	30.84	–	–	29.58	–	–	28.69	–	–	H	–	–	29.03	–	–
S–7	–	24.68	–	–	30.00	–	–	30.05	–	–	30.64	–	–	28.86	–	–	25.16	–	–	28.75	–
S–8	26.97	26.92	S	29.53	29.87	30.36	31.24	30.24	31.90	29.97	30.83	30.66	27.48	30.12	28.18	23.19	H	H	28.80	29.82	30.40
Mean[b]	27.49	25.95	25.37	29.67	29.70	29.59	31.13	29.95	31.35	29.73	30.44	30.28	27.53	29.05	28.03	22.78	24.93	21.92	29.03	29.21	29.16
SD	2.00	2.35	1.88	1.80	1.61	1.82	1.78	1.36	1.85	1.33	1.72	1.39	1.87	2.23	2.08	1.78	1.81	2.34	2.53	2.38	2.93
Range[b]	3.40	5.00	3.05	0.89	2.59	2.42	0.94	1.27	1.25	0.81	0.96	0.92	1.68	1.88	2.04	1.58	1.74	5.51	1.36	1.42	2.11
CV (%)	7.28	9.06	7.39	6.07	5.41	6.14	5.72	4.53	5.91	4.47	5.65	4.59	6.80	7.68	7.42	7.79	7.24	10.70	8.71	8.16	10.05

[a]Monthly average of hourly water temperature in all ponds. [b]Average of hourly water temperature in individual ponds in all months. [c]Range is the difference between maximum and minimum pond averages of hourly water temperature.

Abdelrahman, Hisham A., Asheber Abebe, and Claude E. Boyd. "Influence of variation in water temperature on survival, growth and yield of Pacific white shrimp Litopenaeus vannamei in inland ponds for low-salinity culture." *Aquaculture research* 50.2 (2019): 658-672.

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2) Table Presentation

- Example of **quantitative** information:

TABLE 1 Means, standard deviations (*SD*) for pond areas and depths, stocking density, stocking dates and amounts of feed applied to 22 study ponds at an inland, low-salinity farm in Alabama during the 2012, 2013, 2014 and 2015 growing seasons

			Stocking data											
			PLs/m^2				Date				Feed applied (kg/ha)			
Pond	Depth (m)	Area (ha)	2012	2013	2014	2015	2012	2013	2014	2015	2012	2013	2014	2015
N–1	1.41	0.49	31	26	31	27	22-May	14-May	22-May	5-May	7,577	6,325	8,079	6,693
N–2	1.32	0.57	33	25	31	27	22-May	14-May	22-May	7-May	4,410	5,867	5,775	6,885
N–3	1.44	1.09	29	25	34	27	27-Apr	14-May	21-May	7-May	7,325	7,267	8,634	6,077
N–4	1.43	1.21	25	25	32	45	30-Apr	13-May	21-May	2-Jun	7,804	8,949	6,785	7,649
N–5	1.22	1.34	26	25	28	28	28-Apr	13-May	22-May	7-May	8,898	8,353	8,214	6,989
N–6	1.34	1.5	26	25	30	75[a]	28-Apr	13-May	9-May	2-Jun	8,949	8,744	6,479	14,213[a]
N–7	1.77	2.02	26	23	30	0[a]	28-Apr	6-Jun	21-May	2-Jun	8,757	5,446	9,461	0[a]
N–8	1.43	1.54	26	24	32	27	30-Apr	13-May	21-May	5-May	6,786	8,220	7,931	7,773
N–9	1.44	1.62	21	23	29	26	30-Apr	14-May	22-May	7-May	5,717	5,850	8,067	5,283
N–10	1.41	1.62	26	22	26	27	27-Apr	27-May	22-May	5-May	5,775	6,121	3,473	6,297
N–11	1.41	1.54	26	22	31	28	22-May	13-May	9-May	5-May	5,166	7,843	8,364	7,521
N–12	1.41	1.9	28	22	18	30	22-May	6-Jun	22-May	5-May	5,311	1,687	2,751	5,543
N–13	–	1.21	–	–	41	28	–	–	21-May	5-May	–	–	6,367	8,164
N–14	–	0.81	–	–	31	28	–	–	21-May	5-May	–	–	6,368	7,670
S–1	1.16	1.17	29	25	26	27	26-Apr	27-May	9-May	5-May	6,622	6,110	5,299	6,840
S–2	1.4	0.89	29	25	25	31	26-Apr	14-May	31-May	2-Jun	9,061	5,794	2,669	7,591
S–3	1.19	1.01	32	30	20	29	22-May	27-May	31-May	7-May	6,305	10,337	5,593	4,533
S–4	1.67	1.09	26	26	30	29	22-May	27-May	9-May	3-Jun	5,434	8,908	7,683	3,862
S–5	1.47	0.97	30	25	31	29	11-May	27-May	22-May	5-May	7,992	9,817	10,302	8,785
S–6	1.51	1.42	29	26	30	27	26-Apr	9-May	9-May	7-May	6,827	9,778	6,714	5,445
S–7	1.29	1.9	28	29	29	32	26-Apr	9-May	9-May	2-Jun	6,585	8,522	6,967	5,561
S–8	1.49	1.94	28	25	33	28	26-Apr	14-May	9-May	3-Jun	8,116	7,151	9,841	4,451
Mean	1.41	1.31	27.77	25.00	29.49	29.83	–	–	–	–	6,971	7,355	6,901	6,537
SD	0.14	0.43	2.63	2.07	4.48	12.15	–	–	–	–	1,368	1974	2037	2,490

Note. Ponds N-13 and N-14 were newly constructed in 2014. Their depths were not measured.
[a]In 2015, N-6 and N-7 were connected together to form split-pond system. N-7 had neither PLs nor feed.

Abdelrahman, Hisham A., Asheber Abebe, and Claude E. Boyd. "Influence of variation in water temperature on survival, growth and yield of Pacific white shrimp Litopenaeus vannamei in inland ponds for low-salinity culture." *Aquaculture research* 50.2 (2019): 658-672.

2) Table Presentation

- Example of **quantitative** information:

Table 2 Results of analysis of covariance (ANCOVA) for main effects and interactions of species-location combination, wet mass (gWW), and temperature (Temp.) on resting metabolic rate (RMR_6), regulation index (RI), and critical dissolved oxygen concentration (DO_{crit})

Effect	RMR_6			RI			DO_{crit}		
	df	*F*	*P*	*df*	*F*	*P*	*df*	*F*	*P*
Species-location	4	13.84	**< 0.0001**	4	61.48	**< 0.0001**	4	4.93	**0.001**
gWW	1	1.24	0.2674	1	0.05	0.8308	1	0.53	0.4697
gWW × species-locations	4	0.54	0.7084	4	2.36	0.0569	4	0.81	0.5212
Temp.	1	405.4	**< 0.0001**	1	7.85	**0.0059**	1	8.81	**0.0036**
Temp. × species-locations	3	0.52	0.6661	3	0.92	0.4308	3	1.34	0.2657

Numbers in bold represent significant effects

Haney, A., Abdelrahman, H. & Stoeckel, J.A. Hydrobiologia (2019). https://doi.org/10.1007/s10750-019-04138-4

2) Table Presentation

- Example of **qualitative** information:

Korean J Anesthesiol. 2016 Feb; 69(1): 8–14.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4754273/

Table 1. Analog of Parametic and Nonparametric Tests

	Parametric tests	Nonparametric tests
One sample	One sample t test	Sign test Wilcoxon's signed rank test
Two sample	Paired t test	Sign test Wilcoxon's signed rank test
	Unpaired t test	Mann-Whitney test Kolmorogov-Smirnov test
K-sample	Analysis of variance	Kruskal-Wallis test Jonckheer test
	2 way analysis of variance	Friedman test

Table 3. ANOVA Table Resulted from the Example

	Sum of squares	Freedom	Mean sum of squares	F	Significance probability
Intergroup	273.875 $\sum_{i=1}^{K} n_i(\bar{Y}_i - \bar{Y})^2$	2 $(K-1)$	136.937 $\sum_{i=1}^{K} n_i(\bar{Y}_i - \bar{Y})^2/(K-1)$	3.629	0.031
Intragroup	3282.843 $\sum_{ij=1}^{n} (Y_{ij} - \bar{Y}_i)^2$	87 $(N-K)$	37.734 $\sum_{ij=1}^{n} (Y_{ij} - \bar{Y}_i)^2/(N-K)$		
Overall	3556.718	89			

$\bar{Y}_i$ is the mean of the group i; n_i is the number of observations of the group i; $\bar{Y}$ is the overall mean; K is the number of groups; Y_{ij} is the j^{th} observational value of group i; and N is the number of all observational values. The F statistic is the ratio of intergroup mean sum of squares to intragroup mean sum of squares.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5296382/pdf/kjae-70-22.pdf

2) Table Presentation

Strengths

- Can accurately present information that cannot be presented with a graph.
- A number such as "132.145852" can be accurately expressed in a table.
- Information with **different units** can be presented together.

For instance, blood pressure, heart rate, number of drugs administered, and anesthesia time can be presented together in one table.

- Useful for summarizing and comparing quantitative information of **different variables**.

Weaknesses

- Interpretation of information **takes longer** in tables than in graphs
- **Not** appropriate for studying data **trends**.
- It is **not easy to** identify and selectively **choose** the information required. (since all data are of equal importance in a table)

2) Table Presentation

Heat maps for better visualization of information than tables

- Heat maps help to further visualize the information presented in a table by **applying colors to the background** of cells.
- Information is conveyed in a **more visible** manner, and readers can quickly identify the information of interest.
- Software such as **Excel** have features that enable easy creation of heat maps through the options available on the "**conditional formatting**" menu.

Table 2. Difference between a Regular Table and a Heat Map

Example of a regular table				Example of a heat map			
SBP	DBP	MBP	HR	SBP	DBP	MBP	HR
128	66	87	87	128	66	87	87
125	43	70	85	125	43	70	85
114	52	68	103	114	52	68	103
111	44	66	79	111	44	66	79
139	61	81	90	139	61	81	90
103	44	61	96	103	44	61	96
94	47	61	83	94	47	61	83

All numbers were created by the author. SBP: systolic blood pressure, DBP: diastolic blood pressure, MBP: mean blood pressure, HR: heart rate.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5453888/

3) Graph Presentation

- Simplify **complex information** by using images
- Emphasizing data **patterns or trends**
- Useful for summarizing, explaining, or exploring **quantitative data**.
- Effective for presenting **large amounts** of data
- Can also be used in place of tables to present small sets of data.

❑ **Frequently used graph formats**

a. **Scatter plot**

b. **Bar graph and histogram**

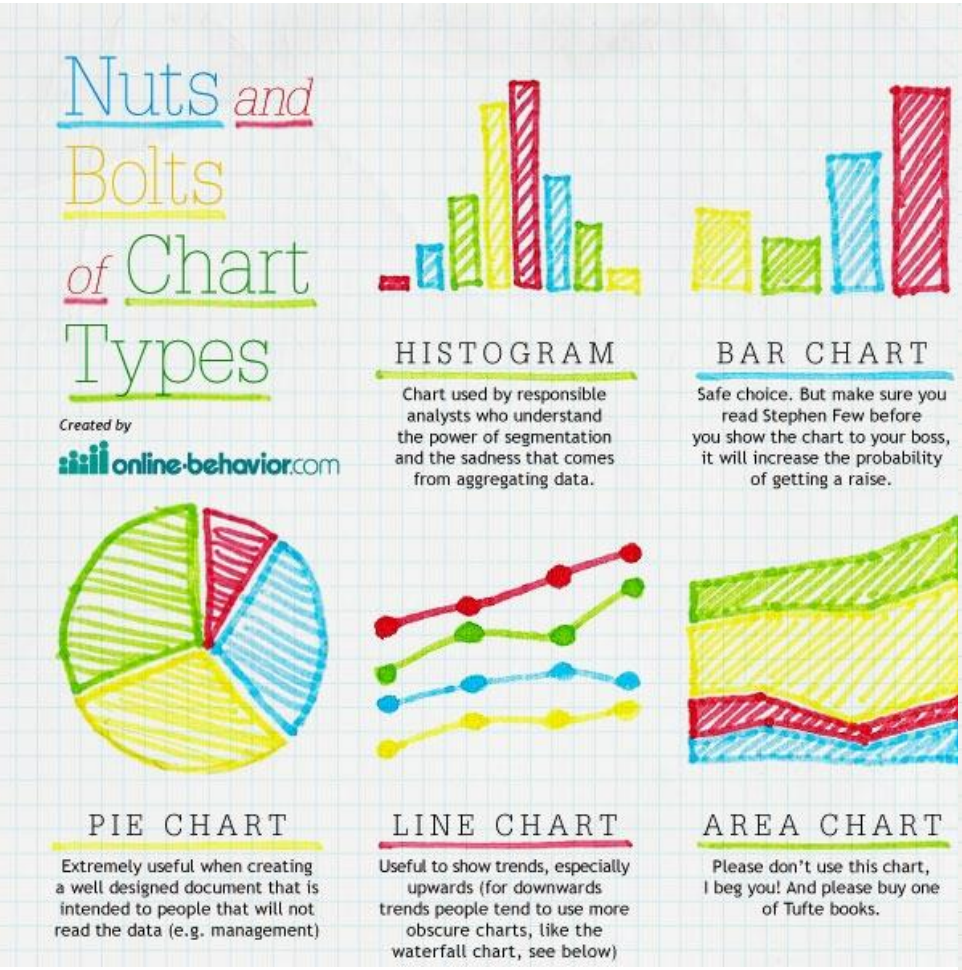
c. **Pie chart**

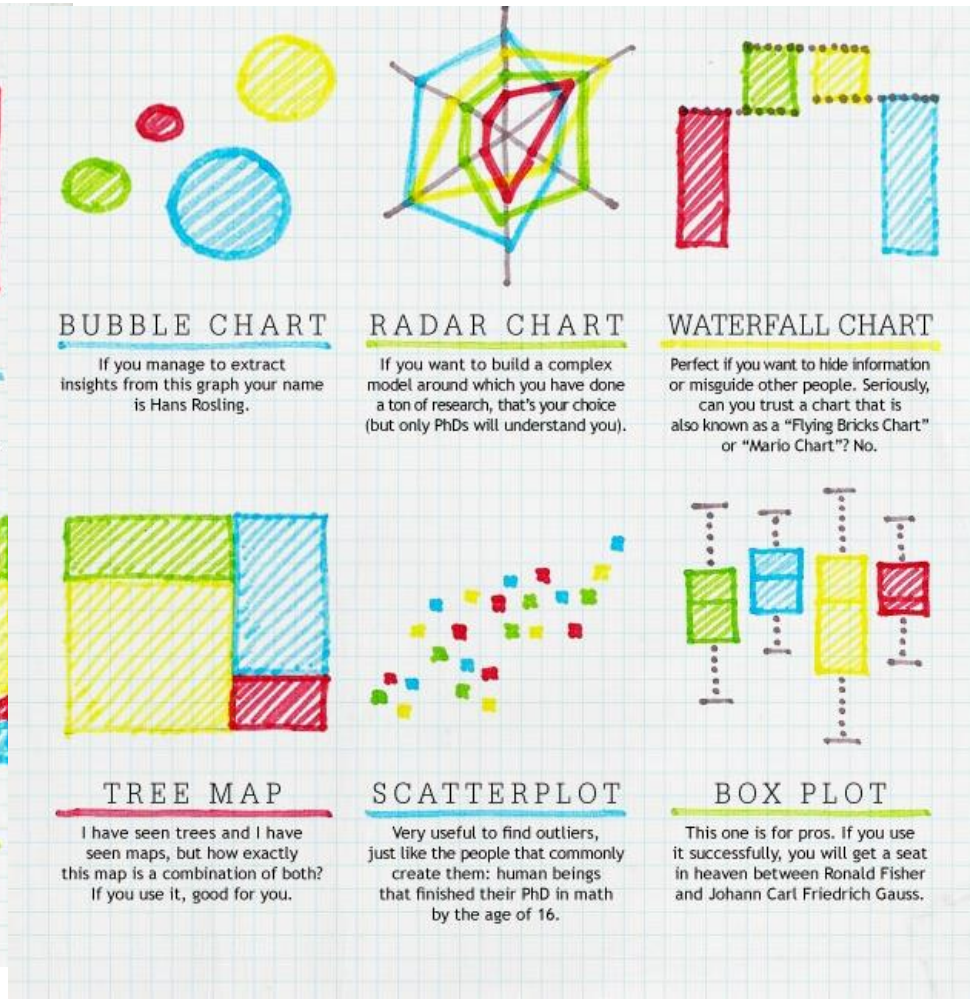
d. **Line plot with whiskers**

e. **Box and whisker chart**

- A graph format that best presents information must be **chosen** so that readers and reviewers can **easily understand** the information.

