Online practice assessment task

Mathematics and Statistics 1.10

Internally assessed
4 credits

Achievement Standard 91035
Investigate a given multivariate data set using the statistical enquiry cycle

Introduction

This activity requires you to undertake a statistical investigation using a randomly selected sample from the 2019 New Zealand CensusAtSchool database (www.censusatschool.org.nz).

First, you will pose two investigative questions. Then you will analyse the sample and form a conclusion for one of your questions.

You will be assessed on the quality of your discussion and reasoning and how well you link this to the context.

Task

As you carry out this task, you will use the statistical enquiry cycle (Problem, Plan, Data, Analysis, Conclusion).

Problem

Pose two investigative questions about Year 11 students that can be explored using the 2019 New Zealand Census At School data. A description of the variables is on the following page.

Your investigative questions must be comparison questions. A suitable comparison investigative question is one that reflects the population, has a clear variable to investigate, compares the values of a continuous variable across different categories, and can be answered with the data.

You should include a reflection on what you would expect the answer to be.

For each question, state the variable you are investigating and the groups you are comparing.

Now choose one of your two questions for investigation using the data found in the table below.

Plan and data

Because the 60 Year 11 students (a mix of boys and girls) in the sample were selected using the random sampler, the sample can be considered representative of all the Year 11 students in the database.

The data was gathered by the 2019 New Zealand Census At School survey team in an online survey.

Analysis

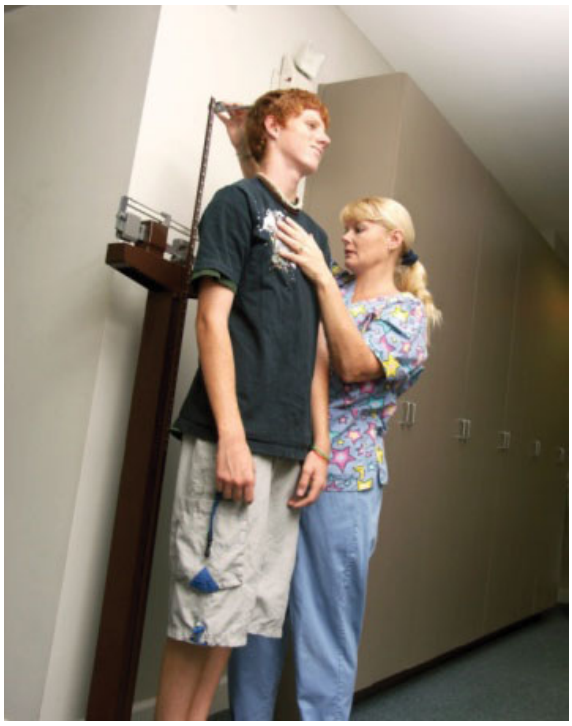
Draw at least two appropriate graphs that show different features of the data in relation to your investigative question.

Give appropriate summary statistics.

Describe features of the distributions comparatively (for example, shape, middle 50%, shift, overlap, spread, unusual or interesting features).

Conclusion

Write a conclusion summarising your findings. The conclusion needs to include an informal inference in response to your investigative question and to be supported with relevant evidence.



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A selection of variables from the survey is listed below, with the survey question used.

Variable	Survey question
gender	Are you: boy/girl?
Year	What Year level are you?
height (in cm)	How tall are you without your shoes on? Answer to the nearest centimetre.
right foot length (in cm)	What is your right foot length, without a shoe? Answer to the nearest centimetre.
Wrist circumference (in cm)	What is the circumference of your wrist? Answer to the nearest centimetre.
Neck circumference (in cm)	What is the circumference of your neck ? Answer to the nearest centimetre.

