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 (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 would also 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 thereby reducing 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 divided by sex and whether or not they participated in sports. Their peak expiratory flow rate's 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-file using a csv format. The specific steps in which the data has been collected can be found in the git repository. The statistical programming language R has been used to process the data. The data has been plotted and visualised using the libraries dplyr, ggplot2 and tidyverse 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 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 paired t-test was performed to determine whether or not there was a significant difference between the PEFR before and after performing 10 jumping jacks. A paired t-test is used on data from two sets of observations.

The two-tailed 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.

The ANOVA (Analysis Of Variance) test was performed on the factors 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 Resultaten

The collected results of this experiment are first visualised in the following order of boxplots, histograms and table result of our test. The discuss of the distribution on the peak expiratory flow rate in the boxplots with the different groups (males,females, exercise, no exercise, before jumping jacks and after 10 jumping jacks).

Figure 1 shows the peak expiratory flow rate in females that exercise before and after performing 10 jumping jacks this visualised using a boxplot where it is also split by if the female sport or not.

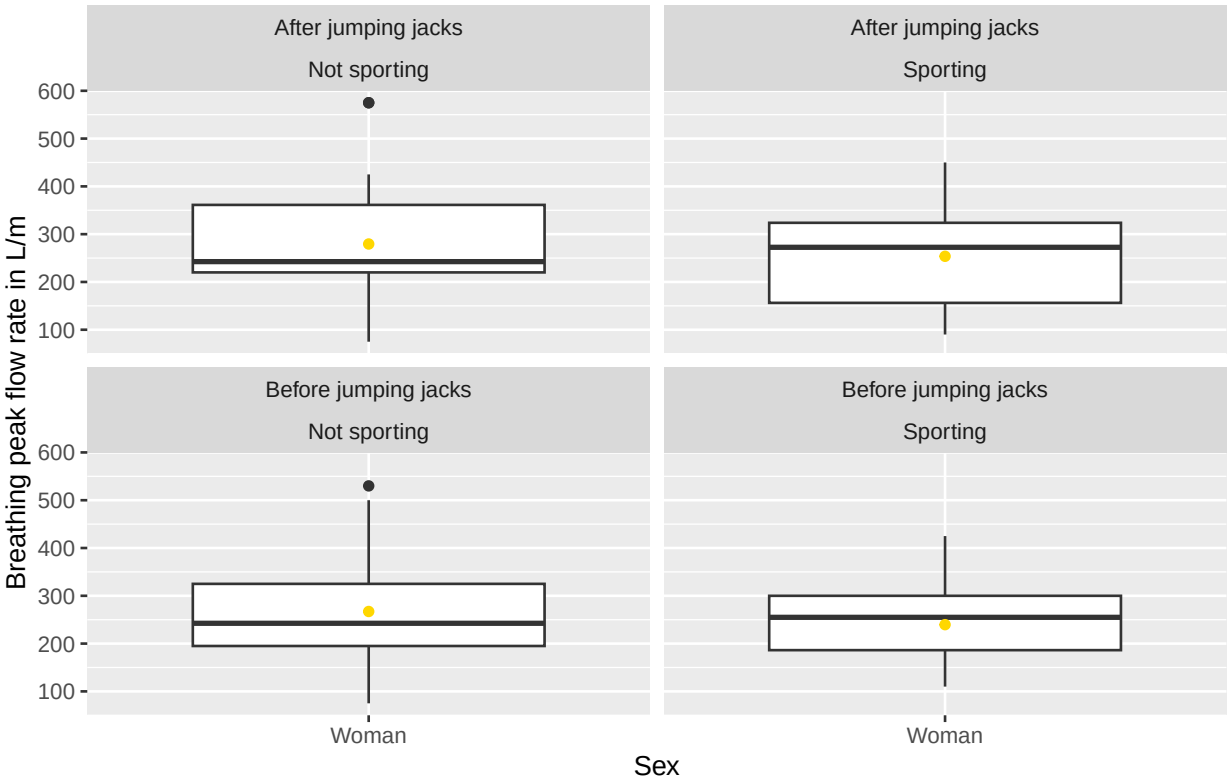

Figure 1: Box plot with the peak flow rate in females that do exercise before performing 10 jumping jacks

Figure 2 shows the peak expiratory flow rate in males that exercise before and after performing 10 jumping jacks this visualised using a boxplot where it is also split by if the male sport or not.