3) Graph Presentation



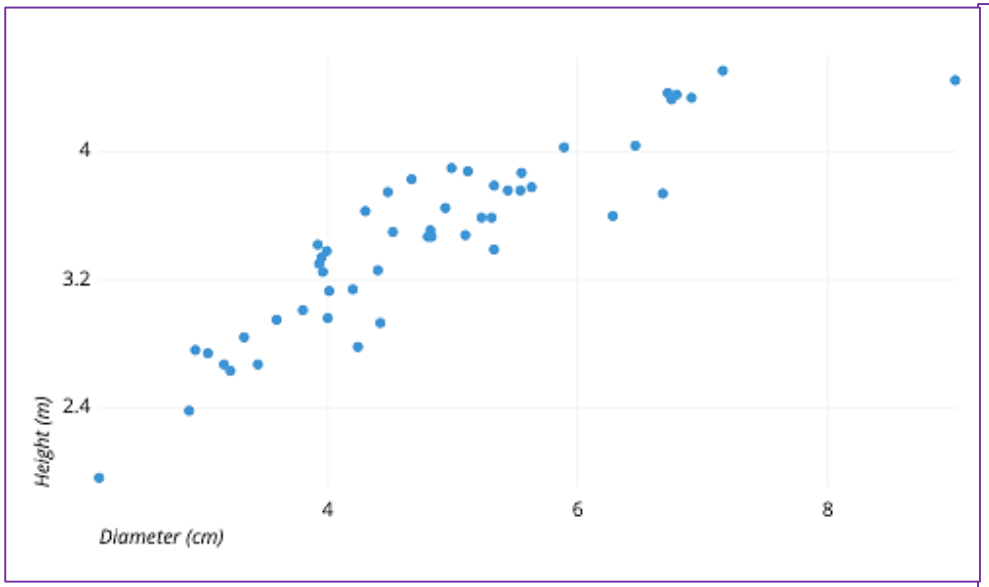


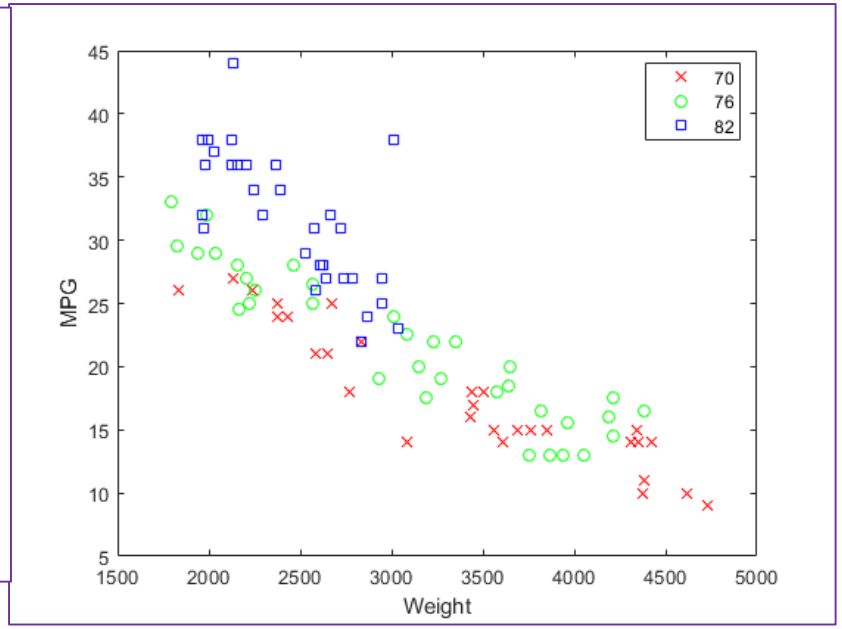
44 Types of Graphs
https://visme.co/blog/types-of-graphs/

3) Graph Presentation

a. Scatter plot

- Present data on the ***x*- and *y*-axes**
- Used to investigate an **association** between two variables.
- A point represents each individual or object, and an association between Two variables can be studied by analyzing patterns across multiple points.





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3) Graph Presentation

a. Scatter plot

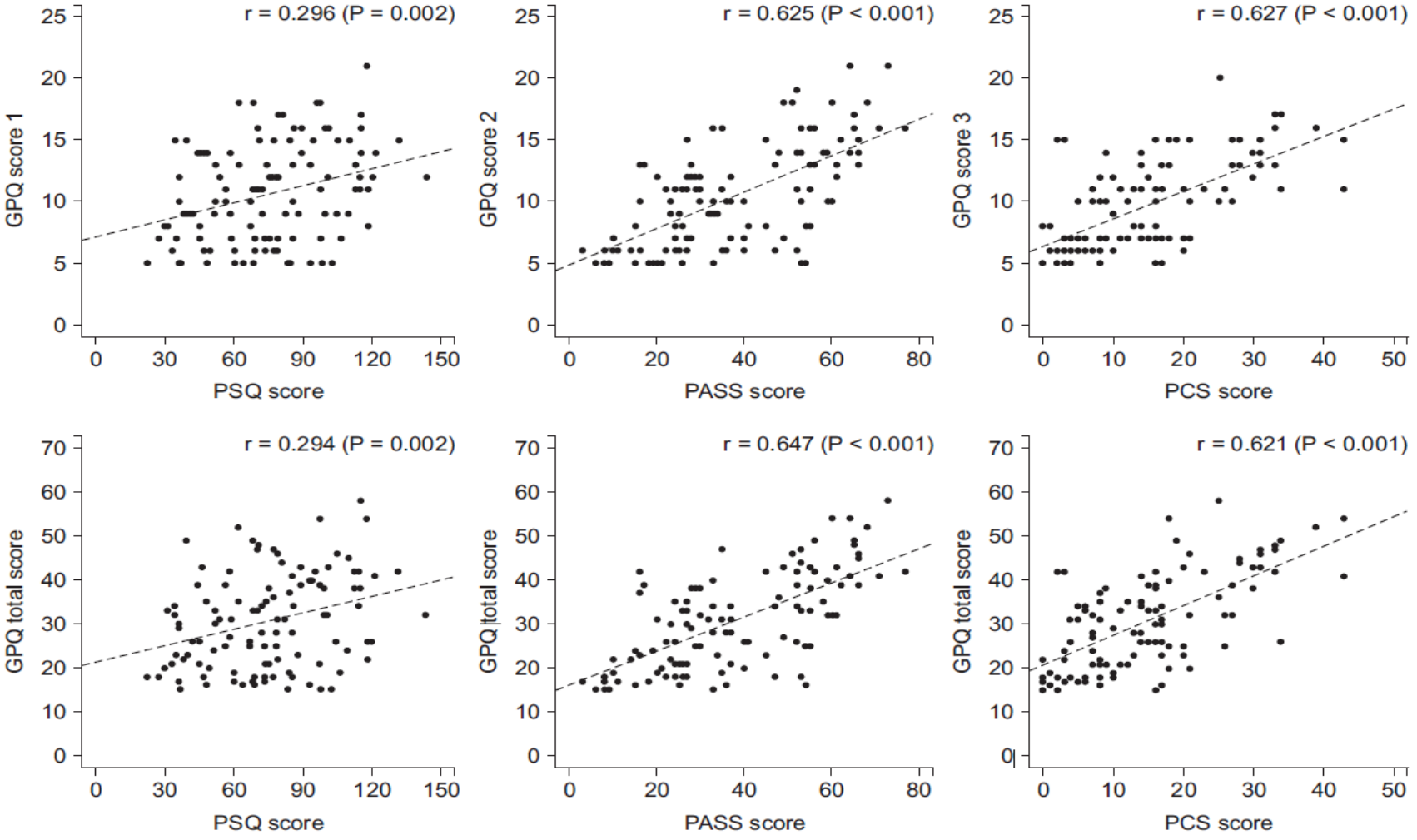
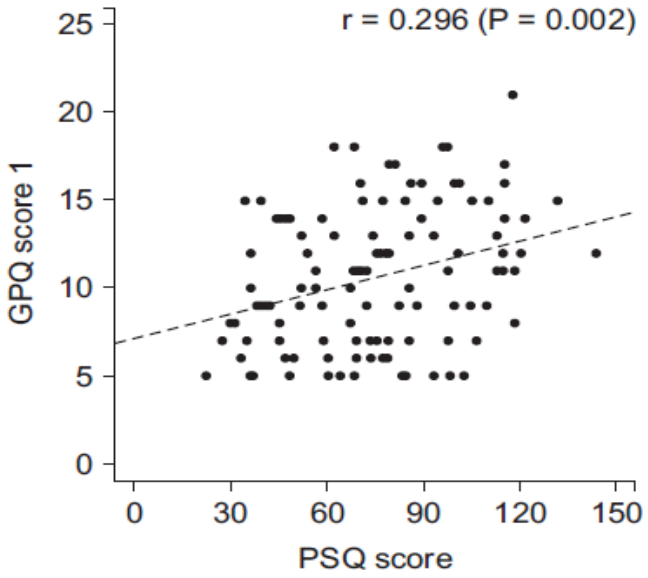


Fig. 2. Scatter plot of GPQ scores and the other questionnaires. Score 1: sensitivity, 2: experience, 3: other. GPQ: Geop-Pain Questionnaire, PSQ: Pain Sensitivity Questionnaire, PASS: Pain Anxiety Symptoms Scale, PCS: Pain Catastrophizing Scale (Adapted from Korean J Anesthesiol 2016; 69: 492-505).

3) Graph Presentation

a. Scatter plot

- A **regression/correlation line** is added to a graph to determine whether the association between two variables can be explained or not.



Example:

correlations between pain scoring systems that are currently used (PSQ, Pain Sensitivity Questionnaire;

- PASS, Pain Anxiety Symptoms Scale; PCS, Pain Catastrophizing Scale) and Geop-Pain Questionnaire (GPQ)

- Notice:

correlation coefficient (r) and regression line indicated on the scatter plot.

- added to further elucidate the correlation.

3) Graph Presentation

a. Scatter plot

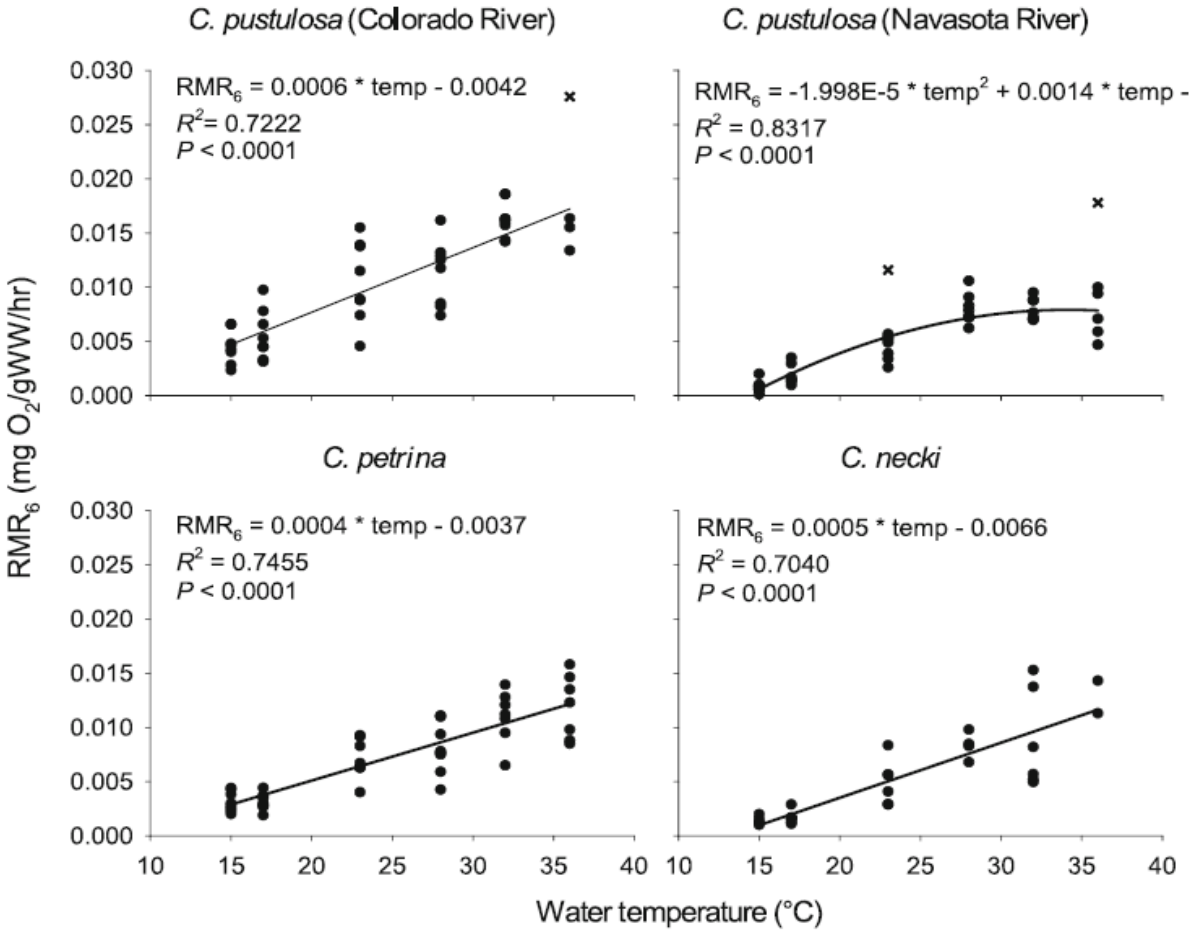


Fig. 3 Relationship between resting metabolic rate at 6 mg O_2/l (RMR_6) and water temperature (temp) for the four mussel populations tested. Black circles represent respiration rates of individual mussels. "*X*" symbols represent outliers (studentized residuals > 3) that were removed. Lines represent the best fit regression through each dataset excluding outliers

Haney, A., Abdelrahman, H. & Stoeckel, J.A. Hydrobiologia (2019). https://doi.org/10.1007/s10750-019-04138-4

3) Graph Presentation

a. Scatter plot

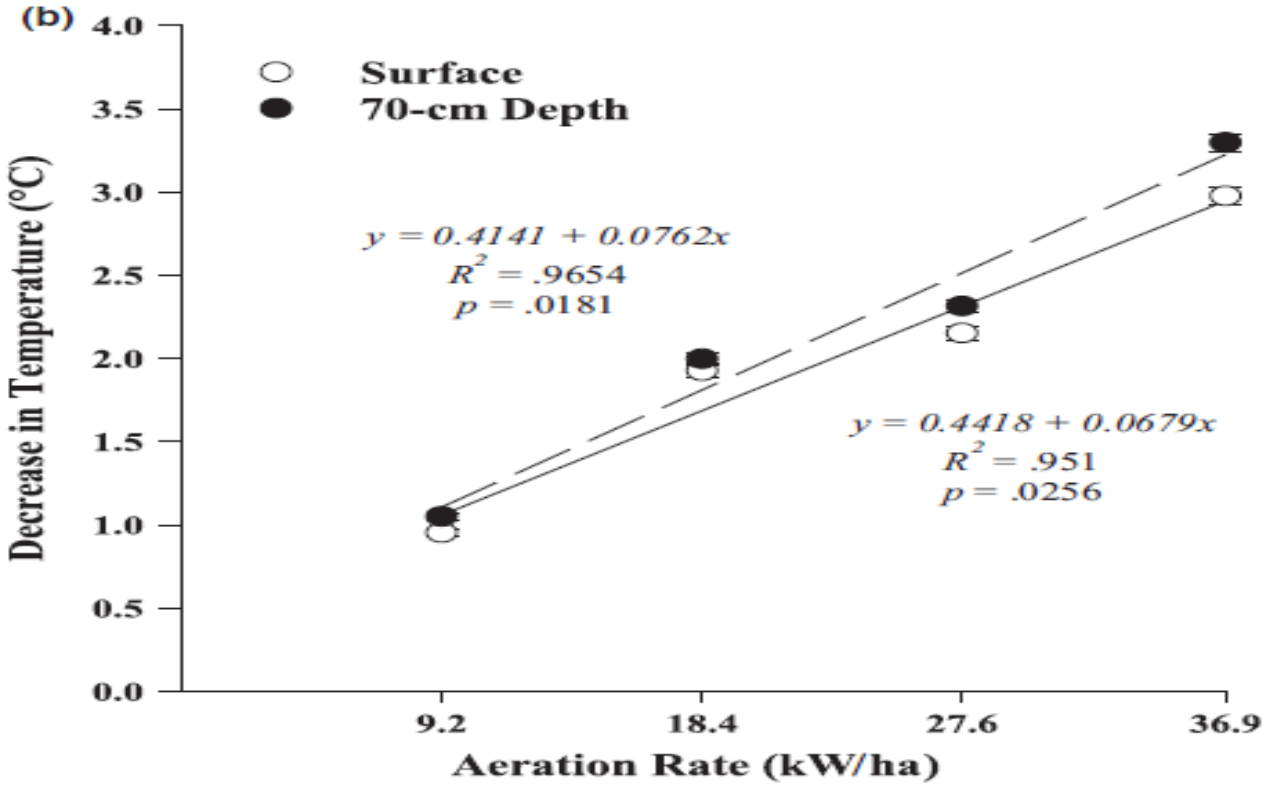


FIGURE 2 Relationships between the aeration rate (kW/ha), and the mean for differences in water temperature—at the surface and 70-cm depth—between aerated ponds and the nutrient-enriched control pond when aerators were operated continuously during daytime (a), and night-time (b)

Abdelrahman, Hisham A., and Claude E. Boyd. "Effects of mechanical aeration on evaporation rate and water temperature in aquaculture ponds." *Aquaculture research* 49.6 (2018): 2184-2192.

