AS 91582 - Statistical Inference: Merit example (Body Mass Index).

INTRODUCTION

Body Mass Index is an estimator how the "amount of body fat a person has" *(LiveScience, 2014)*. It is calculated by taking a persons weight (in kilograms), and dividing it by the square of their height (in metres). For example a person with a height of 1.72m and a weight of 85kg will have a BMI of 28.73.

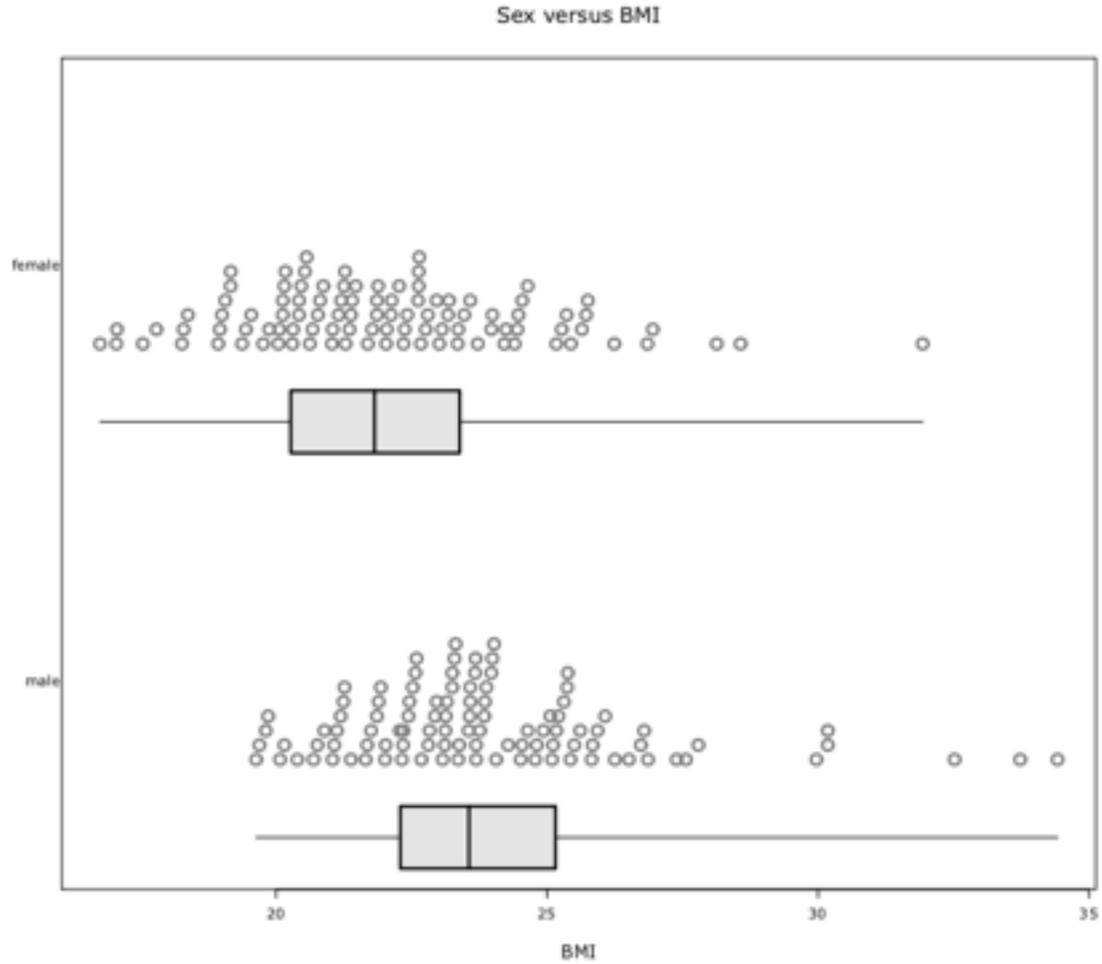
A BMI below 18.5 would put a person in the "underweight" category, between 18.5 and 24.9 is the "normal" range, 25 to 29.9 is "overweight", and anything above 30 puts a person in the "obese category" *(LiveScience, 2014)*. According to the BMI, this person in the example would be in the "overweight" range.

