Physical activity causes significant effect on peak expiratory flow rate in students at the Hanze University

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Abstract

For this experiment the peak expiratory flow rate in students at Hanzehogeschool was measured to determine whether or not exercising has a significant effect on one's peak expiratory flow rate. The peak expiratory flow rate can indicate a patient's ventilation adequacy.
Results suggested that exercising does in fact lead to a significant increase of one's peak expiratory flow rate. These findings could possibly offer a solution for patients suffering from shortness of breath. This would mean these patients would no longer have to rely on medicine to treat their shortness of breath. If there is no longer need for these medicines this could possibly reduce the costs of asthma care.

1 Introduction

Asthma is a chronic lung disease that causes the airways to be constantly inflamed. The disease can occur at any age but is mostly present in children and adolescents. Approximately 600.000 people in the Netherlands suffer from asthma, of which 80.000 are children. In the year 2019 alone, the Dutch government has spent nearly 444 billion euros on asthma care. From this 444 billion euros, 40 percent was spent on medication. One of the symptoms of asthma that requires medical aid is shortness of breath, which is caused by the narrowing of the airways due to muscle tightening or inflammation.

"Regular Exercise Improves Asthmacontrol in Adults: A Randomizedcontrolled Trial" (2019)

Research has proven that exercising can improve asthma control in patients, but that it has little to no effect on one's peak expiratory flow rate. The peak expiratory flow rate is the maximum rate of airflow that a person can forcefully exhale. The peak expiratory flow rate can reliably indicate the adequacy of someone's ventilation and whether or not someone suffers from airflow obstruction. This experiment was conducted out of pure curiosity. However, if exercising does turn out to significantly increase one's peak expiratory flow rate, and dilate their airways, it could help reduce shortness of breath in patients and thereby possibly reduce the costs of asthma care. A healthy peak expiratory flow rate ranges between 400 and 600 litres per minute. A peak expiratory flow rate between 200 and 400 litres per minute can indicate asthma. A healthy peak expiratory flow rate varies from person to person and is also influenced by factors such as sex, age and height. The peak expiratory flow rate tends to be higher in males and taller people compared to females and shorter people. The peak expiratory flow rate is measured using a Peak Flow Meter, a small device with a scale ranging from 50 L/min to 800 L/min. This paper aims to assess whether or not exercising can increase one's peak expiratory flow rate. Additionally it will examine the effects of several factors on the

peak expiratory flow rate. To conduct this experiment the peak expiratory flow rate of students from the Hanze University were measured using a Peak Flow Meter. These students were grouped by sex and whether or not they participated in sports. Their peak expiratory flow rates were measured before and after asking them to perform 10 jumping jacks.

2 Materials and methods

Software: R, Excel

Libraries: Dplyr, Ggplot2, Tidyverse, Tidyr

Devices: Peak flow meter, disinfectant wipes, laptop (for storing data)

To collect the data a peak flow meter, disinfectant wipes and a laptop have been used. The data was stored in an Excel spreadsheet using a CSV format. The specific steps in which the data has been collected can be found in the git repository that is linked in the section 'Attachments'. The statistical programming language R has been used to process the data. The data has been plotted and visualised using the libraries dplyr, ggplot2, tidyverse and tidyr in R. Hypothesis testing of our data has also been achieved using R. The hypothesis tests used for this experiment were the Shapiro-Wilk test, two-tailed paired t-test and ANOVA test.

The Shapiro-Wilk test was performed to determine whether or not the data was normally distributed. Data is normally distributed when most of the data points are in the middle of the range whilst the rest of the data points are in the two extremes.

The two-tailed paired t-test was performed on the factor jumping jacks. A two-tailed t-test is used to determine if there is a significant difference between groups in general, not specifically in one direction. A paired t-test is used on data from two sets of observations from the same variable.