3) Graph Presentation

b. Bar graph and histogram

- used to indicate and compare **values** in a discrete category or group

  Values are :

  - ❑ frequency ➔ Histogram
  - ❑ measurement parameters (i.e. mean) ➔ bar graph

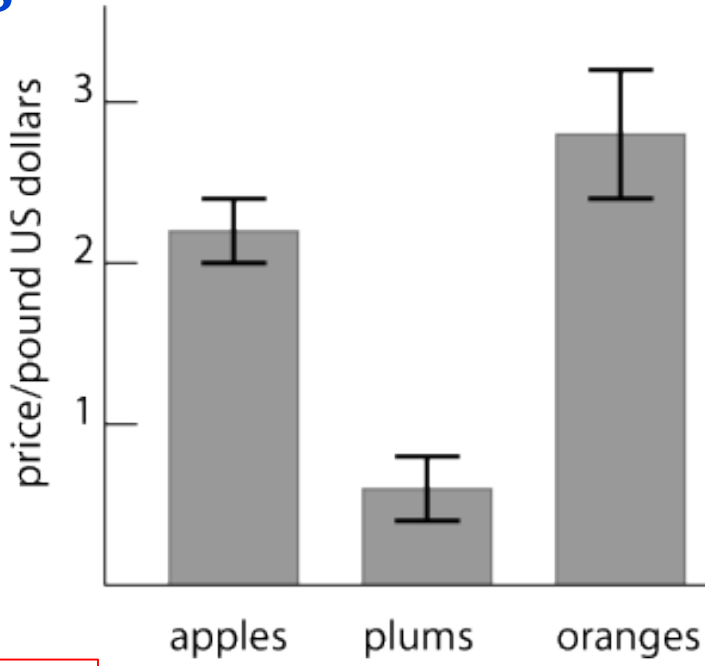
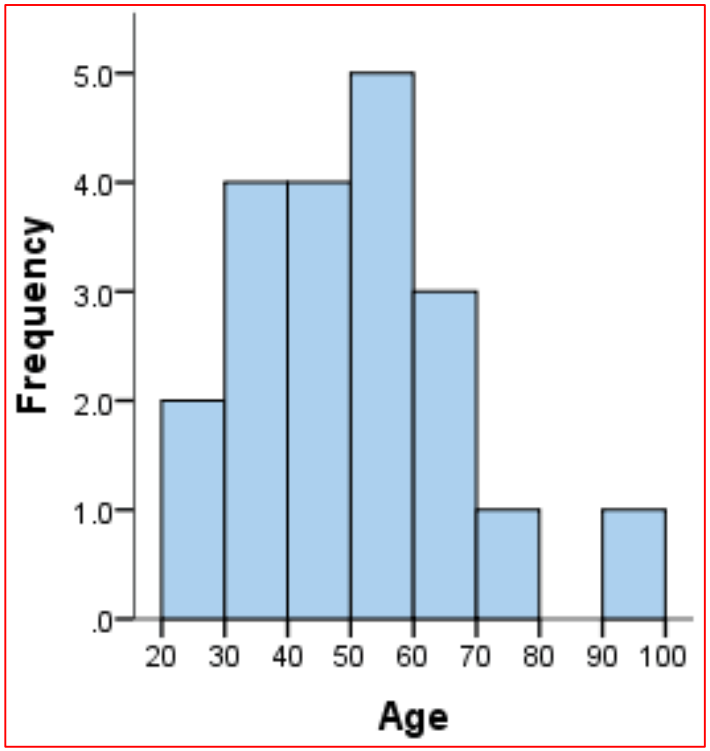
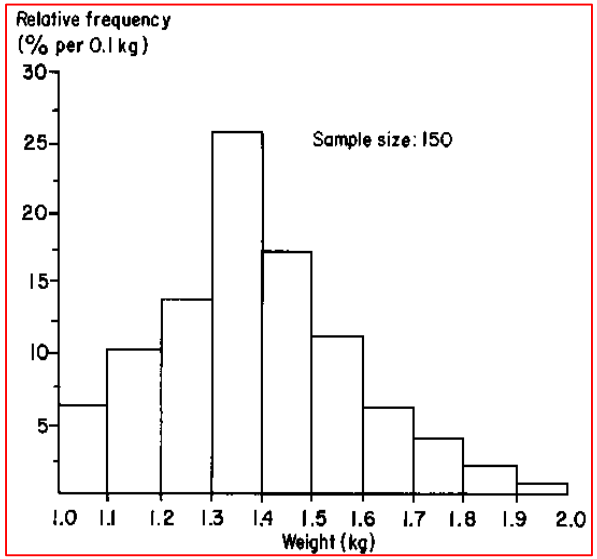


Fig 1. Cost comparison among three common fruit items based on prices in twelve major cities (bars represent standard deviation of the mean).





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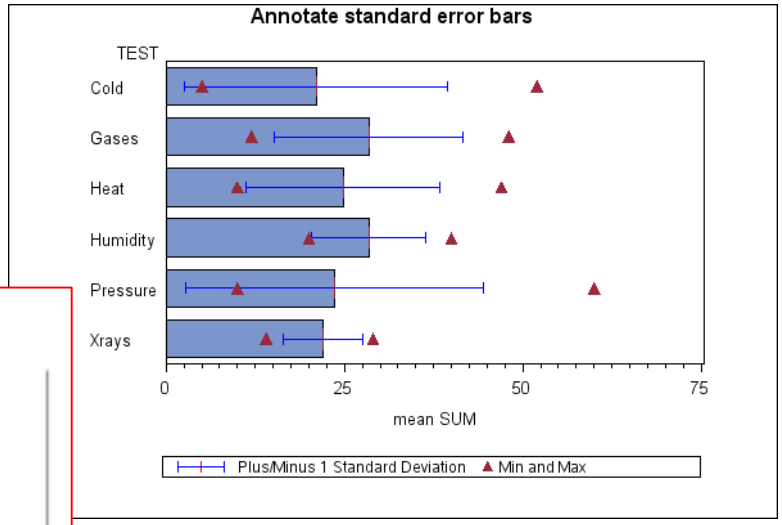
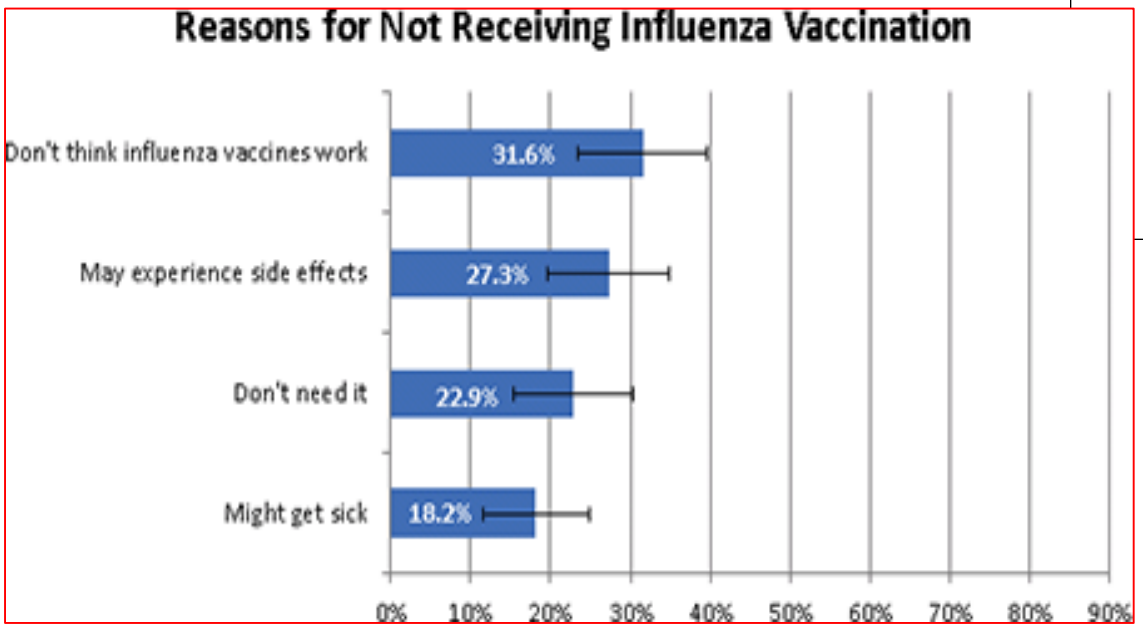
3) Graph Presentation

b. Bar graph and histogram

- Bars may be created vertically or horizontally.

- The height (or length) of a bar represents the amount of information in a category.





3) Graph Presentation

b. Bar graph and histogram

❑ Bar graphs are flexible, and can be used in a grouped or subdivided bar format in cases of two or more data sets in each category.

- ❑ Example of a grouped **vertical** bar graph
  - ***x*-axis** ➔ the length of recovery room stay and drug-treated group
  - ***y*-axis** ➔ the visual analog scale (VAS) score.
  - The mean and standard deviation of the VAS scores are expressed as whiskers on the bars

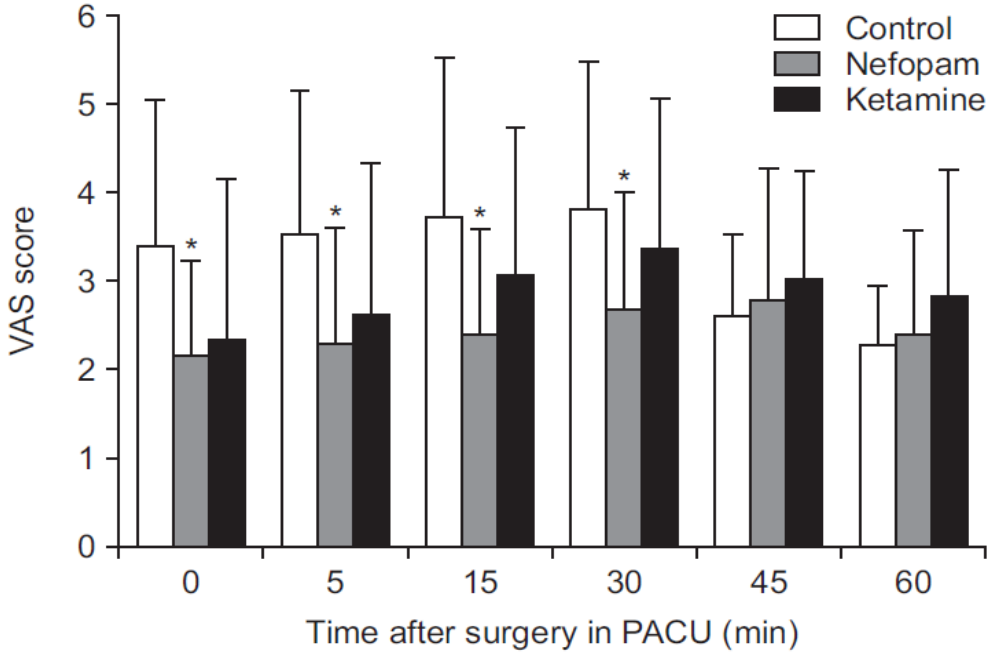
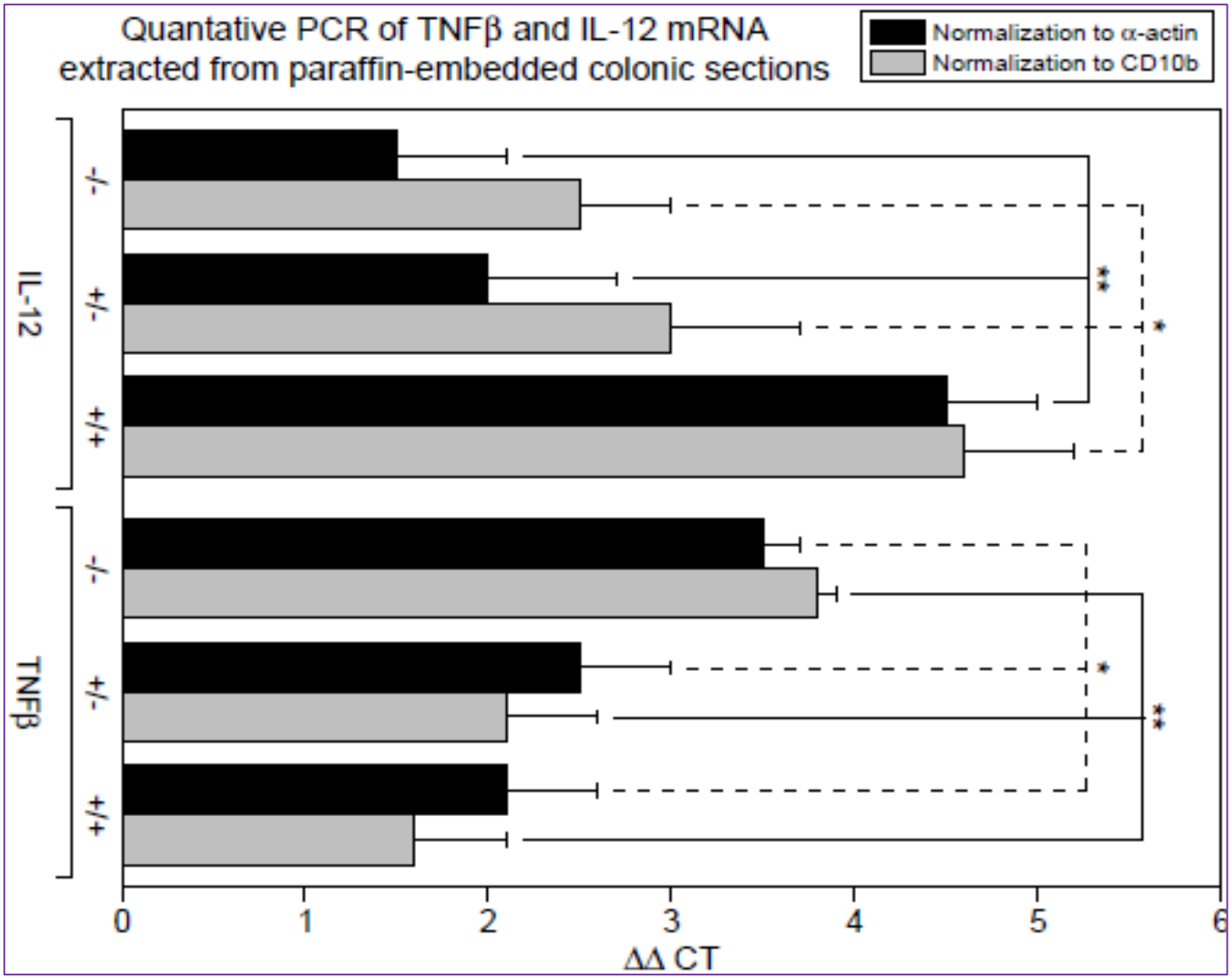


Fig. 3. Multiple bar graph with whiskers. Pain scores in the recovery room. *P < 0.05 compared with the control group. The nefopam group showed significant lower visual analogue scale (VAS) score at 0, 5, 15, 30, 45 and 60 minutes on postanesthesia care unit compared with the control group (Adapted from Korean J Anesthesiol 2016; 69: 480-6. Fig. 2).

3) Graph Presentation

b. Bar graph and histogram

- Example of a grouped **horizontal** bar graph

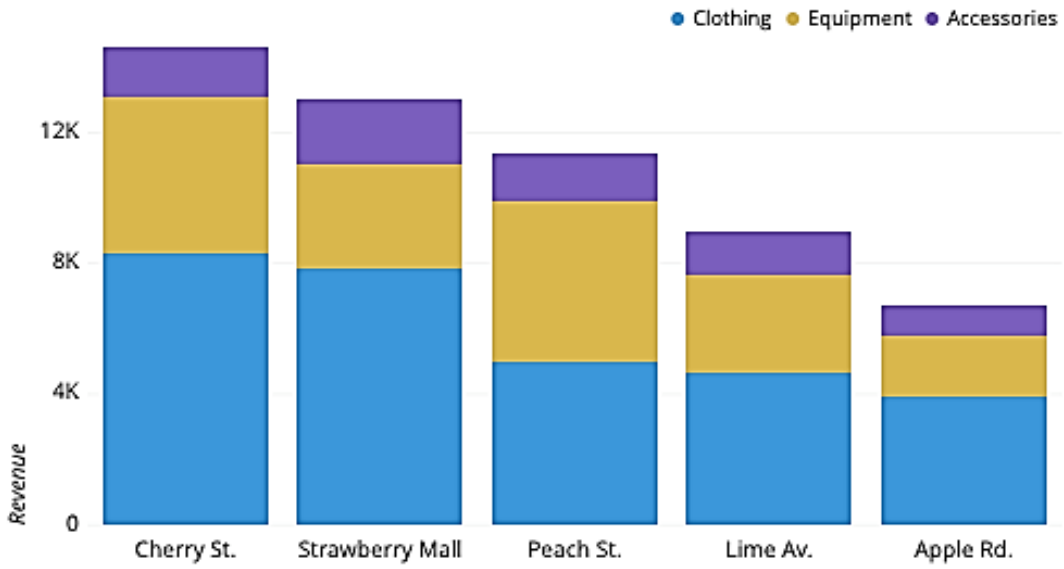


3) Graph Presentation

b. Bar graph and histogram

- By comparing the endpoints of bars, one can:
  - identify the largest and the smallest categories
  - understand gradual differences between each category.