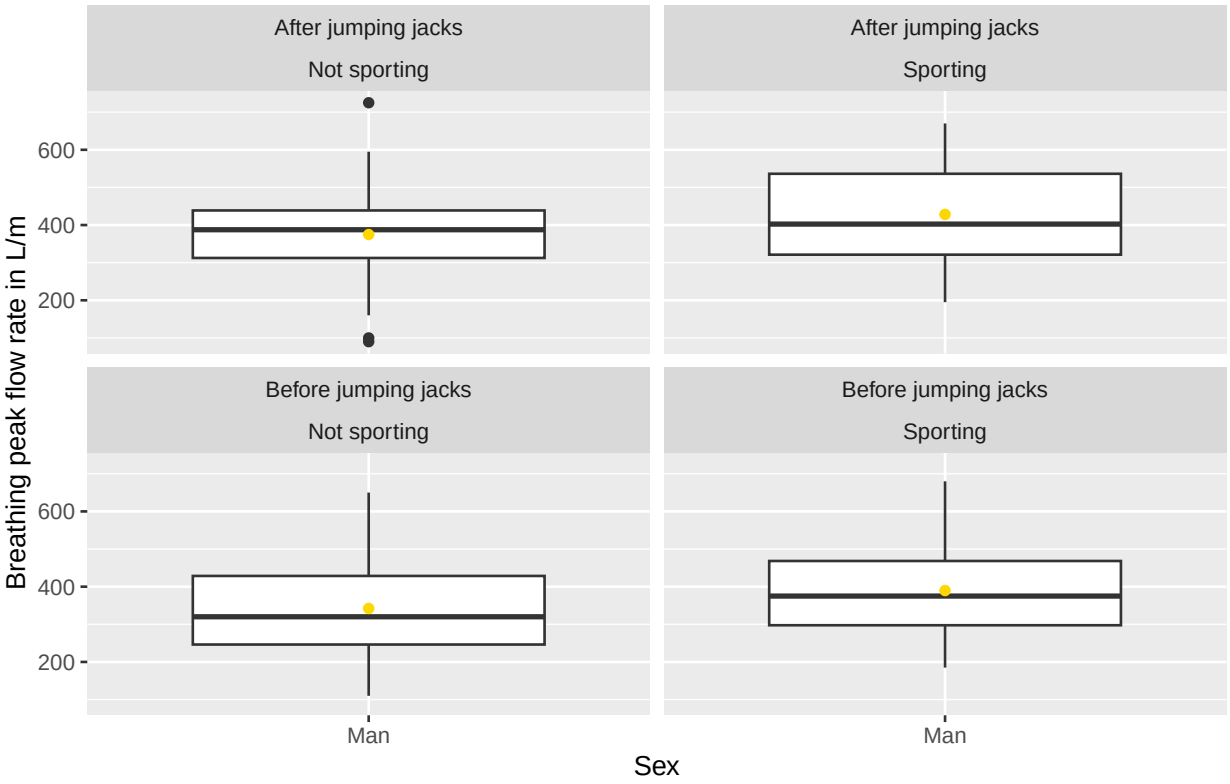

Figure 2: Box plot with the peak flow rate in males that do exercise before performing 10 jumping jacks

The boxplots visualised above [Figure 1 & Figure 2] shows that for both males and females the mean of the peak expiratory flow rate is higher after performing the 10 jumping jacks compared to it 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 students that exercised grouped by their sex.