According to *Clinareo Inc. (2014)* BMI is not an accurate measure for athletes. This is because athletes tend to be more muscular that the average make or female, and because muscle weighs more than fat, will overstate an athletes BMI. A number of medal winners would be considered "obese" according to the BMI.

Sample data of 202 elite male and female athletes who belong to the Australian Institute of Sport (AIS) will be used in this investigation. The AIS is Australia's premier sports body, who is the government organisation in charge of all sport in Australia. BMI is one piece of information that the AIS collects from their elite athletes.

I will investigate the difference between male athlete and female athlete BMI, for athletes who belong to the Australian Institute of Sport.

I expect to find a difference between female athlete BMI and male athlete BMI, because according to *LiveScience (2014)* female BMI tends to be larger than male BMI because naturally women carry more body fat than men for the purposes of rearing children.



5 POINT SUMMARY	Male athletes	Female athletes
Minimum	19.6	16.8
Lower Quartile (LQ)	22.3	20.3
Median	23.6	21.8
Upper Quartile (UQ)	25.1	23.4
Maximum	34.4	31.9
Interquartile range (UQ - LQ)	2.8	3.1
Sample size	100	102

ANALYSIS: Technical notes

Centre

[S,N,C] I notice that the sample median BMI for male athletes is 23.6, compared with the sample median BMI for female athletes of 21.8. The sample median BMI for male athletes is 1.8 higher than the sample median BMI for female athletes.

[S,N,C] I notice that the sample distribution of BMI for male athletes appears to be symmetric, compared with the sample distribution BMI for female athletes which appears to be right skewed.

[R] & [P] The differences in the sample median and sample distribution suggests that male BMI is centred further up the scale than female BMI. A reason for this (as stated earlier) from *LiveScience (2014),* is that female BMI tends to be larger than male BMI because naturally women carry more body fat than men for the purposes of rearing children.

Spread

[S,N,C] I notice that the sample middle 50% of male athlete BMI is between 22.3 and 25.1, compared with the sample middle 50% of female athlete BMI which is between 20.3 and 23.4. The male athletes BMI middle 50% (IQR = 2.8) is larger than the female athlete BMI middle 50% (IQR = 1.7)

[R] & [P] The *U.S. Department of Health and Human Services (2014)* does not think it's necessary to measure BMI separately for male and female adults; but does for teenagers. I expect there to be a mix of adults and teenagers in the sample data which is one reason why the IQRs are different.

[S,N,C] I notice that the sample middle 50% of male weekly income is shifted further up the scale compared with the sample middle 50% of female weekly income, however some overlap exists of the middle 50% of about 40%.

[R] & [P] As I expect there to be a mix of adults and teenagers in the sample data, I suspect the teenager athletes are causing the right shift, whilst the adult athletes are causing the overlap.

Unusual Features

[S,N,C] I notice there is in an outlier in the female athlete BMI sample data at 31.9.

[R] & [P] Further investigation into the sample data, shows this female athlete is a very tall (1.7m) and heavy (94.8kg) person who is a 'field' athlete. She may be involved in a sport such as shot put which normally has athletes with large builds competing.

[S,N,C] I notice there is in an cluster of extreme values in the male athlete BMI sample data at 34.4, 33.7 and 32.5.

[R] & [P] Further investigation into the sample data, shows these male athletes are very tall (about 1.9m tall) and heavy (111kg to 123kg) people who is are also 'field' athlete. They may be involved in a sports such as shot put which normally has athletes with large builds competing.