The ANOVA (Analysis Of Variance) test was performed on the variables sport, sex and activity. An ANOVA test is used when comparing more than two means. The ANOVA test can be performed using more than one independent variable.

3 Results

The collected results of this experiment are first visualised in the following boxplots, histograms and tables. The boxplots show the distribution of the peak expiratory flow rate in the different groups (males,females, exercise, no exercise, before jumping jacks and after jumping jacks).

Figure 1 shows the peak expiratory flow rate in females grouped by whether or not they exercise and before and after they were asked to perform 10 jumping jacks.

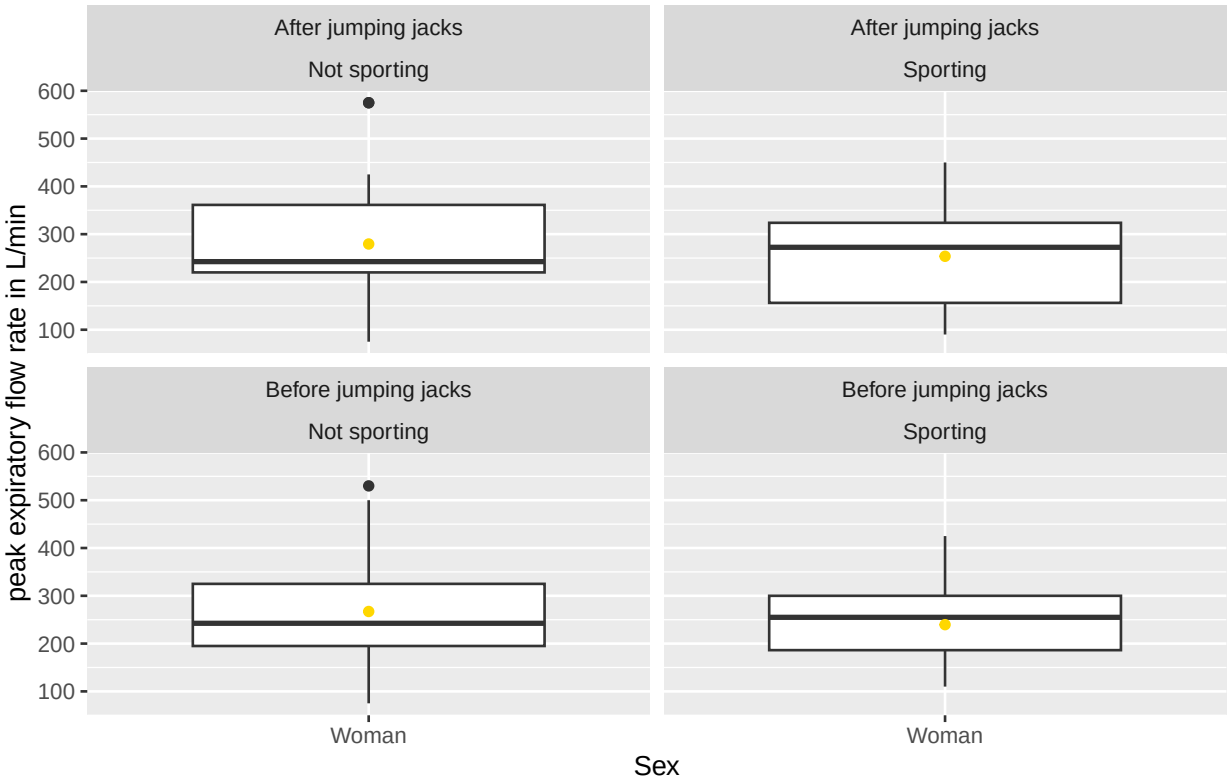

Figure 1: Box plot with the peak flow rate in females that do exercise before performing 10 jumping jacks

Figure 2 shows the peak expiratory flow rate in males grouped by whether or not they exercise and before and after they were asked to perform 10 jumping jacks.