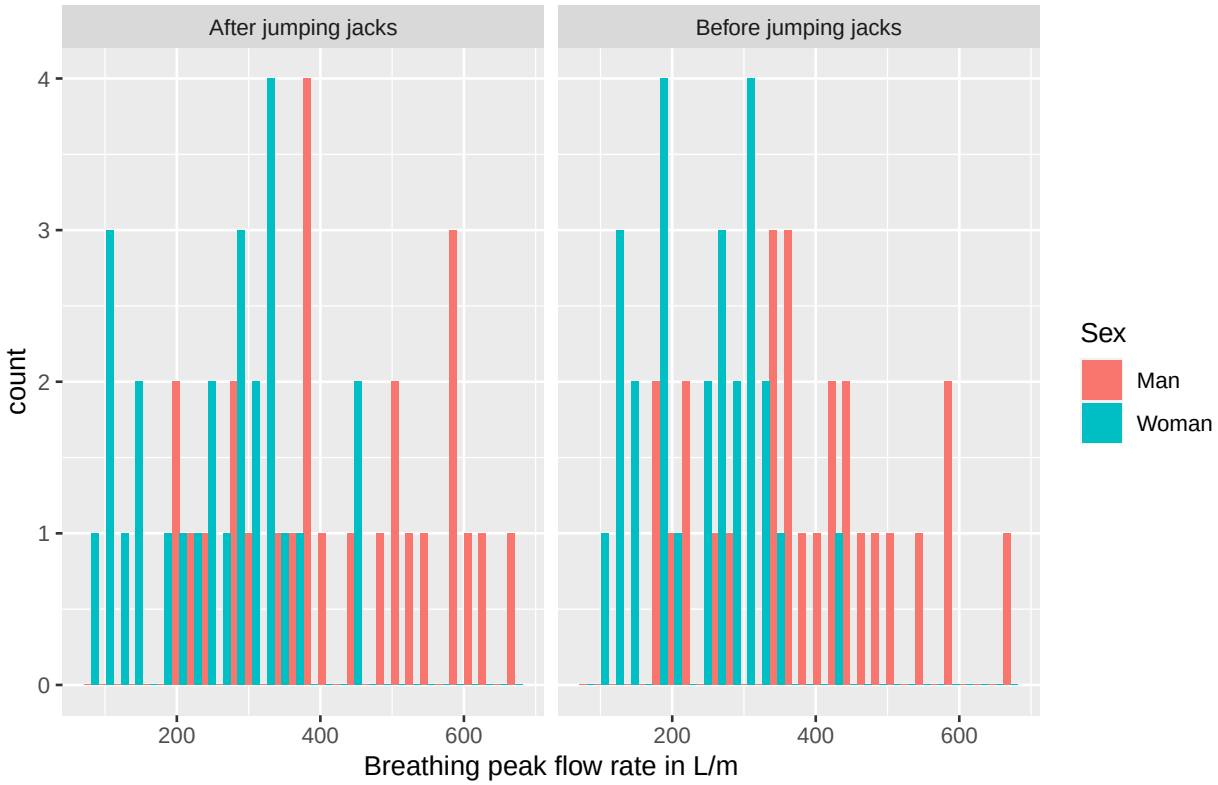

Figure 3: A histogram plotted from a data collection with the filter if the person sport and grouped by sex with a $P < 0.01$

These following histograms were made to show the distribution to get further insight on the effects of exercising on the peak expiratory flow rate The histogram in figure 4 shows the peak expiratory flow rate in students that don't exercise, grouped by sex.

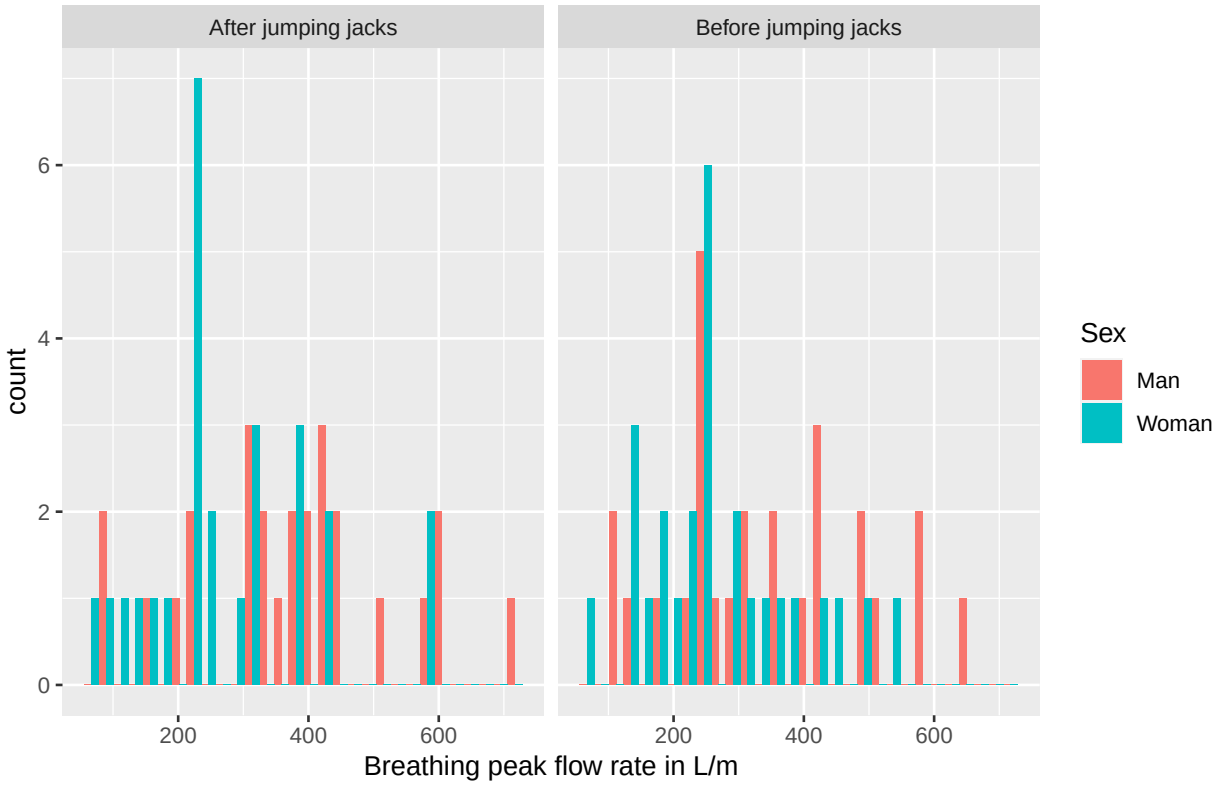

Figure 4: A histogram plotted from a data collection with the filter if the person does not sport and grouped by sex with a $P < 0.01$

