# Case Study: 10000 Meter race at the 2016 Rio Olympics

In 10000 meter race, runners complete over 25 laps or a 400 meter track. It is the longest track running event held. The men’s 10000 meter began at the 1912 Olympics. It was 1988 (over seventy years later) before the women’s 10000 meter was added to Olympic competition. The official world records in the 10,000 meters are held by Kenenisa Bekele with 26:17.53 minutes for men and Almaz Ayana from Ethiopia with 29:17.45 minutes for women.

We are going to take a look at the 2016 Rio Olympics men and women 10000 meter competition. All the times for the participant’s times are given to you in minutes. You should leave the times in minutes and round to the nearest thousandth when needed. Assume the populations are normally distributed.

1. Use the samples to find the mean completion time of the
   1. male runners \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. female runners \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Use the samples to find the sample standard deviation of the completion times for the
   1. male runners \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. female runners \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Find a point estimate for the mean completion time of the
   1. male runners \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. female runners \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Construct a 95% confidence interval for the population mean completion time of the
   1. male runners \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. female runners \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Interpret the results of number 4.
   1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
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   2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
      \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. Use the samples to construct a 95% confidence interval for the population mean completion time of all runners. How do your results differ from those in number 4? Explain.  
   1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Based on the 95% confidence intervals found in number 4, do you think that the men’s mean completion time and the women’s mean completion time could be the same? Explain why you believe that.

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1. Using the values that you found in numbers 1 and 2, perform the following hypothesis test.

At a 10% significance level, test the claim that the women’s mean completion time is greater than \_\_\_\_\_\_\_\_\_\_\_ (the men’s mean completion time from 1a).

* 1. Ho: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Ha: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Label the claim.
  2. What type of test will you use? (Z-Test, T-test, or 1-ProZTest) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  3. Where is the rejection region? (Left-tailed, Right-tailed, Two-tailed test) \_\_\_\_\_\_\_
  4. Find the critical value(s). α = 0.10 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  5. What is the value of the standardized test statistic? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  6. What is your p-value? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  7. What is your decision? (Reject Ho or Fail to Reject Ho) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  8. Write your conclusion.   
     There \_\_\_\_\_\_\_\_\_\_\_\_ (is/is not) enough evidence to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ (support/reject) the claim that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

1. A trainer decides to do a study because he wants to estimate the population mean completion times for both male and female runners within 1/4 minute (0.25 minute). How many runners of each sex does he need for his study? Determine the minimum sample size required to construct a 99% confidence interval for the population mean completion times of
   1. male runners. Assume the population standard deviation is 0.64 minutes. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. female runners. Assume the population standard deviation is 1.12 minutes. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| Country | Men's Name | Time in Minutes |
| KEN | Paul Kipngetich TANUI | 27.09 |
| ETH | Yigrem DEMELASH | 27.11 |
| UGA | Joshua Kiprui CHEPTEGEI | 27.17 |
| ERI | Zersenay TADESE | 27.40 |
| BRN | Abraham Naibei CHEROBEN | 27.53 |
| NZL | Zane ROBERTSON | 27.56 |
| USA | Leonard Essau KORIR | 27.59 |
| TUR | Polat Kemboi ARIKAN | 27.59 |
| ETH | Abadi HADIS | 27.61 |
| JPN | Suguru OSAKO | 27.87 |
| USA | Shadrack KIPCHIRCHIR | 27.97 |
| PER | Luis OSTOS | 28.03 |
| UGA | Timothy TOROITICH | 28.08 |
| GBR | Andrew VERNON | 28.32 |
| BDI | Olivier IRABARUTA | 28.55 |
| JPN | Yuta SHITARA | 28.92 |
| GBR | Ross MILLINGTON | 29.25 |

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| Country | Women's Name | Time in minutes |
| KEN | Vivian Jepkemoi CHERUIYOT | 29.54 |
| KEN | Alice Aprot NAWOWUNA | 29.89 |
| USA | Molly HUDDLE | 30.22 |
| ETH | Gelete BURKA | 30.45 |
| AUS | Eloise WELLINGS | 31.25 |
| SWE | Sarah LAHTI | 31.47 |
| BDI | Diane NUKURI | 31.48 |
| GBR | Joanne PAVEY | 31.56 |
| GRE | Alexi PAPPAS | 31.60 |
| KGZ | Darya MASLOVA | 31.62 |
| RSA | Dominique SCOTT | 31.86 |
| UAE | Alia Saeed MOHAMMED | 31.95 |
| CAN | Lanni MARCHANT | 32.07 |
| RWA | Salome NYIRARUKUNDO | 32.13 |
| ESP | Trihas GEBRE | 32.16 |
| BRA | Tatiele Roberta DE CARVALHO | 32.64 |
| USA | Marielle HALL | 32.66 |
| MEX | Marisol ROMERO | 35.55 |