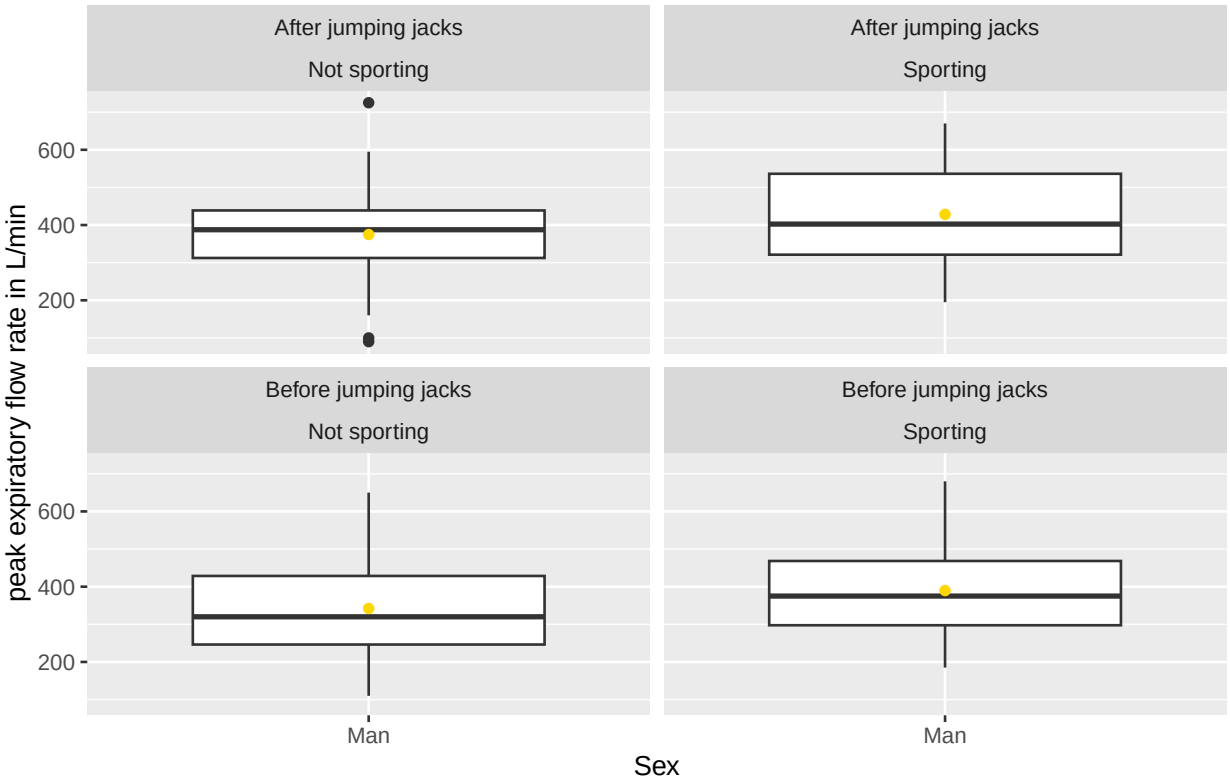

Figure 2: Boxplot with the peak flow rate in males that do exercise before performing 10 jumping jacks

The boxplots visualised above [Figure 1 & Figure 2] show that for both males and females the mean of the peak expiratory flow rate is higher after performing the 10 jumping jacks compared to before.

To get further insight on the effects of exercising on the peak expiratory flow rate, these following histograms were made to show the distribution of the peak expiratory flow rate in subjects that exercise and do not exercise. The histogram in figure 3 shows the peak expiratory flow rate in subjects that exercised grouped by their sex.