gender	Year	height	rightfoot	wrist	neck
girl	11	161	23	17	34
girl	11	180	26	19	32
boy	11	180	27	16	30
boy	11	171	26	17	34
girl	11	165	24	15	30
boy	11	178	28	20	37
girl	11	162	23	16	31
boy	11	175	27	16	38
boy	11	165	25	19	34
girl	11	158	23	15	
girl	11	168	24	16	30
girl	11	158	24	14	33
girl	11	158	22	15	33
boy	11	180	30	20	39
girl	11	160	22	15	33
boy	11	175	26	17	35
boy	11	162	23	16	35
boy	11	164	23	16	31
girl	11	165	22	16	33
boy	11	176	23	16	36
girl	11	170	22	17	35
girl	11	163	24	16	35
girl	11	167	28	18	
boy	11	185	25	18	35
boy	11	174	26	17	36
boy	11	187	26	17	36
boy	11	167	29	18	36
boy	11	173	25	17	34
girl	11	164	21	14	29
girl	11	169	25	15	31

gender	Year	height	rightfoot	wrist	neck
boy	11	175	29	18	37
girl	11	159	19	15	32
boy	11	174	26	18	40
boy	11	180		18	40
girl	11	165	26	15	34
girl	11	164	24	18	37
girl	11	153	22	18	35
girl	11	169	23	17	34
boy	11	173	26	16	35
girl	11	163	20	16	31
girl	11	155	21	16	33
girl	11	175	26	15	31
girl	11	164	23	15	35
girl	11	168		21	
girl	11	157	22	16	32
boy	11	178			30
boy	11	180	28	19	36
girl	11	156	20	20	35
boy	11	169	26	17	33
girl	11	175	26	19	
boy	11	173	26	18	36
girl	11	160	22	16	37
girl	11	175	25	16	35
girl	11	167	25	14	30
girl	11	165	23	15	35
girl	11	170	24	17	35
girl	11	163	24	16	35
boy	11	180	28	20	35
boy	11	180	27	20	32
girl	11	162	23	16	31

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Solution

Answers will vary; the following is an example of a possible investigation. Note that the investigation has more than is required for achievement of the standard (see description of assessment criteria at end of solution).

Problem

How does the wrist circumference (in centimetres) of New Zealand Year 11 boys compare with the wrist circumference (in centimetres) of New Zealand Year 11 girls?

Prediction: I think that by Year 11 in New Zealand, boys are bigger on average than Year 11 girls, so I think Year 11 boys are likely to have bigger wrist circumferences than Year 11 girls. This is because boys are maturing physically around Year 11, and becoming more muscular than girls, and are likely to be involved in more physically demanding activity which develops and bulks up the muscles in their arms and wrists.

Other investigations could involve comparing the heights of New Zealand Year 11 boys and New Zealand Year 11 girls; comparing the right foot length of New Zealand Year 11 boys and New Zealand Year 11 girls; comparing the neck circumference of New Zealand Year 11 boys and New Zealand Year 11 girls.

Data

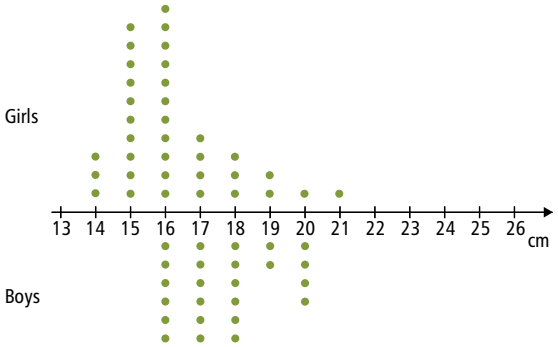
A multivariate data set is given. The variable selected is wrist circumference.

I noticed that one of the boys in the sample had no measurement recorded for his wrist circumference, so this person was omitted from the analysis, which should not be an issue. There were other Year 11 students in the sample who had data missing for other variables, but I used their wrist circumference measurements because their other data appeared to have realistic values and be genuine.

Analysis and conclusion

A dot plot of wrist circumferences for Year 11 boys and girls is shown below.

Dot plot of Year 11 wrist circumferences

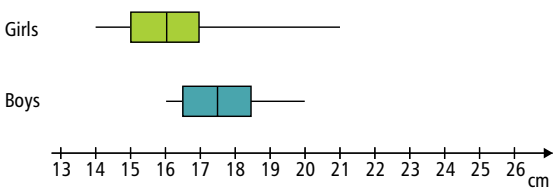


Summary statistics are shown in the table below.