- One form of vertical bar graph is **the stacked vertical bar** graph.
  - used to compare the sum of each category, and analyze parts of a category.
  - Stacked vertical bar graphs do not have a reference line, making comparison of parts of various categories challenging



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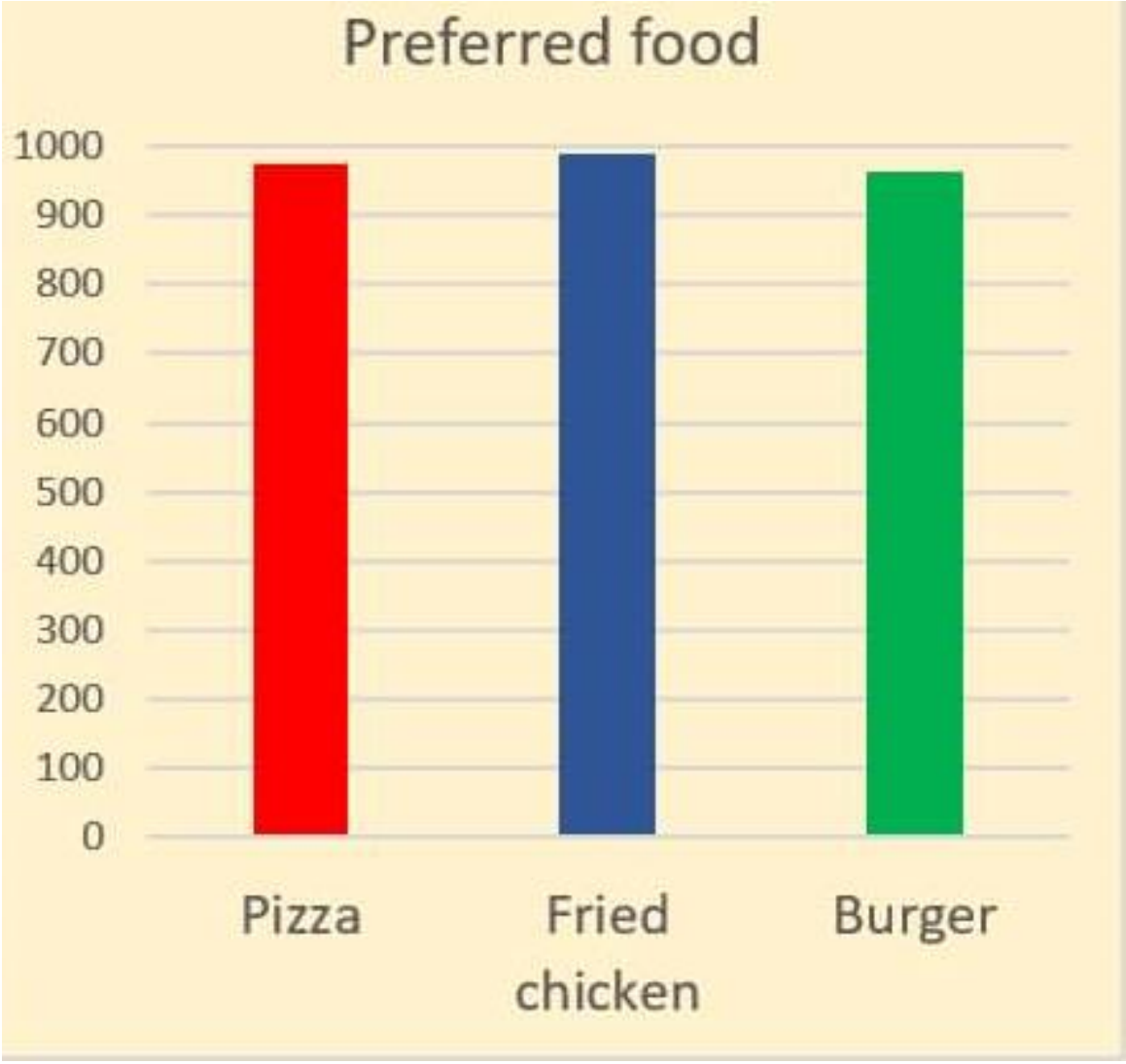
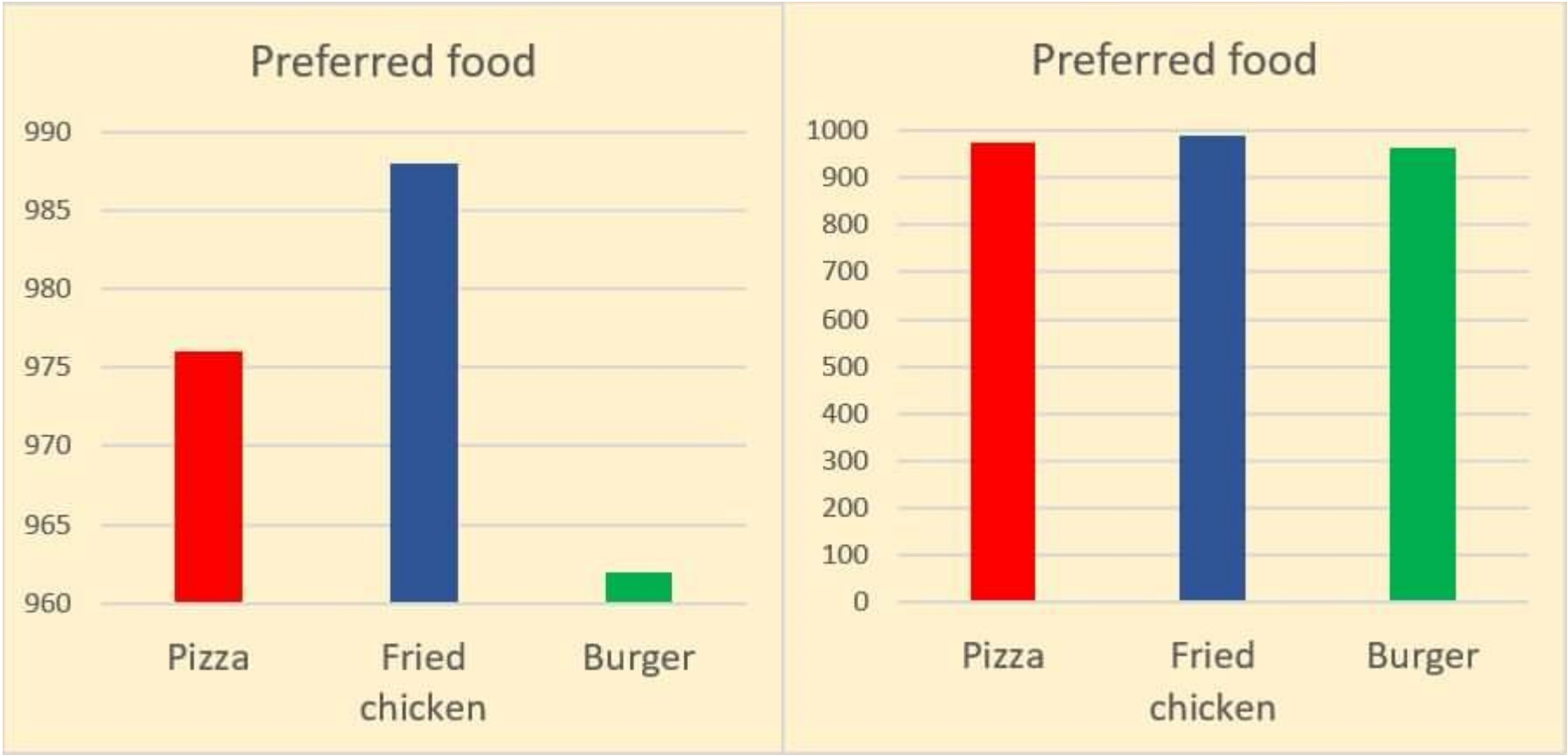

Preferred food
1000
900
800
700
600
500
400
300
200
100
0
Pizza
Fried chicken
Burger



- It is advised to start the *x*- and *y*-axes from 0.

- Illustration of comparison results in the *x*- and *y* axes that do not start from 0 can deceive readers' eyes and lead to overrepresentation of the results.

3) Graph Presentation

c. Pie chart

- Used to represent nominal data (data classified in different categories)
- Visually represents a distribution of categories.
- Most appropriate format for representing information grouped into a small number of categories.

- Example: the distribution of regular waste from operation rooms by their weight.

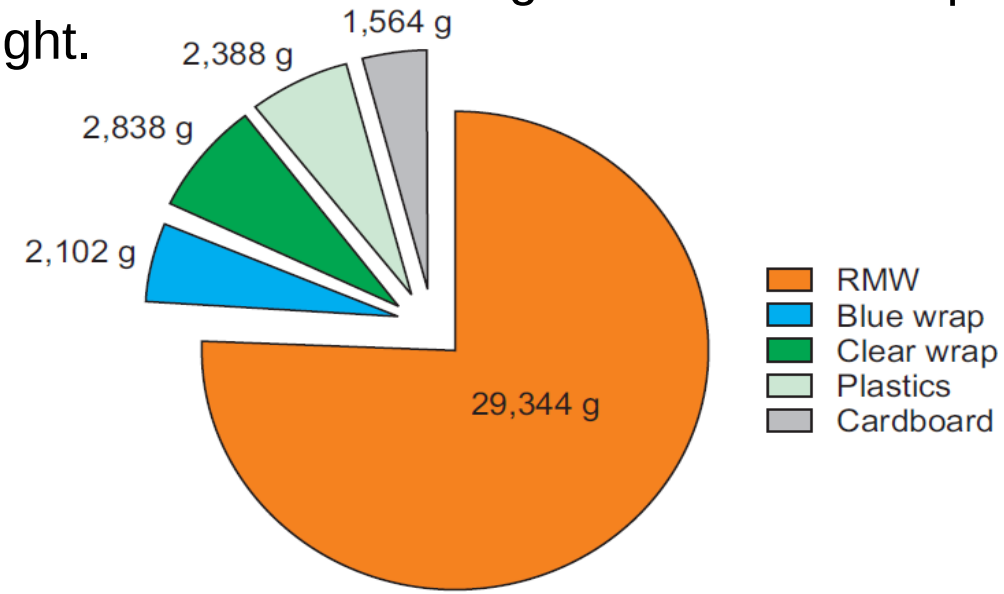


Fig. 5. Pie chart. Total weight of each component from the three operations. RMW: regulated medical waste (Adapted from Korean J Anesthesiol 2017; 70: 100-4).

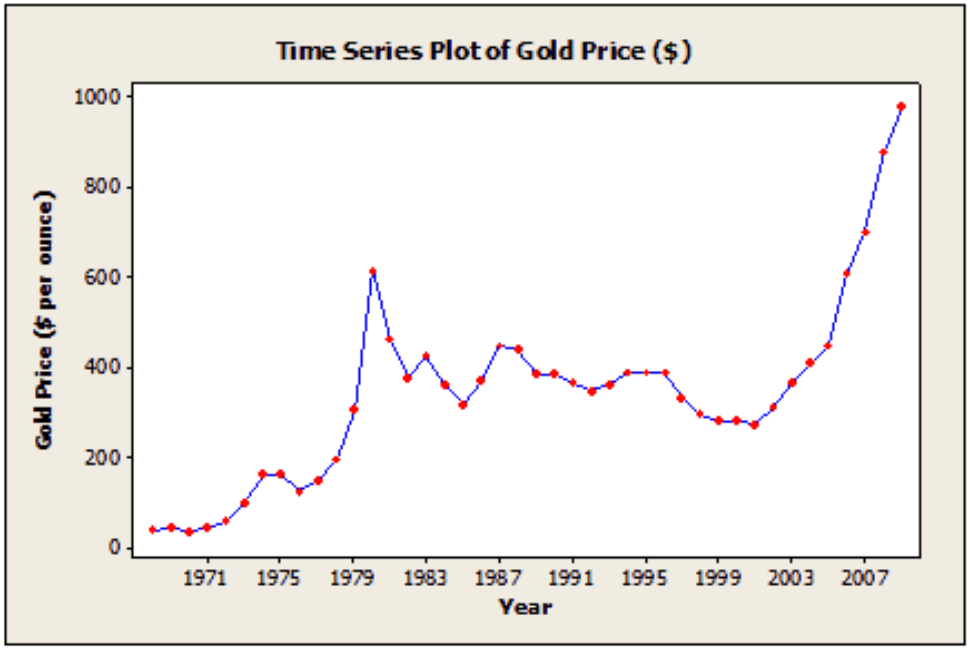
3) Graph Presentation

d. Line plot with whiskers

- Useful for representing time-series data such as monthly precipitation and yearly unemployment rates

  = Used to study variables that are observed over Time.

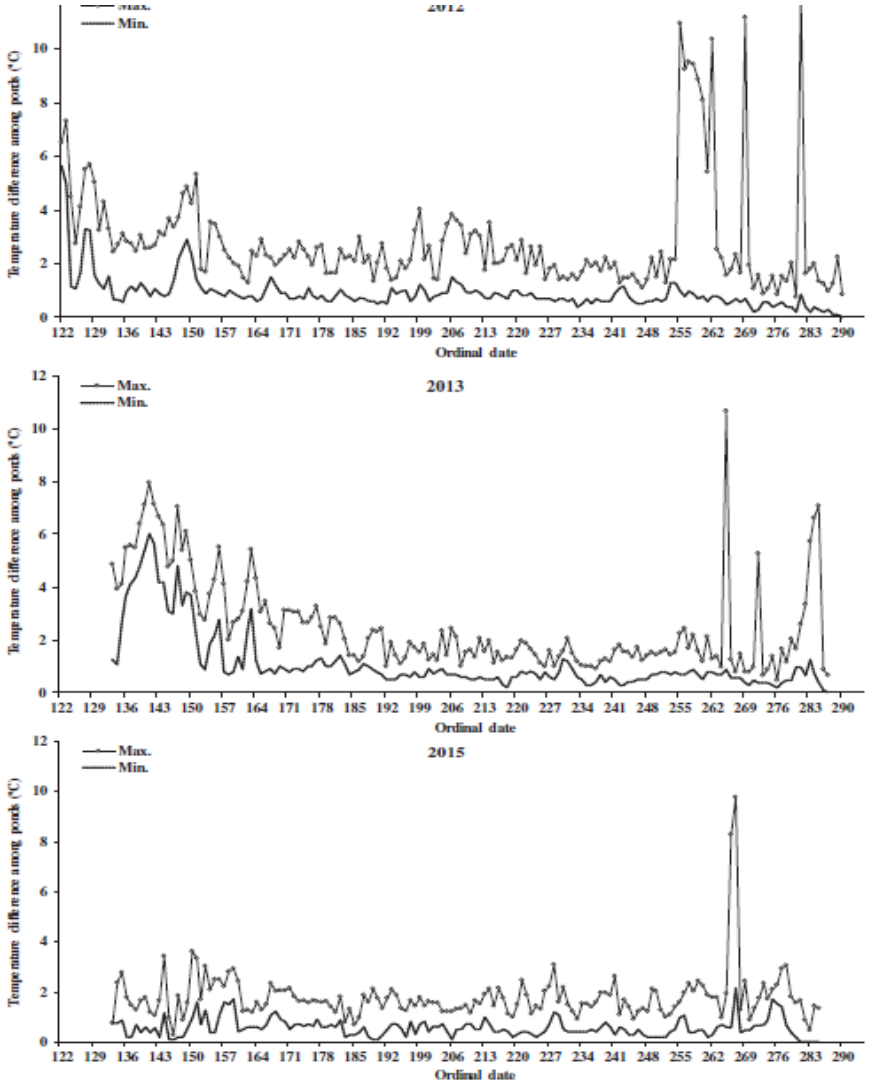
- Useful for studying patterns and trends across data that include climatic influence, large changes or turning points



3) Graph Presentation

d. Line plot with whiskers

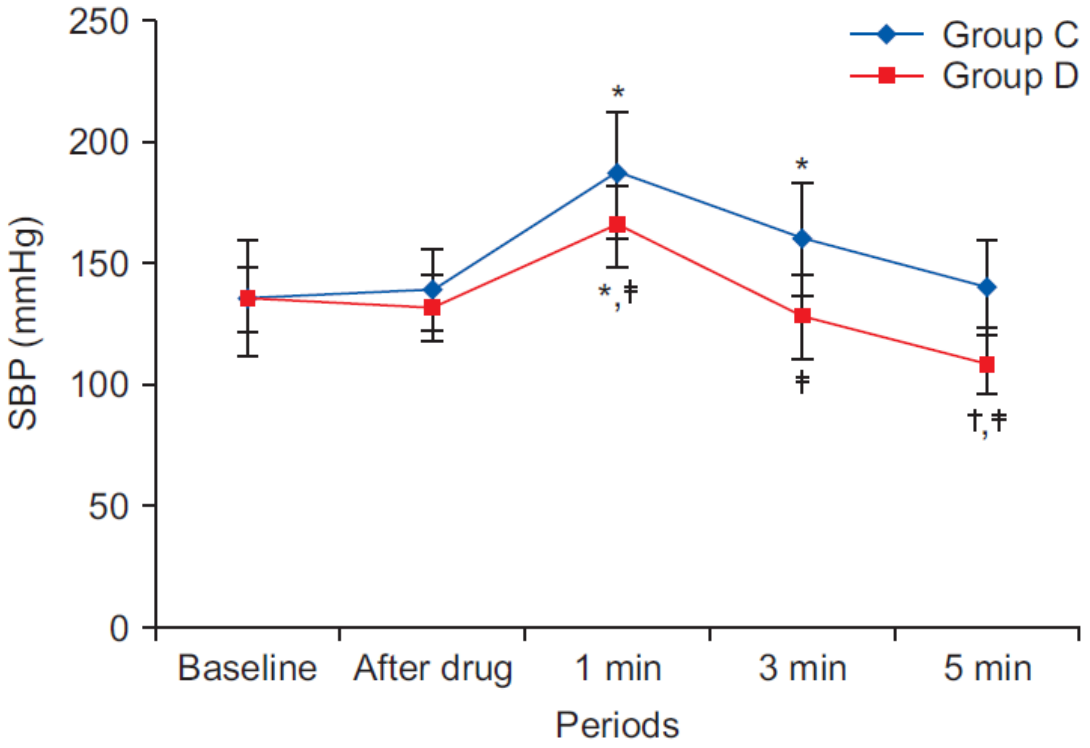
Time Series Data

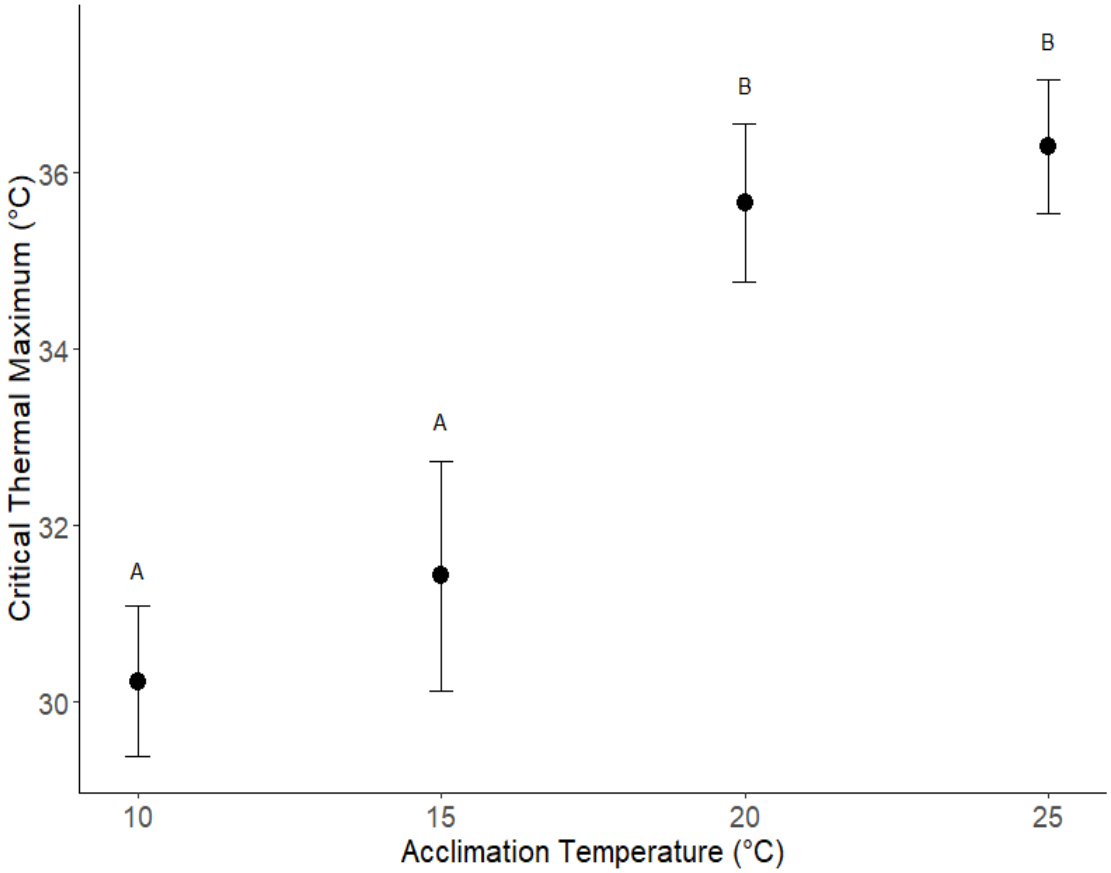


3) Graph Presentation

d. Line plot with whiskers

- Appropriate for representing not only time-series data, but also data measured over the progression of a continuous variable such as distance.
- The x-axis represents the continuous variable, while the y-axis represents the scale and measurement values.
- Useful to represent multiple data sets on a single line graph to compare and analyze patterns across different data sets.