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 is normally distributed a Shapiro-Wilk test was performed. To do this the data has been divided into smaller separate datasets. The peak expiratory flow rate's have first been grouped by sex. Then the sexes have been further grouped by whether or not they exercise, and the peak expiratory flow rate's before and after performing jumping jacks.[Table 1]

Table 1: Per different group the p-value in a Shapiro-Wilk test.

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 two-sided t-test was performed. [Table 2]

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

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 not exercise.

Males that exercise and do not exercise do show a significant difference in the peak expiratory flow rate before and after 10 jumping jacks. This is mostly because the sporting group of men did a fintess sport. Also the flow rate resulted somethimes in a lower flow rate.

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]

```
##   ANOVAtest       Pvalue
## 1     sport 5.046752e-11
## 2       sex 5.035232e-01
## 3  activity 1.723715e-01
```

Table 3: P values for ANOVA testing the effects of sports, an athletic activity and gender.

ANOVAtest	Pvalue
sport	0.0000000

sex	0.5035232
activity	0.1723715

Based on the P value made by the ANOVA test, there could be suggested that gender has a effect on the data. The statistical analysis revealed a p-value of 5.046752e-11, further emphasizing the significance of this disparity. The effect of alone sport and athletic activity on the different sexses.

```
##         ANOVAtest     Pvalue
## 1    sporting men 0.07643009
## 2 activity by men 0.20953402
```

Table 4: (#tab:ANOVA men)P values for ANOVA testing the effects of sports and an athletic activity on men.

ANOVAtest	Pvalue
sporting men	0.0764301
activity by men	0.2095340

```
##           ANOVAtest    Pvalue
## 1    sporting women 0.2137593
## 2 activity by women 0.5383175
```

Table 5: (#tab:ANOVA women)P values for ANOVA testing the effects of sports and an athletic activity on women.

ANOVAtest	Pvalue
sporting women	0.2137593
activity by women	0.5383175

Looking at sporting men with a P value of 0.07643009, there could be a effect on the data if men sport or not. # Discussie en Conclusies

The results obtained from this experiment provide an insights into the relationship between physical activity, exercise, and peak expiratory flow rate.

As depicted in Figure 1 and figure 2, the data suggests a clear association between the physical activity and a higher peak expiratory flow rate.

Looking deeper into the results, it becomes clear that there is a significant difference in peak expiratory flow rate between males who exercise and those who do not, particularly following the completion of 10 jumping jacks. The statistical significance of this difference was viewed by the ANOVA test (table 3), which yielded a p-value below the commonly accepted threshold of 0.05.

In contrast, the analysis revealed no significant difference in peak expiratory flow rate between females who exercise and males who do not exercise, both before and after the 10 jumping jacks. The only thing we found is that the peak expiratory flow rate can be lower after 10 jumping jacks. These findings suggest that gender may play a role in the relationship between exercise and peak expiratory flow rate.

It is important to acknowledge the limitations of this experiment, as they may affect the reliability of the results. Firstly, the relatively small data set used in the analysis limits the statistical result of the findings. Additionally, the measurement of peak expiratory flow rate relied on visual observation, introducing potential subjectivity and measurement errors. The rounding off of recorded values further diminishes the precision and accuracy of the results. Also not every person handled the peak flow device the samen.

In summary, while the results of this experiment provide valuable insights, they should be interpreted with caution due to the limitations discussed. But the result determine that there is a relation between sporting and peak expiratory flow rate.

4 Online bijlagen

Daniel Pastoor Vaak zijn online bijlagen vele malen groter dan het eigenlijke artikel. Wees nooit bang om te veel aan bijlagen aan te bieden. Je kan hierbij denken aan

- de ruwe data
- de code voor dataverwerking
- de code voor analyse
- aanvullende figuren en tabellen

Natuurlijk is een git(hub) repo daar de beste plek voor! Zorg ervoor de je repo logisch is ingericht met goede Readme document(en). Ook de code zelf is waar nodig natuurlijk goed gedocumenteerd.

4.1 Wordcount

Method	koRpus	stringi
Word count	1731	1742
Character count	10524	10579
Sentence count	103	Not available
Reading time	8.7 minutes	8.7 minutes

Referenties

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