Statistic	Girls	Boys
Max	21	20
UQ	17	18.5
Med	16	17.5
LQ	15	16.5
Min	14	16

A box-and-whisker plot of wrist circumference for Year 11 boys and girls is shown below.

Box-and-whisker plot of Year 11 wrist circumferences



Features of the plot

The dot plot shows that the wrist circumferences for the Year 11 girls are mostly in the 14 cm to 18 cm range with the majority of measures either 15 cm or 16 cm. The wrist circumferences for Year 11 boys are mostly in the 16 cm to 18 cm range with equal numbers of the sample having measures of 16 cm, 17 cm and 18 cm.

The box-and-whisker plots show that the wrist circumferences of Year 11 girls in this sample are more spread out than the wrist circumferences of the Year 11 boys in the sample – the girls' wrist circumferences have a range of 7 cm, compared with the boys' wrist circumferences which have a range of 4 cm.

Both samples of wrist circumferences are postitively skewed, but the girls' wrist measurements are more skewed than the boys' wrist measurements since two girls have much larger wrist circumferences than usual (these two girls have bigger wrist measurements than any of these boys' wrist circumferences), with measures of 20 cm and 21 cm. This may need further investigation – maybe these two girls are significantly bigger than the average Year 11 girl, or maybe the values are errors.

The middle 50% of the Year 11 girls in the sample have wrist circumferences between 15 cm and 17 cm whereas the middle 50% of the Year 11 boys in the sample have wrist circumferences between 16.5 cm and 18.5 cm. Both boxes are reasonably symmetrical. The interquartile range of wrist circumferences for both the Year 11 boys and the Year 11 girls in the sample is 2 cm, but the boys' box (showing the middle 50% of wrist circumferences) is positioned further right up the scale than the girls' box.

The box-and-whisker plot shows that for this sample of Year 11 students, all of the boys in the sample have a wrist circumference greater than or equal to the median of the girls' wrist circumferences, so all of these boys have a wrist circumference greater than or equal to the smallest 50% of the Year 11 girls' wrist circumferences.

The median wrist circumference for the Year 11 boys in the sample is 17.5 cm which is 1.5 cm larger than median wrist circumference (16.5 cm) for the Year 11 girls in the sample, and both medians are outside the overlap of the boxes. This shift in the median wrist circumferences of 1.5 cm is nearly half of the overall visual spread (which is $18.5 - 15 = 3.5$ cm).

Inference

I claim that wrist circumferences of New Zealand Year 11 boys tends to be bigger than the wrist circumferences of New Zealand Year 11 girls back in the 2019 CensusAtSchools population.

I make this call based on the fact that each group's median wrist circumference is outside the other group's box, and that a shift in the median wrist circumference of nearly 50% of the overall visual spread would be required for the medians to match. In addition, all the boys have wrist circumferences greater than or equal to the girls' median wrist circumference.

This result was the one I predicted, which adds to my confidence that my inference is correct. (I predicted that Year 11 boys tend to have a larger wrist circumference than Year 11 girls as they mature physically at this age, becoming more muscular and bulkier than girls on average.)

I believe that I would come to the same conclusion if I were to repeat the experiment because the shift in the medians was quite large (much more than a third of the overall visual spread, which is significant for samples of size 30). The unequal sample sizes, with more girls (35) than boys (24), do not change this conclusion.

It may be interesting to investigate the wrist circumferences of younger students to find out if girls and boys have similar wrist circumferences at a younger age.

For Achieved you must have the following:

- *an appropriate comparison question*
- *a graph and summary statistics*
- *at least two statements describing comparative features of the distribution in context*
- *an answer to the comparison question in the context of the investigation.*

For Merit you must have enough for Achieved, plus:

- *make a correct informal inference about the population from the sample data that shows an understanding of the samples variability or of the context*
- *an answer to the comparison question with at least one statement of supporting evidence.*

For Excellence you must have enough for Merit, plus:

- *at least 2 graphs*
- *at least three statements describing different features such as middle 50%, shift and overlap, shape, spread, unusual or interesting features*
- *a correct informal inference about the population, giving a summary of reasons in context – the statistical basis for the claim, and whether it makes sense considering the actual situation.*

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