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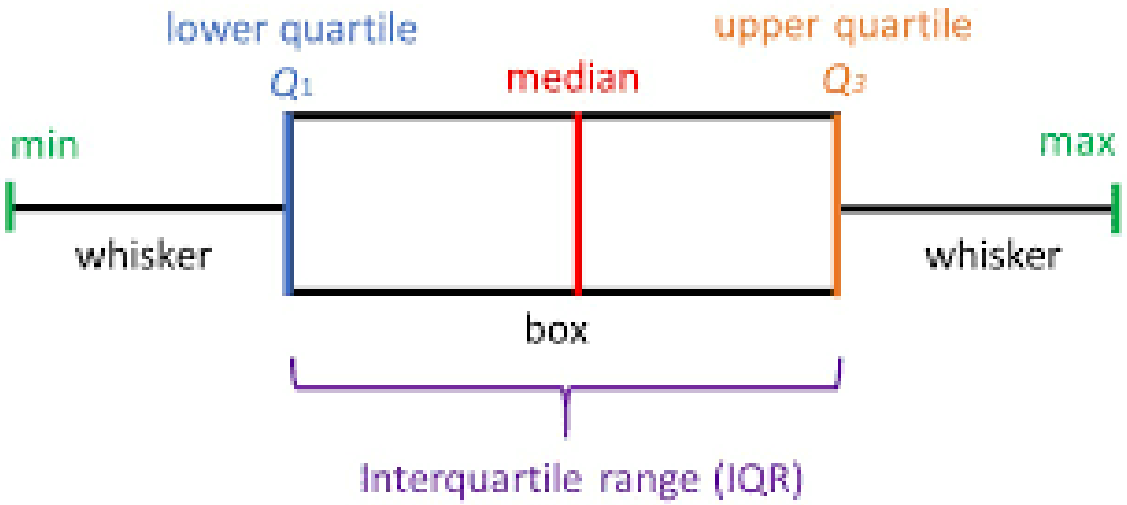
3) Graph Presentation

e. Box and whisker chart

- A box and whisker chart does not make any assumptions
- about the underlying statistical distribution
- Represents variations in samples of a population
- Appropriate for representing nonparametric data.
- Consists of:
  - boxes that represent interquartile range (one to three)
  - the median
  - the mean of the data
  - Whiskers presented as lines outside of the boxes.



3) Graph Presentation

e. Box and whisker chart

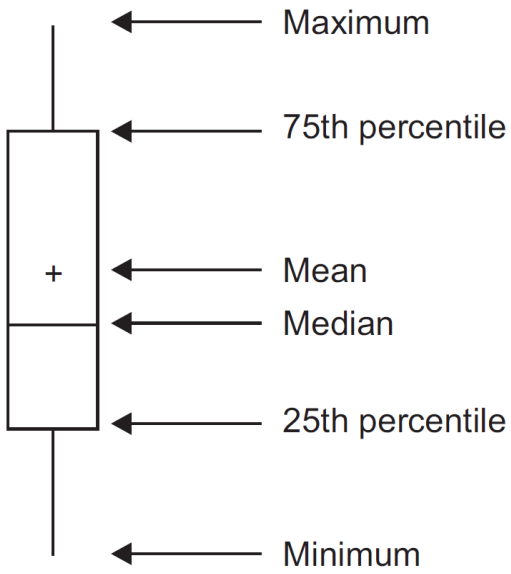


Fig. 6. Box graph with whiskers. This graph is a standardized way of displaying the distribution of data based on the five-number summary; minimum, first quartile, median, third quartile, and maximum. The central rectangle represents from the first quartile to the third quartile (the interquartile range [IQR]). A segment inside the rectangle shows the median and "whiskers" above and below the box show the locations of the minimum and maximum.

3) Graph Presentation

e. Box and whisker chart

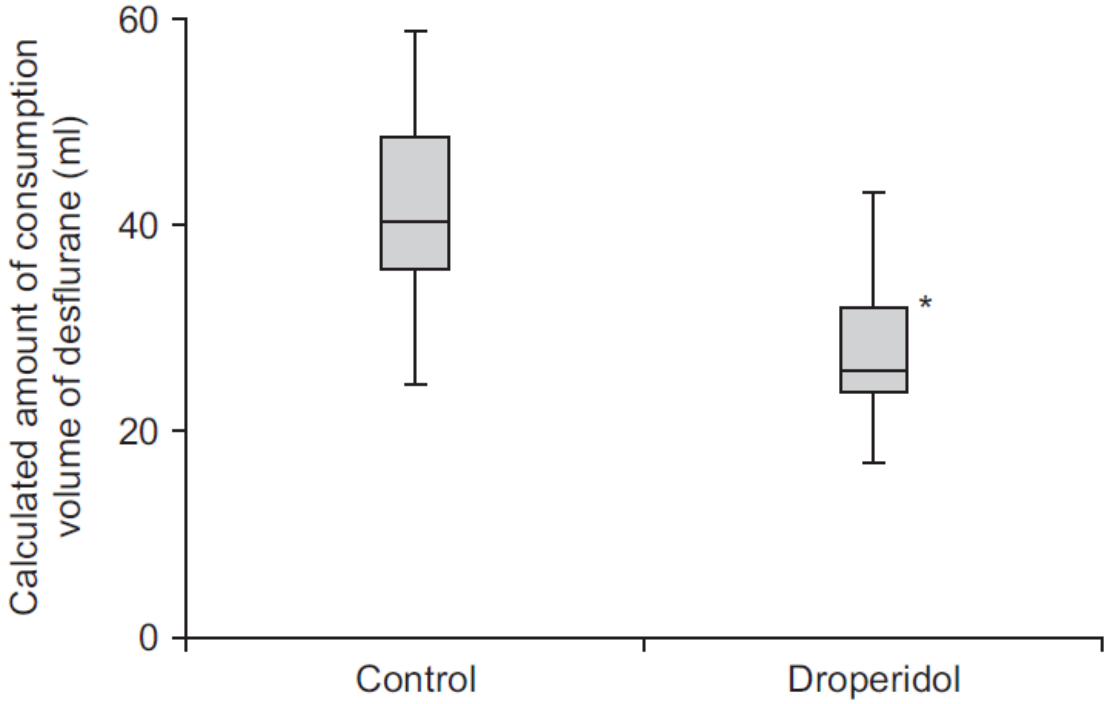
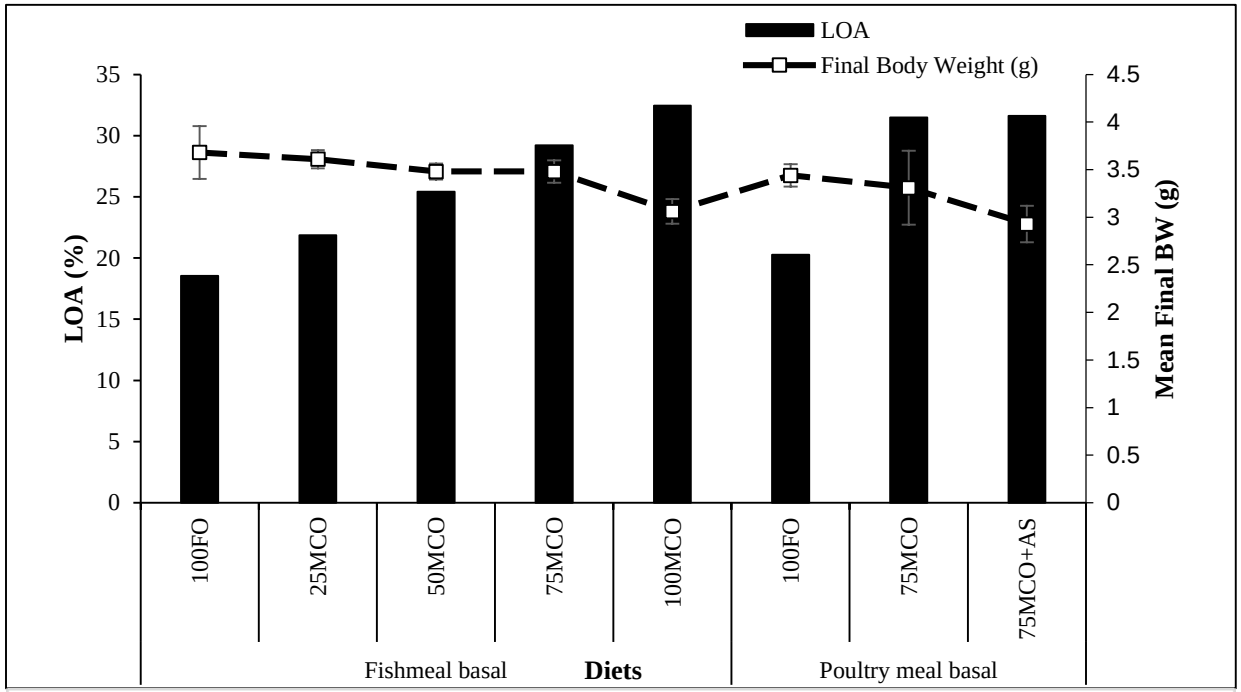


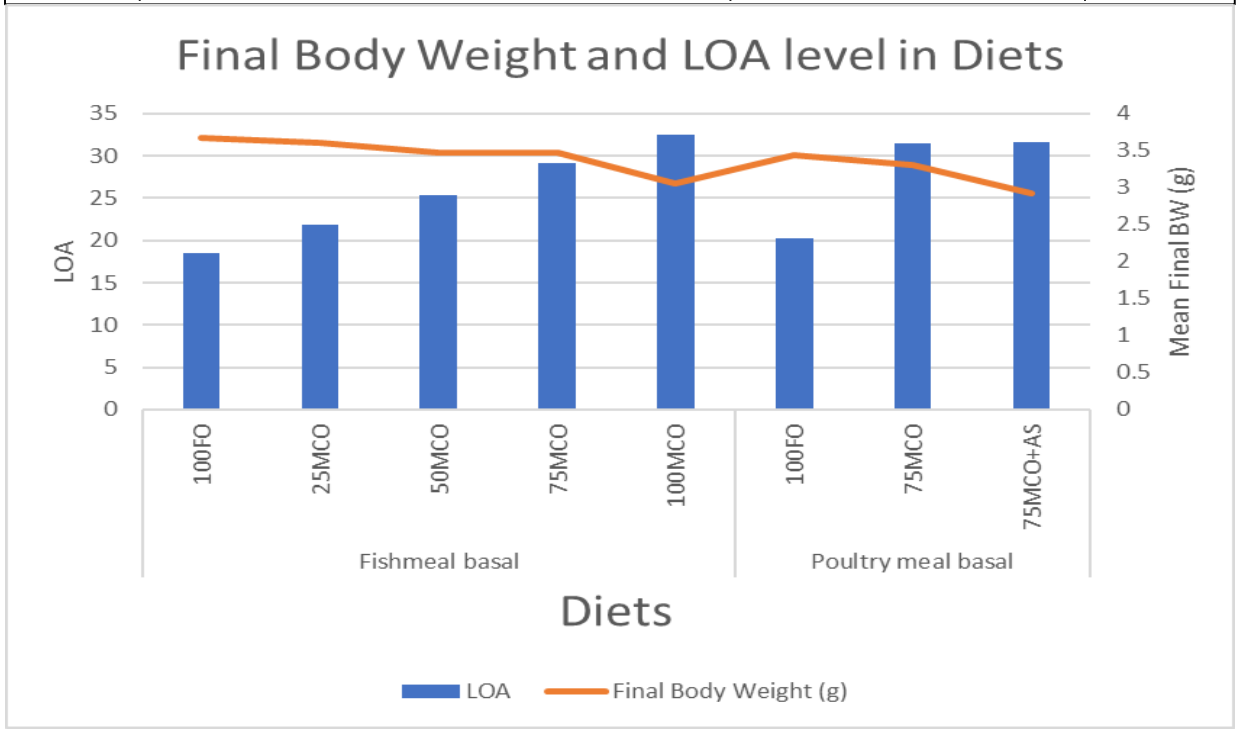
Fig. 7. Box graph with whiskers. Calculated volume of desflurane consumed during the observation period. The groups differed significantly. Data are expressed as median, minimum, first interquartile, third interquartile, and maximum values. *P < 0.05 (Adapted from Korean J Anesthesiol 2017; 70: 27-32).

3) Graph Presentation

e. Box and whisker chart

- Whiskers can be used to present the largest and smallest values in a set of data or only a part of the data (i.e. 95% of all the data).
- Data that are excluded from the data set are presented as individual points and are called outliers.
- The spacing at both ends of the box indicates dispersion in the data.
- The relative location of the median demonstrated within the box indicates skewness





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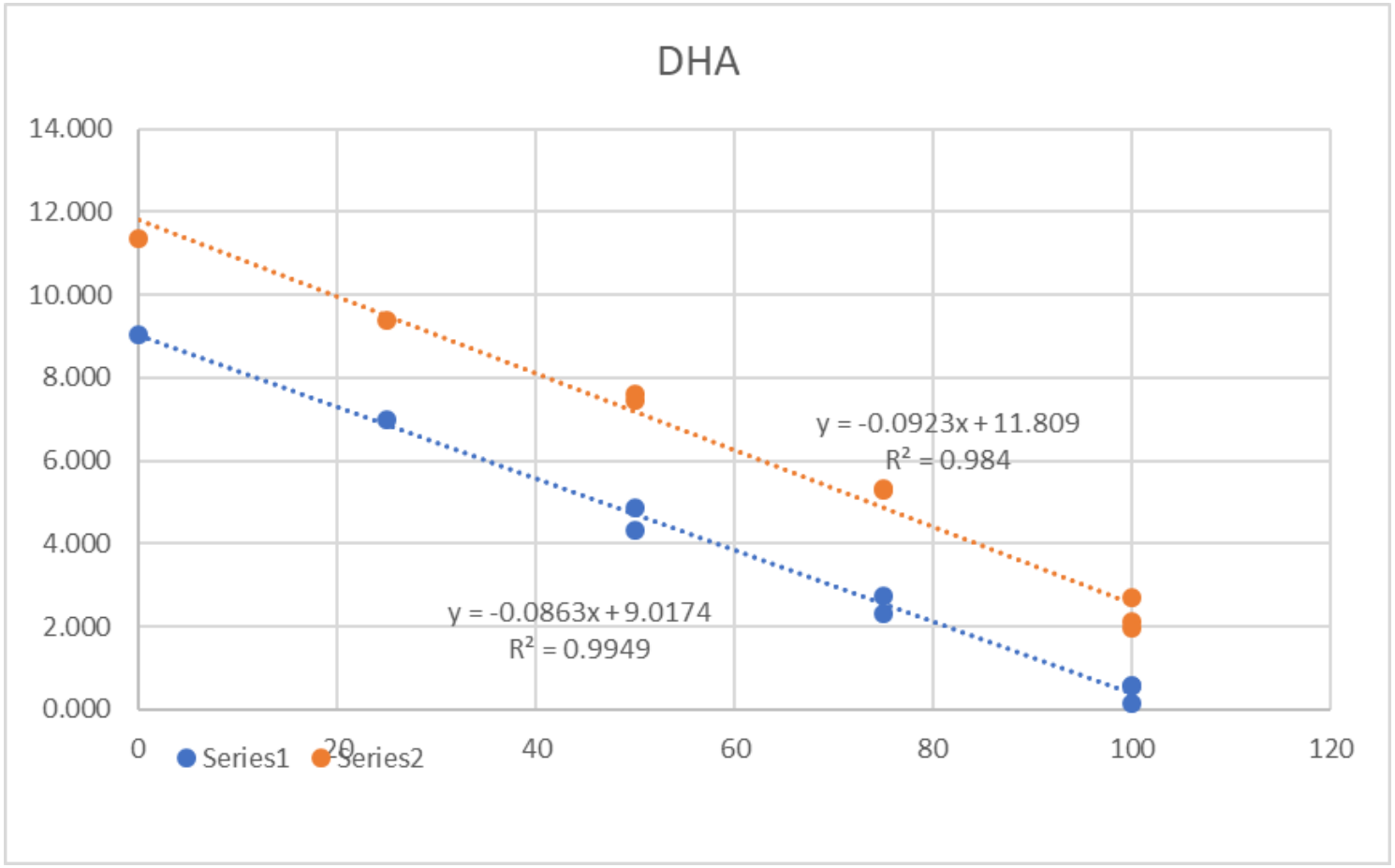