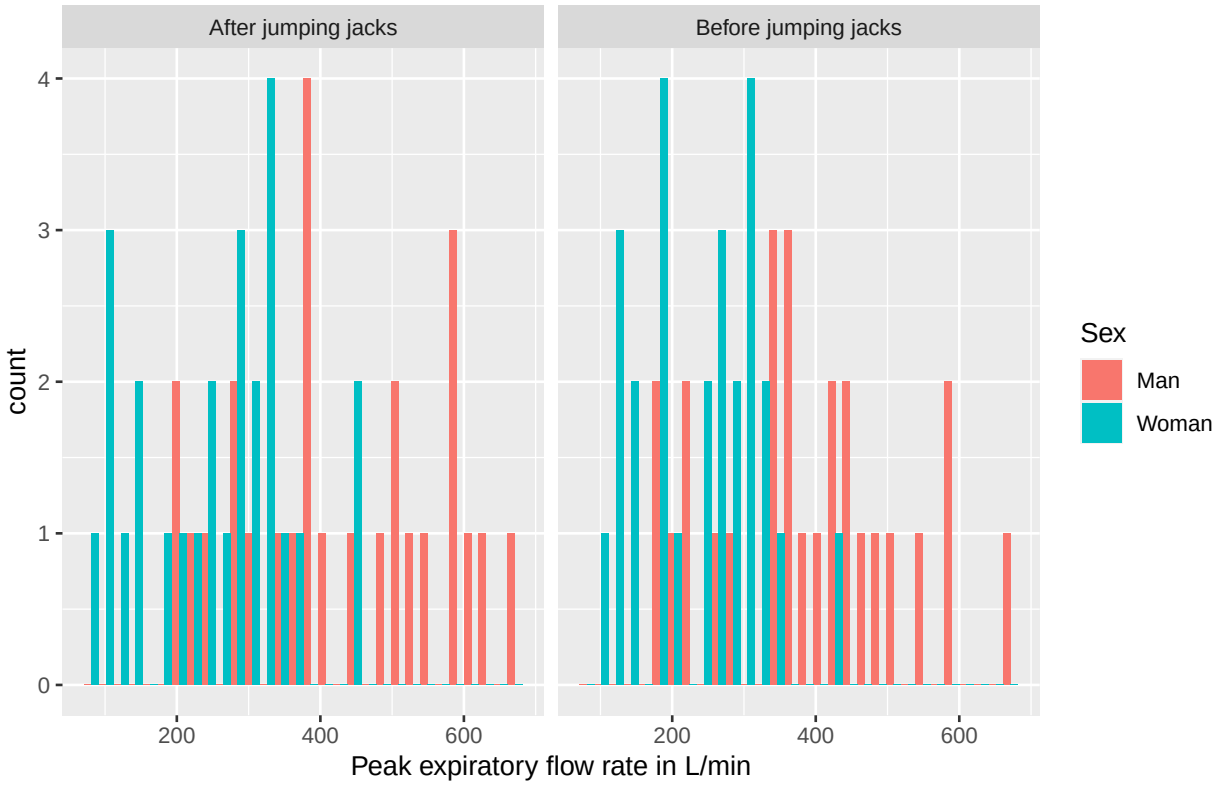

Figure 3: A histogram of peak expiratory flow rates in subjects that do exercise grouped by sex with a $P < 0.01$

The histogram in figure 4 shows the peak expiratory flow rate in students that don't exercise, grouped by sex.