CONCLUSION: Executive Summary

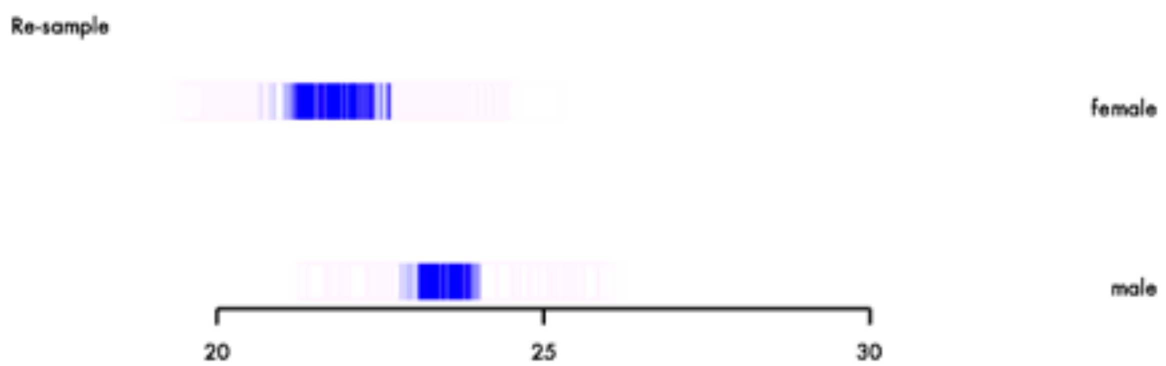
	Evidence of difference between BMI	Evidence of no difference between BMI
Centre: median	Yes	
Centre: sample distribution	Yes	
Spread: middle 50%	Yes	
Spread: shift	Yes	
Spread: overlap		Yes

The technical notes section explains possible reasons for the differences in the sample median, sample distributions, sample middle 50%, sample shift and sample overlap. When looked at together, 4 out of the 5 features suggest that there is a difference between the male athlete BMI and the female athlete BMI (for athletes from the AIS).

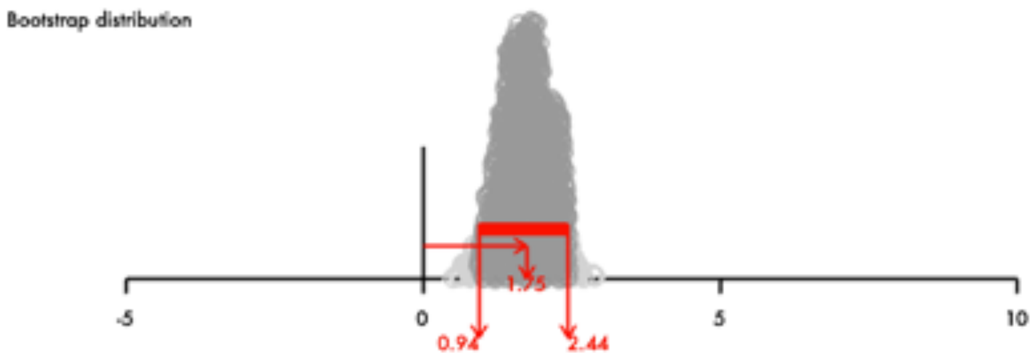
I expect this to be true for the population as because according to *LiveScience (2014)* female BMI tends to be larger than male BMI because naturally women carry more body fat than men for the purposes of rearing children.

What I have not taken into account is sampling error (sampling variability). If I were to take subsequent samples of male and female athletes of a similar sample size (202) from the AIS, the sample medians will vary, as shown in the graph below. Most of the re-sampled medians will be fairly close to the the population medians.

Because I physically cannot take more samples from the AIS, instead I will take re-samples from my original sample and compare the sample statistics from these re-samples with my original sample. This should give me enough information to make a judgement on male athlete and female athlete BMI.



Comparing the re-sampled median BMIs of male and female athletes, there seems to be a clear shift right of the re-sampled median BMIs compared to the female athlete BMIs.



The bootstrapped confidence interval of the differences between the re-sampled medians, tell me that it is a fairly safe bet that the median BMI for male athletes from the Australian Institute of Sport, is *larger* than the median BMI for female athletes from the Australian Institute of Sport, by 0.94 to 2.44.

There **is** a difference between male and female BMI for athletes from the AIS. Evidence of the features from the Analysis of the sample data from the AIS appears to be true.

I would like to separate adults and teenagers from the sample data, and run an investigation on the adults only to see if a different exists between adult females and adult males.

The End.

References

LiveScience. (2014). What is BMI?. Retrieved from http://www.livescience.com

Clinareo Inc. (2014). BMI for athletes. Retrieved from http://bmi.emedtv.com/

U.S. Department of Health and Human Services. (2014). About BMI for adults. Retrieved from http://m.cdc.gov/