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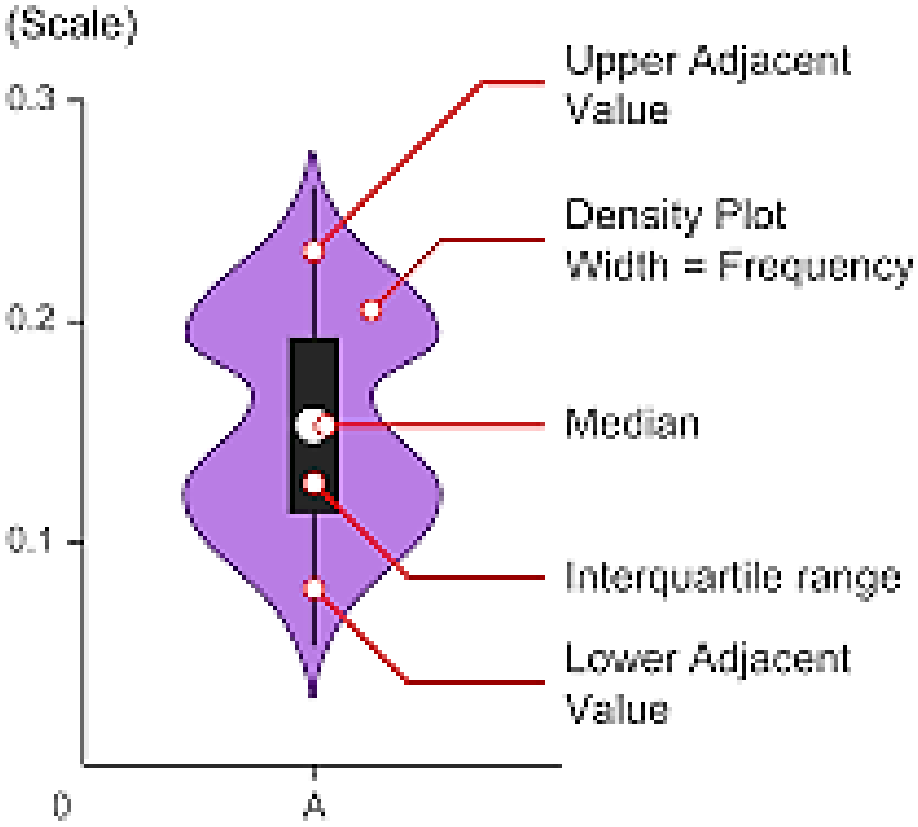
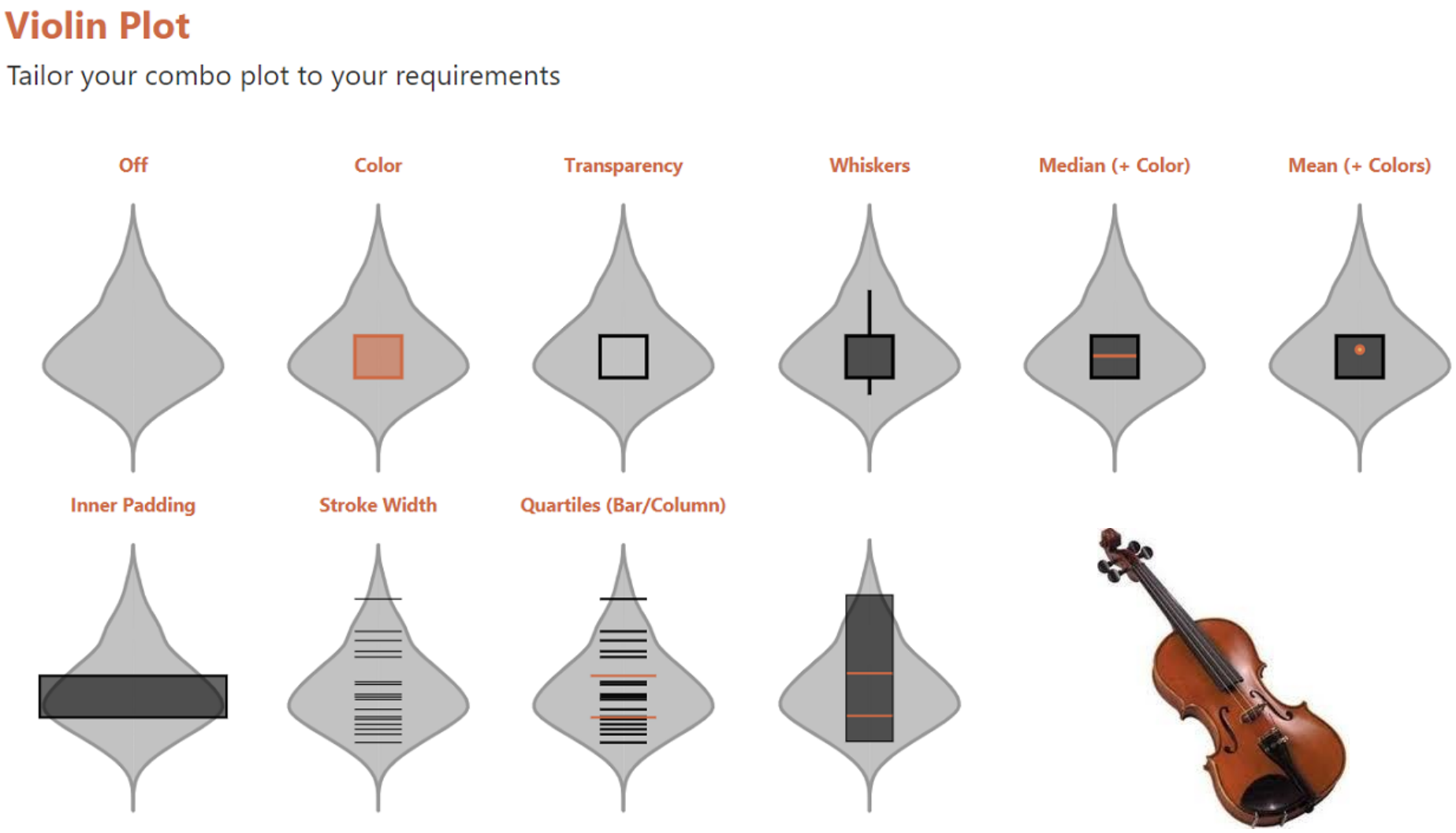
3) Graph Presentation

f. Others: **Violin Plot**



3) Graph Presentation

f. Others: Violin Plot



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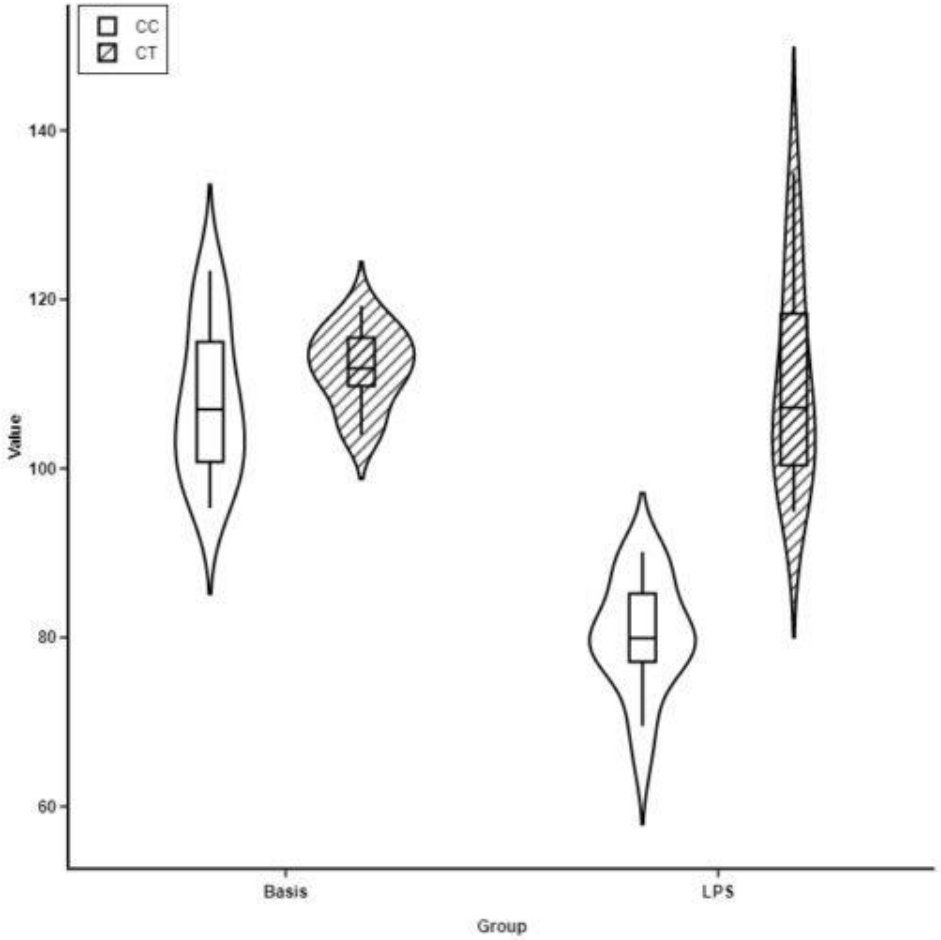
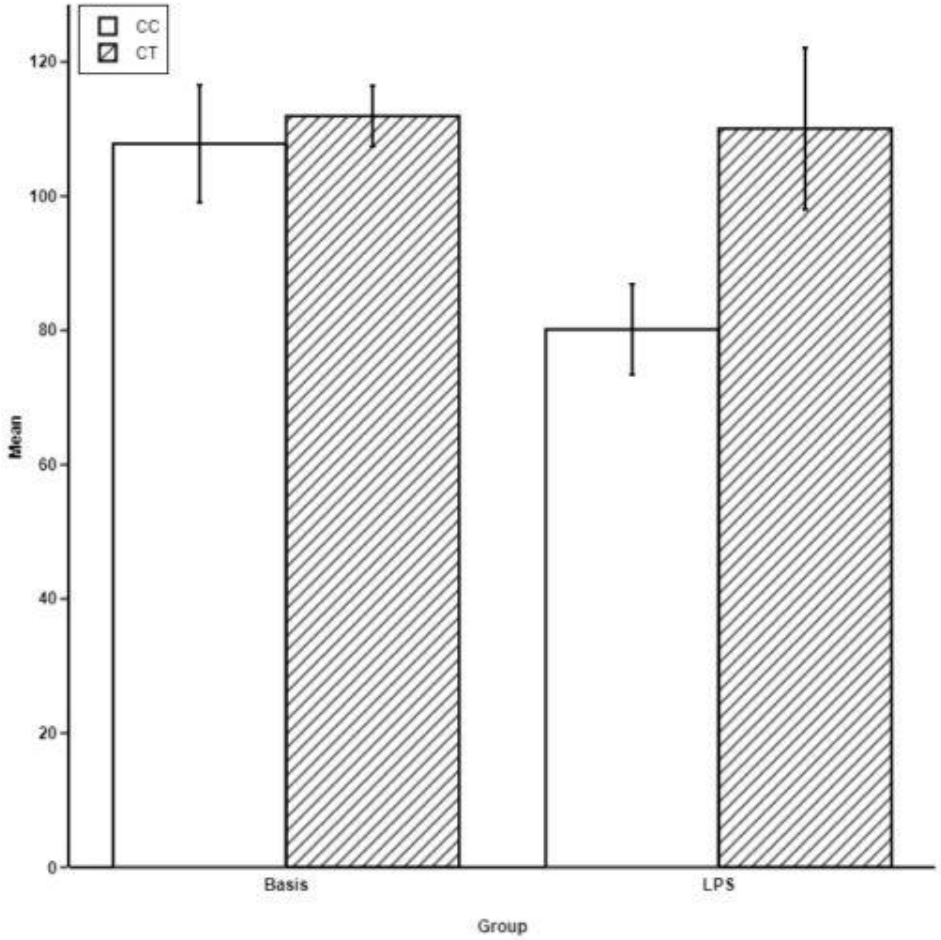
3) Graph Presentation

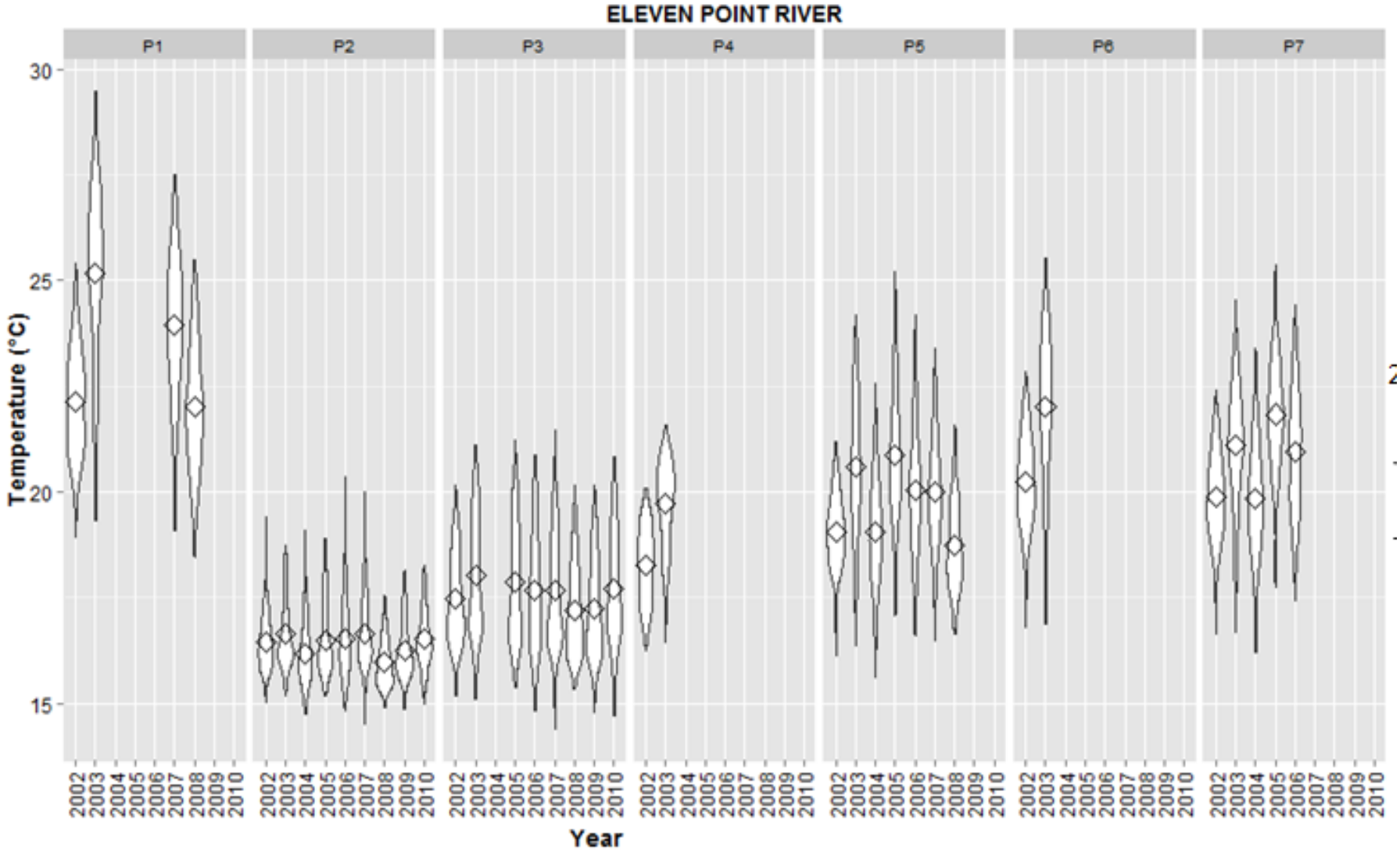
f. Others: **Violin Plot**





3) Graph Presentation

f. Others: **Violin Plot**



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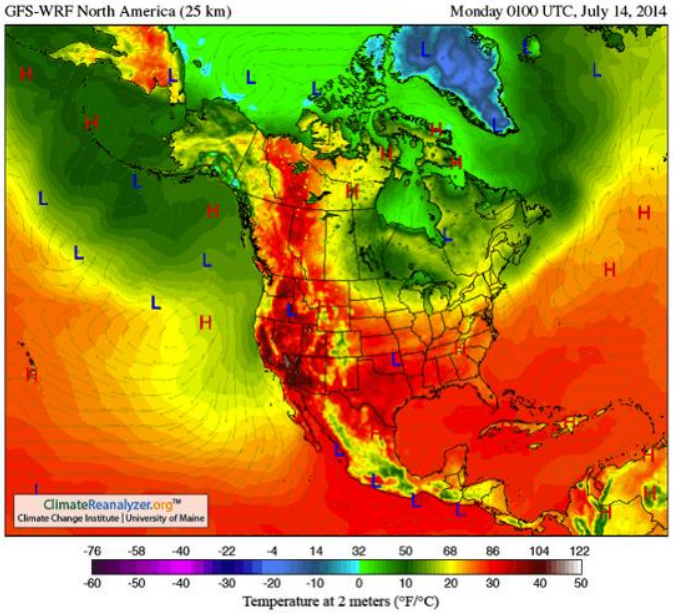
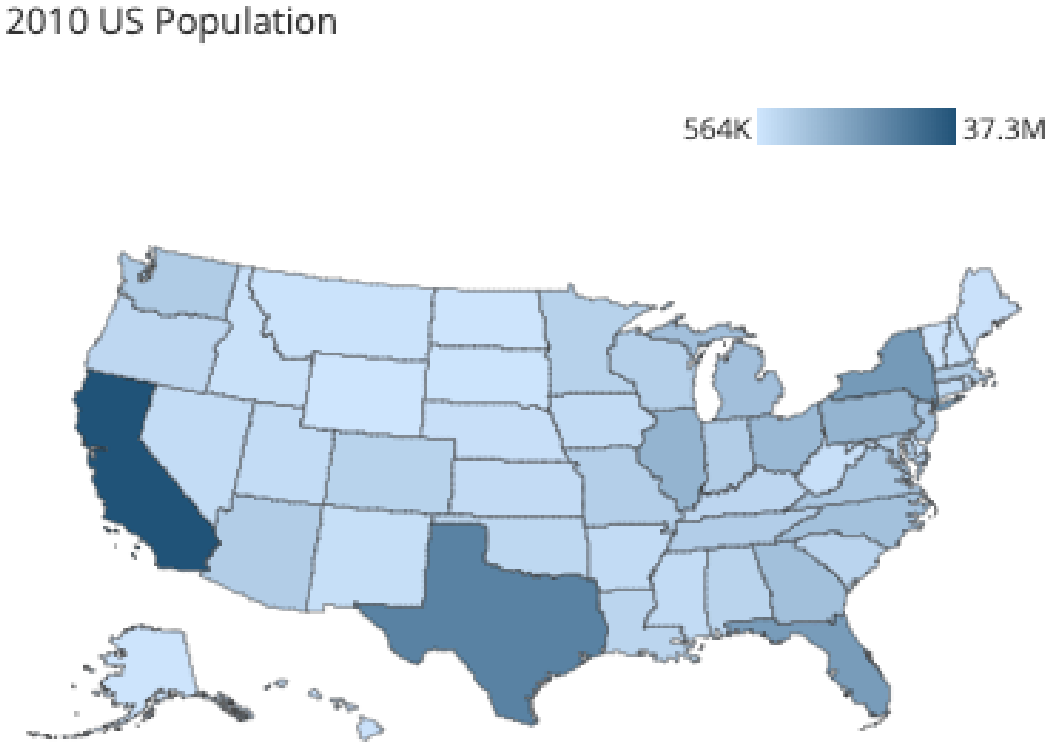
3) Graph Presentation