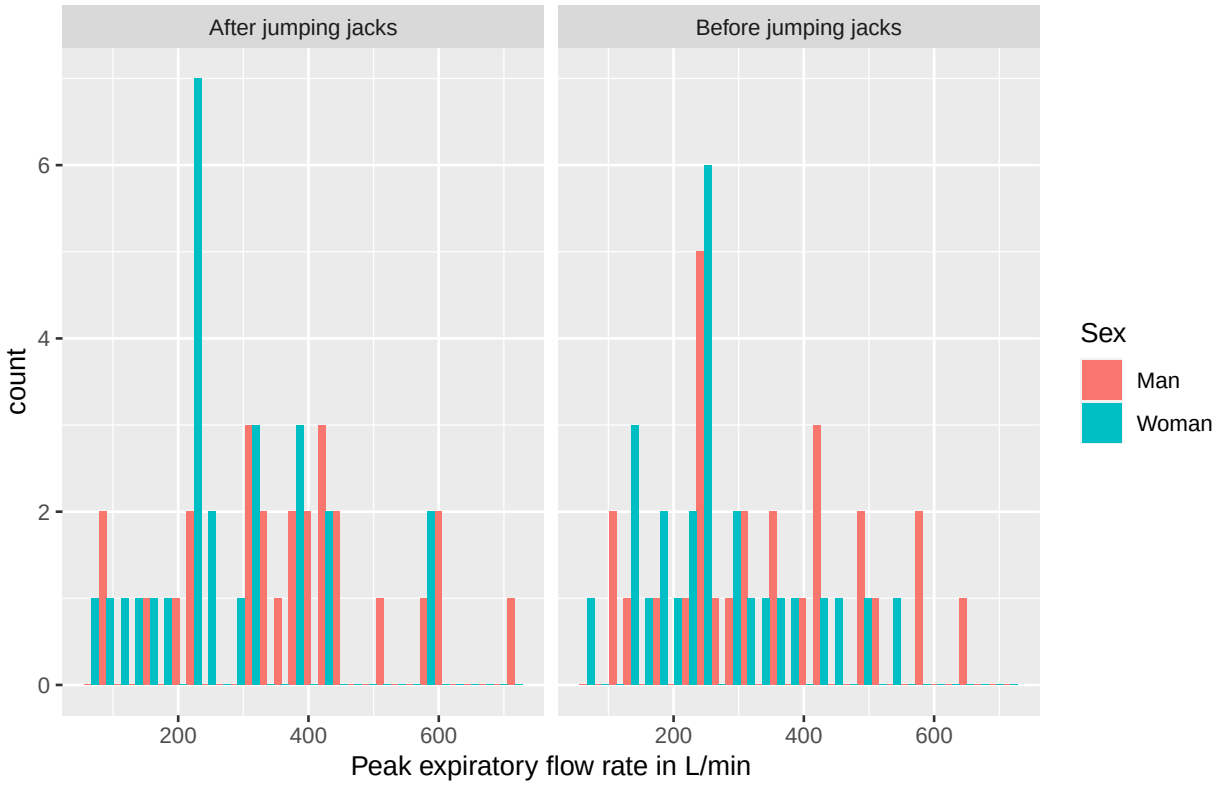

Figure 4: A histogram of peak expiratory flow rates in subjects that don't exercise grouped by sex with a P < 0.01

The histograms of males and females that exercise show a higher peak expiratory flow rate compared to males and females that don't exercise. Furthermore, the difference between the peak expiratory flow rate before and after jumping jacks seems to be higher in males and females that exercise than in males and females that don't.

Another observation is that the peak expiratory flow rate in males and females that don't exercise seems to be lower after performing jumping jacks.

To determine whether or not these observations were significant, several t-tests have been performed on the data.

T-tests can only be performed on data that is normally distributed. To determine whether or not the data was normally distributed a Shapiro-Wilk test was performed. To do this the data has been divided into smaller separate datasets. The peak expiratory flow rates were first grouped by sex. Then the sexes were further grouped by whether or not they exercise, and the peak expiratory flow rates before and after performing jumping jacks. In the table below the column 'Has_activity' refers to the jumping jacks.[Table 1]

Table 1: The p-value from a Shapiro-Wilk test per different group.

Has_activity	Sex	Sporting	Pvalue
False	Man	FALSE	0.4623611
False	Man	TRUE	0.5876950
True	Man	FALSE	0.7543905
True	Man	TRUE	0.2901990
False	Woman	FALSE	0.2390909
False	Woman	TRUE	0.2685957
True	Woman	FALSE	0.1462523
True	Woman	TRUE	0.2202456

All the p-values are higher than 0.05 meaning that all the data is normally distributed.