f. Others: Mapping-based Graph





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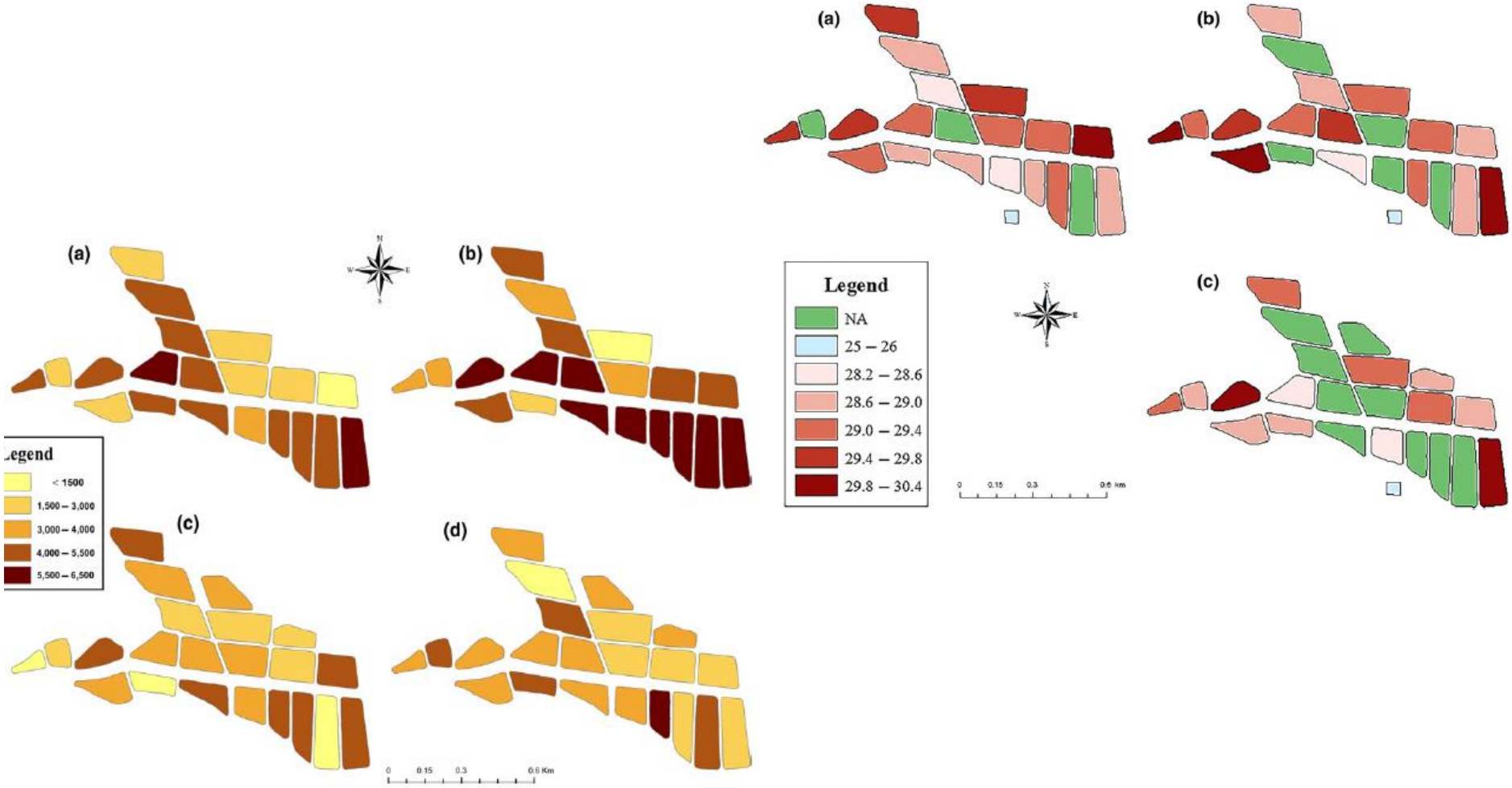
3) Graph Presentation

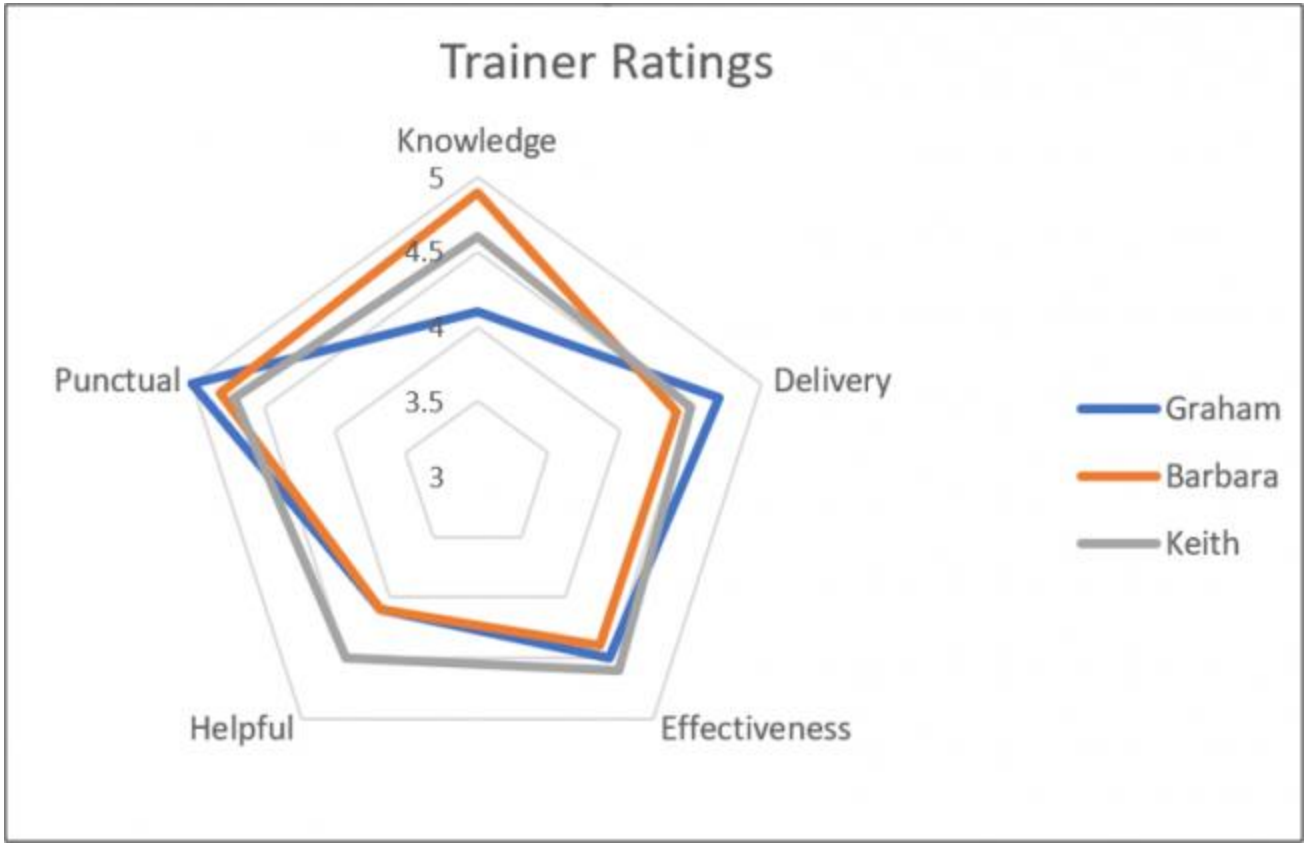
f. Others: Mapping-based Graph



Abdelrahman, Hisham A., Asheber Abebe, and Claude E. Boyd. "Influence of variation in water temperature on survival, growth and yield of Pacific white shrimp Litopenaeus vannamei in inland ponds for low-salinity culture." *Aquaculture research* 50.2 (2019): 658-672.

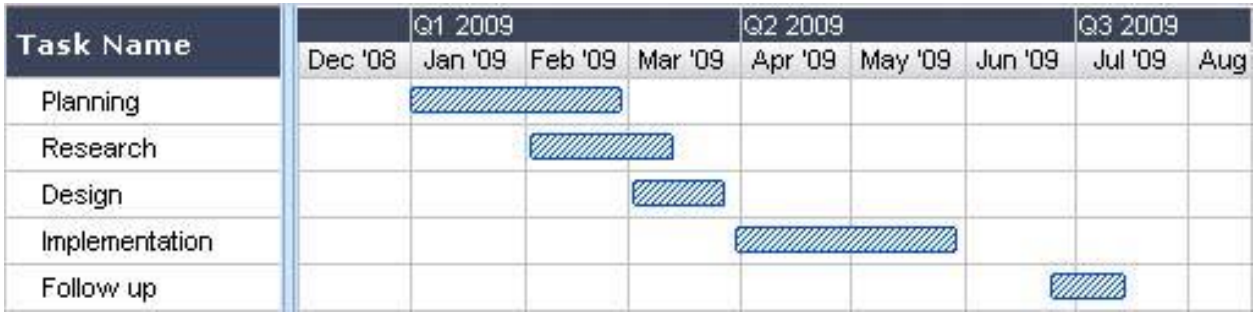
3) Graph Presentation

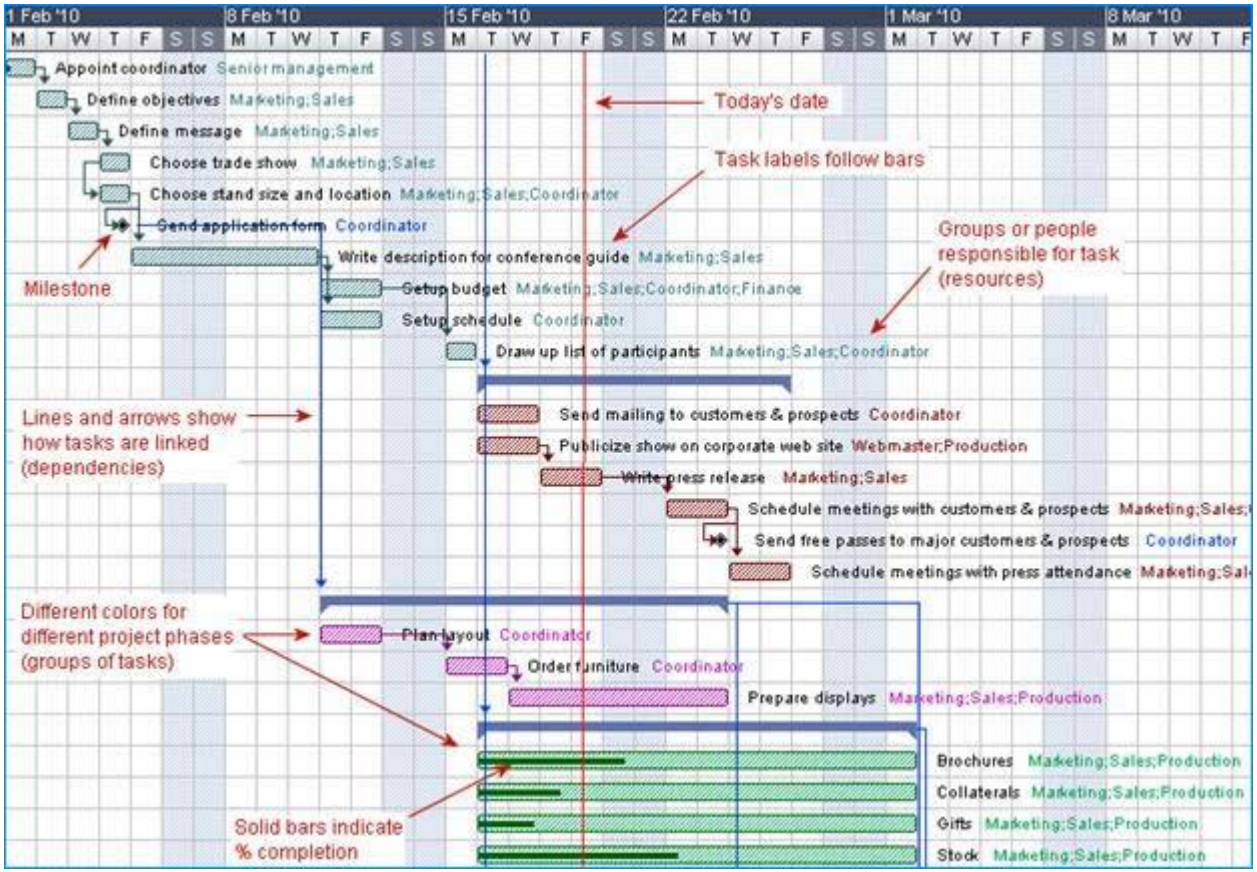
f. Others: **Radar Plot**



3) Graph Presentation

f. Others: Gantt Chart



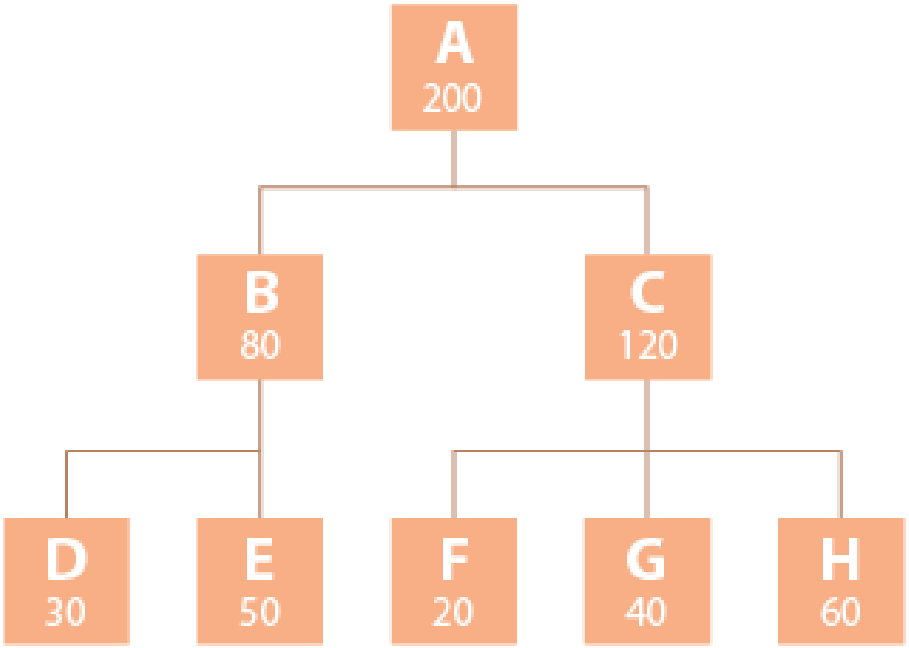


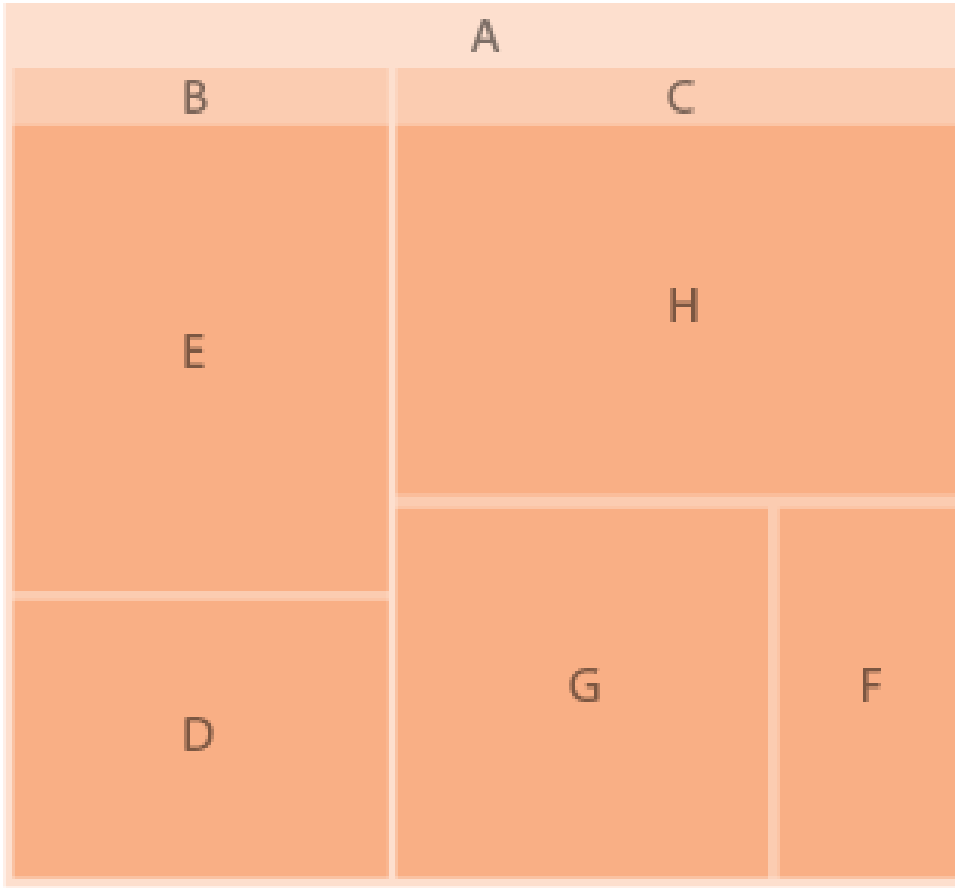
Henry Gantt

https://www.gantt.com/

3) Graph Presentation

f. Others: **TreeMap**

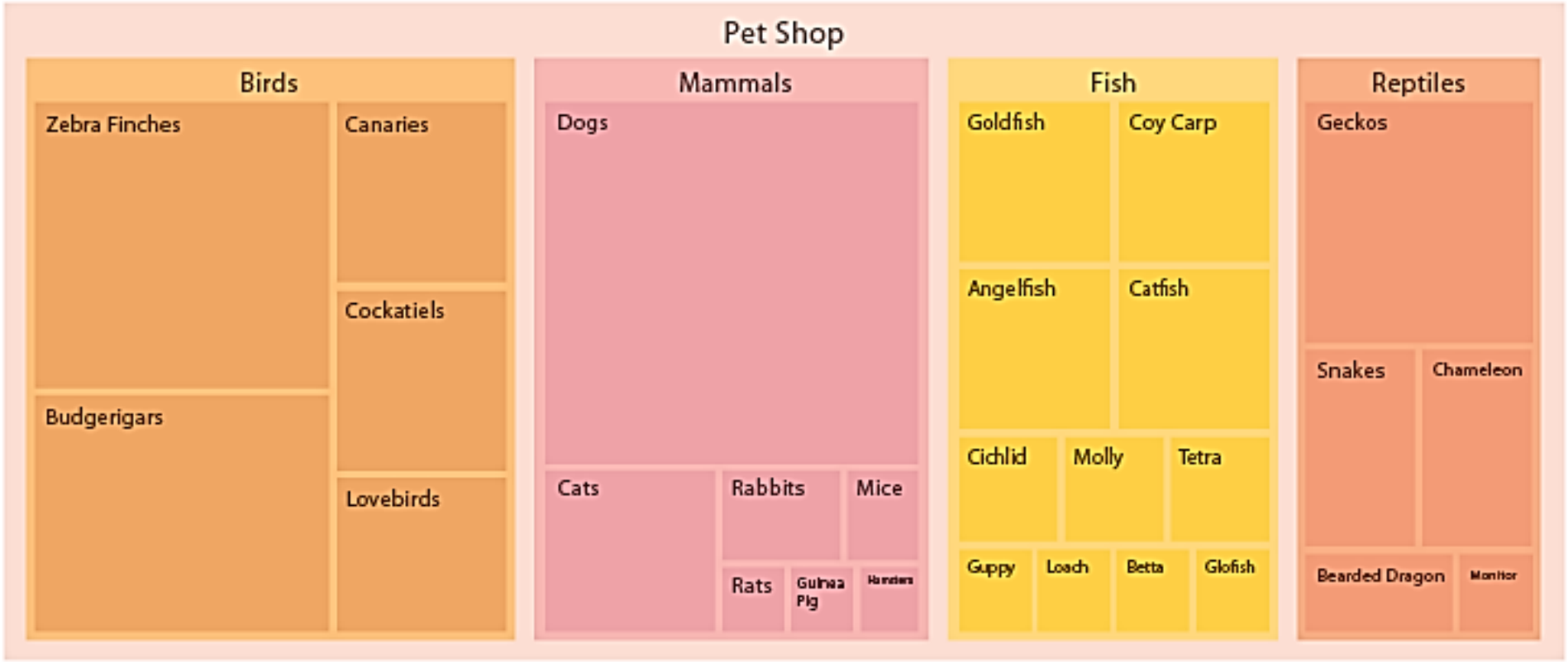




https://www.edureka.co/blog/treemap-in-java/

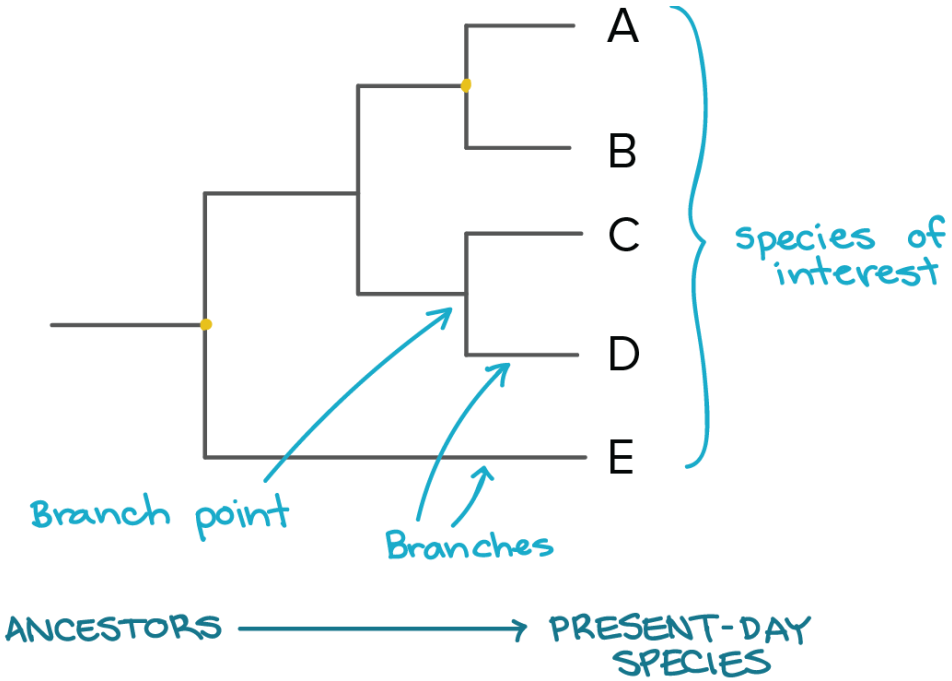
3) Graph Presentation

f. Others: **TreeMap**



3) Graph Presentation

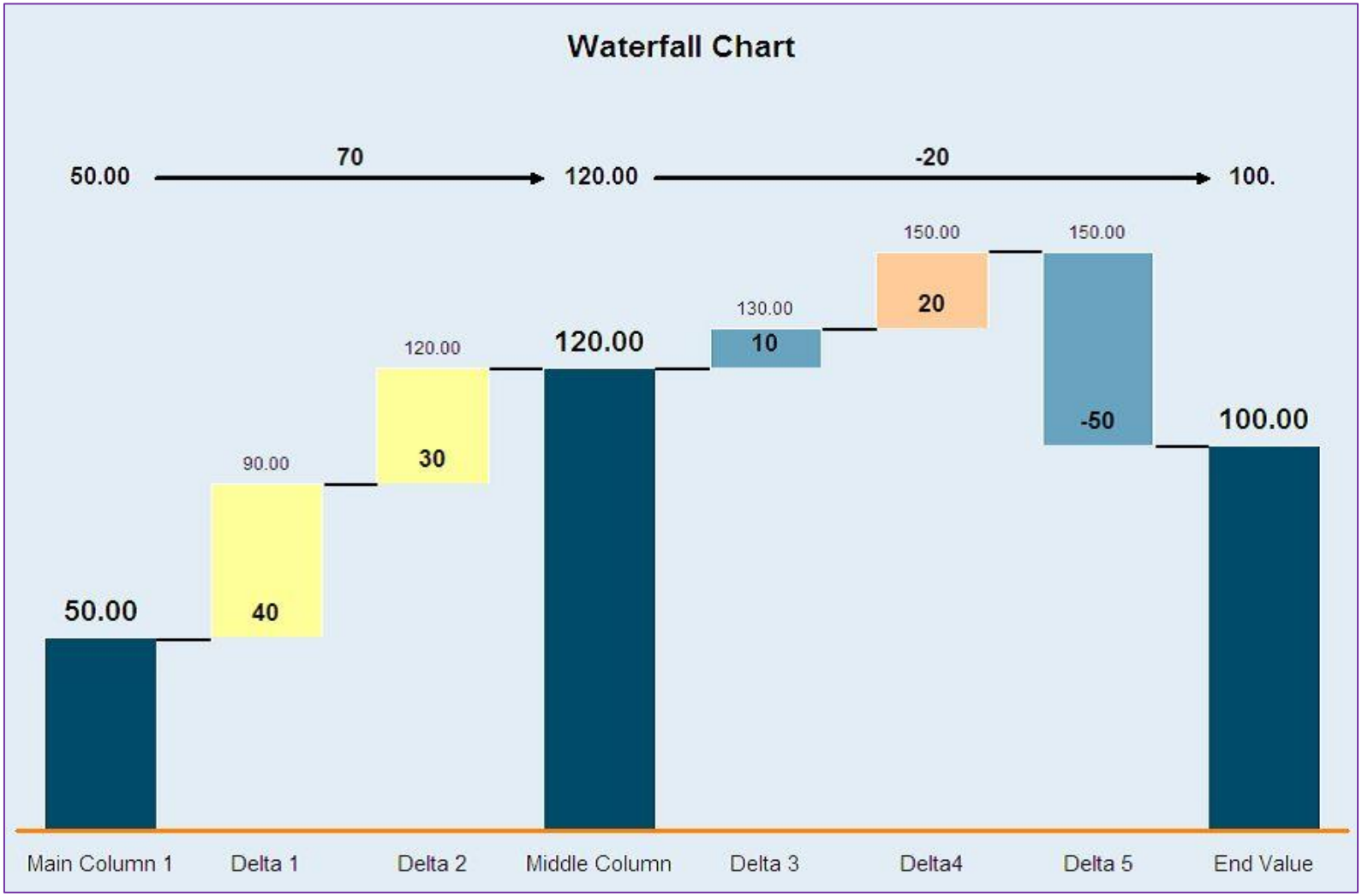
f. Others: **Phylogenetic Tree**



https://www.nature.com/scitable/topicpage/reading-a-phylogenetic-tree-the-meaning-of-41956/

3) Graph Presentation

f. Others: **Waterfall Chart**

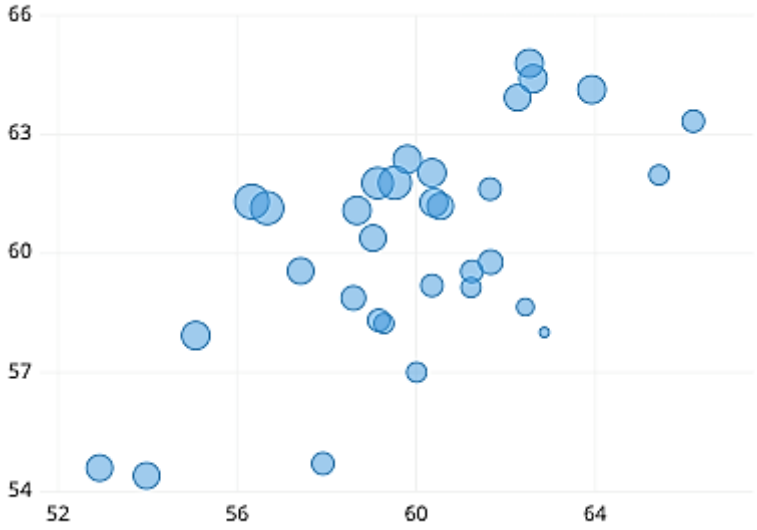


https://www.fusioncharts.com/resources/chart-primers/waterfall-chart

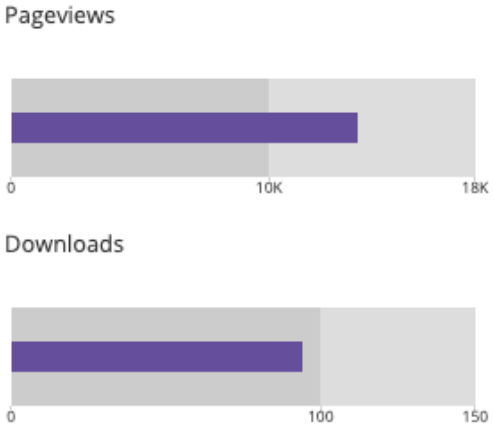
3) Graph Presentation

f. Others:

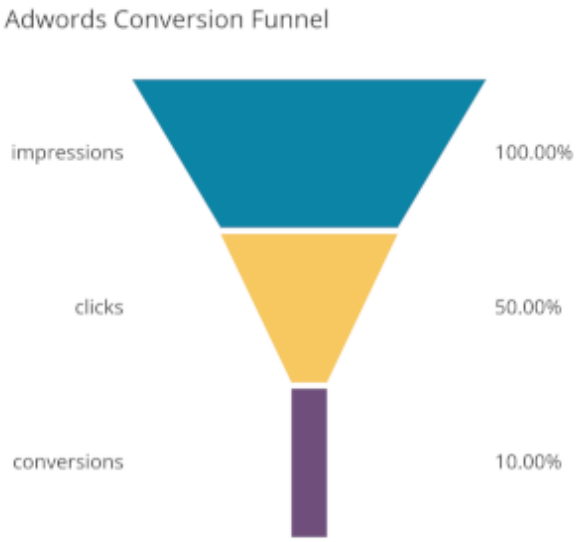
Bubble Chart



Bullet Chart



Funnel Chart



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Citing table or figure in text

Do not be verbose in citing figures and tables.

Do not say,
"It is clearly shown in Table 1 that nocillin inhibited the growth of *N. gonorrhoeae.*"

Say,
"Nocillin inhibited the growth of *N. gonorrhoeae* (Table 1)."

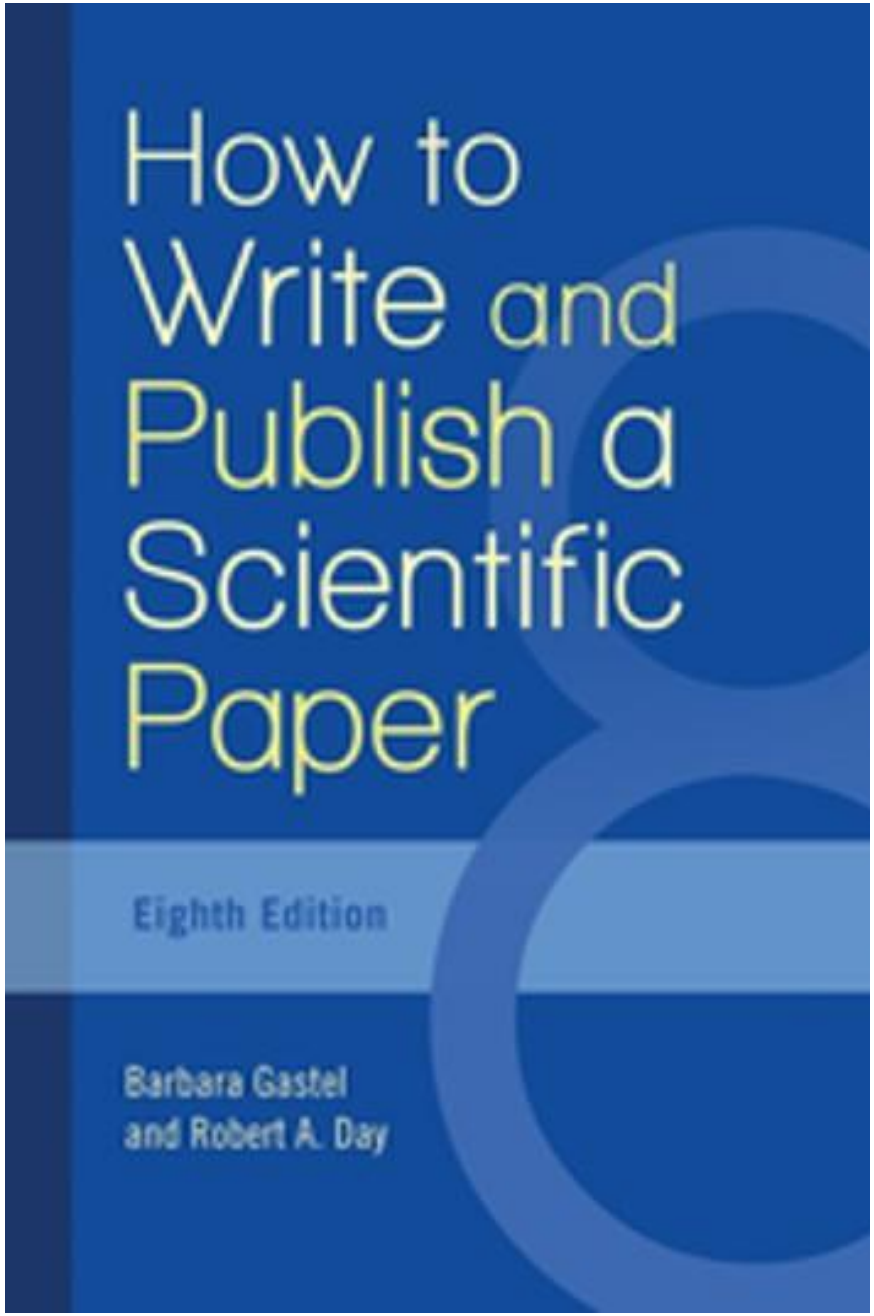
The latter format has multiple benefits.

- Briefer
- helps authors comply with journals' word limits.
- more readable.
- directs attention to what is most important:
  (The findings, not the table or figure).

Table 3. Types of Charts depending on the Method of Analysis of the Data

Analysis	Subgroup	Number of variables	Type
Comparison	Among items	Two per items	Variable width column chart
		One per item	Bar/column chart
	Over time	Many periods	Circular area/line chart
		Few periods	Column/line chart
Relationship		Two	Scatter chart
		Three	Bubble chart
Distribution		Single	Column/line histogram
		Two	Scatter chart
		Three	Three-dimensional area chart
Comparison	Changing over time	Only relative differences matter	Stacked 100% column chart
		Relative and absolute differences matter	Stacked column chart
	Static	Simple share of total	Pie chart
		Accumulation	Waterfall chart
		Components of components	Stacked 100% column chart with subcomponents

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5453888/


How to Write and Publish a Scientific Paper
Eighth Edition
Barbara Gastel
and Robert A. Day