To determine if there was a significant difference in peak expiratory flow rate before and after 10 jumping jacks in the different groups, a paired t-test was performed. [Table 2]

Table 2: The different p-values of the t-tests among the different groups before and after 10 jumping jacks.

Sex	Sporting	Pvalue
Man	FALSE	0.0164226
Man	TRUE	0.0150269
Woman	FALSE	0.5506667
Woman	TRUE	0.2268565

There is no significant difference in peak expiratory flow rate before and after 10 jumping jacks in females that exercise and don't exercise.

Males that exercise and don't exercise do show a significant difference in the peak expiratory flow rate before and after 10 jumping jacks.

To determine whether or not the factors exercise, jumping jacks and sex had a significant effect on the peak expiratory flow rate, an ANOVA test was performed. [Table 3]

Table 3: P values of ANOVA-test on the effects of exercise, jumping jacks and sex.

ANOVAtest	Pvalue
sport	0.0000000
sex	0.5035232
activity	0.1723715

The ANOVA-test calculated a p-value of 5.046752e-11 for the variable exercise which suggests that it has a significant effect on the peak expiratory flow rate. The variables sex and jumping jacks had p-values greater than 0.05, suggesting that they had no significant effect on the peak expiratory flow rate.

Table 4: P values of ANOVA-test on the effects of exercise and jumping jacks in males.

ANOVAtest	Pvalue
sporting men	0.0764301
activity by men	0.2095340

Table 5: P values of ANOVA-test on the effects of exercise and jumping jacks in females.

ANOVAtest	Pvalue
sporting women	0.2137593
activity by women	0.5383175

The p-values from the ANOVA-tests displayed in table 4 and table 5 all seem to be greater than 0.05, suggesting that none of these variables have a significant effect on the peak expiratory flow rate.

4 Discussion and conclusion

From the results that came out of the two-tailed paired t-test that was performed, it can be concluded that there is a significant difference in PEFR before and after performing 10 jumping jacks in males that exercise and males that don't exercise. There was no significant difference in PEFR before and after performing 10 jumping jacks in females that exercise and females that don't exercise. The ANOVA-test in table 3, which tested the effect of the variables exercise, jumping jacks and sex on the peak expiratory flow rate, calculated a p-value of 5.046752e-11 for the variable exercise. This suggests that exercise has a significant effect on the peak expiratory flow rate. The variables sex and jumping jacks had p-values greater than 0.05, suggesting that they had no significant effect on the peak expiratory flow rate. The ANOVA-tests in table 4 and table 5 however, in which the effect of exercise and jumping jacks on the peak expiratory flow rate in males females was tested, showed that when the data is divided by sex there no longer seems to be a significant effect of exercise or jumping jacks on the peak expiratory flow rate. All the p-values were greater than 0.05. In conclusion, exercise has a significant effect on the peak expiratory flow rate, however sex does seem to play a role in it. It is important to note that the findings of this experiment were based on a relatively small data set in which individuals with asthma or other lung conditions were not included. Judging from the results of this experiment and the way the data was collected, the data is not reliable and thereby of no use in the workfield. The measurements for the peak expiratory flow rate were visually observed and the measurements were rounded off as well.

In addition to that there was no literature found that was relevant enough to this experiment that could be used to compare the data with. For that reason it is difficult to determine whether or not this experiment was relevant. Conducting this experiment on a bigger scale,with a greater sample size and more variables would have granted more insight on the relation between exercise/physical activity and the peak expiratory flow rate.

5 Online attachments

For attachments follow the link below to the github repository of this experiment:

https://github.com/danielpastoor/breathing_peak_flow

References

"Regular Exercise Improves Asthmacontrol in Adults: A Randomizedcontrolled Trial." 2019. *Nature*, 11.