**SUMMARY : The Impact of COVID Vaccination on Symptoms of Long COVID:**

**An International Survey of People with Lived Experience of Long COVID**

**The objective of the project :**

     The research was written when more than 470 million worldwide people were infected by SARS-CoV-2. Although some people had mild severity of Covid, which can be recovered within a few days, they might experience long-lasting symptoms afterward. These post-Covid symptoms can be called a post-Covid-19 syndrome, long Covid-19, or post-acute sequelae of SARS-COV-2 infection (PASC). According to the World Health Organization definition, long Covid-19 syndrome consists of a variety of new, previous, or ongoing symptoms that a person may experience more than 4 weeks after getting Covid-10. [1] After the vaccine's publication, anecdotal evidence has suggested that vaccines can contain both potential benefits or exacerbate the symptoms of a person with long-Covid. In this research, we measured the effectiveness of different types of Covid vaccines on approximately 900 people with long-COVID symptoms, who already received their first dose of the vaccine.

**Data collection and processing methods :**

     The survey was conducted by researchers from different universities and medical clinics. 900 patients who experienced long-COVID were invited to complete an online questionnaire through postings on social media, online support groups, and direct mailing in the UK and abroad. They were asked to provide information based on their COVID-19 testing status and the severity of the infection in five time periods. Survey takers need to wait at least one week after their vaccination to take the survey. Data were collected after their first vaccine and after each dose of the vaccine, which involves the information about which vaccines were received, when, and the severity of the initial disease. Additionally, regarding chronic conditions, general demographics (age, biological sex, and ethnic group) were requested. A scale from 1 to 10 is used for the severity and 0 is used for the absence of symptoms.

**Statistical methods to analyze the data:**

    Multivariate regression analysis was used to evaluate the impact of each vaccine on the symptoms. This was adjusted for baseline symptom score, age group, sex, ethnicity and duration of long COVID symptoms. After that, mean and 95% CI are presented, with a positive number showing an improvement in symptoms and a negative number indicating deterioration. As the interpersonal agreement is not as good as the intrapersonal reproducibility of visual analogue scores, the symptom score is measured in terms of individual percentage change instead of absolute difference.

   Sensitivity analysis was performed for those who had PCR or antibody-confirmed COVID-19 infections. A further analysis was made for those with confirmed COVID-19 contact in addition to symptoms. Following the recommendations of Cupples [2] and Rothman [3], the measured significance of the variables of interest is reported without adjustment for multiple testing. Statistical significance was considered at p<0.05. Statistical analysis was carried out with Stata SE 16.1.

**Results and conclusions were drawn by the author :**

     Out of 900 people who completed the questionnaire, 812 individuals were included in the final analysis. All of the patients were injected with the first dose of vaccine, predominantly Astra\_Zaneca vaccine, followed by Pfizer vaccine and Modern. In the total population, the number of respondents with no or mild symptoms (scoring 0-4 out of 10) showed good results after vaccination while those with moderate or severe symptoms (>4 out of 10) reduced post-vaccination. The sensitivity analysis exploring how vaccines impact fatigue, brain fog, and myalgia, showed the same results with the full data set.

     Based on the sample of 812 participants with long COVID, most of them reported improvement in their symptoms after their first vaccination while only a few of them experienced deterioration. These symptoms demonstrate themselves as a direct vaccine effect. This should further be tested using prospective randomized controlled trials.

[1] Mayo Clinic: COVID-19: Long-term effects, 28 June 2022

[2] Cupples L.A., Heeren T., Schatzkin A., Colton T. Multiple testing of hypotheses in comparing two groups. Ann. Intern. Med. 1984;100:122–129. doi: 10.7326/0003-4819-100-1-122. [[PubMed](https://pubmed.ncbi.nlm.nih.gov/6691637)] [[CrossRef](https://doi.org/10.7326%2F0003-4819-100-1-122)] [[Google Scholar](https://scholar.google.com/scholar_lookup?journal=Ann.+Intern.+Med.&title=Multiple+testing+of+hypotheses+in+comparing+two+groups&author=L.A.+Cupples&author=T.+Heeren&author=A.+Schatzkin&author=T.+Colton&volume=100&publication_year=1984&pages=122-129&pmid=6691637&doi=10.7326/0003-4819-100-1-122&)]

[3] Rothman K.J. No adjustments are needed for multiple comparisons. Epidemiology. 1990;1:43–46. doi: 10.1097/00001648-199001000-00010. [[PubMed](https://pubmed.ncbi.nlm.nih.gov/2081237)] [[CrossRef](https://doi.org/10.1097%2F00001648-199001000-00010)] [[Google Scholar](https://scholar.google.com/scholar_lookup?journal=Epidemiology&title=No+adjustments+are+needed+for+multiple+comparisons&author=K.J.+Rothman&volume=1&publication_year=1990&pages=43-46&pmid=2081237&doi=10.1097/00001648-199001000-00010&)]

Research link : https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9146071/#B21-vaccines-10-00652

**Terms explanation:**

* Multivariate regression is a technique used to measure the degree to which the various independent variable and various dependent variables are linearly related to each other. The relation is said to be linear due to the correlation between the variables. Once the multivariate regression is applied to the dataset, this method is then used to predict the behaviour of the response variable based on its corresponding predictor variables.

In the multiple linear regression model, Y has normal distribution with mean



The model parameters β0 + β1 + +βρ and σ must be estimated from data.

β0 = intercept

β1 βρ = regression coefficients

σ = σres = residual standard deviation

* Sensitivity analysis determines how different values of an independent variable affect a particular dependent variable under a given set of assumptions. In other words, sensitivity analyses study how various sources of uncertainty in a mathematical model contribute to the model's overall uncertainty.

Mathematically, the dependent output formula is represented as,

**Z = X2 + Y2**

Our sample data is taken from a group of men and women who died due to Covid during June 2022. The table below shows the data.

**Checking the data :**

The data values of deaths in women and men are independent. The deaths from women do not depend on the deaths from men. We assume that the people represent a simple random sample from the population of people who passed away from Covid.

* We assume the data are normally distributed, and we can check this assumption
* The data values are deaths cause by Covid. The measurements are CONTINUOUS
* We assume the variances for men and women are equal, and we can check this assumption

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Examining the summary statistics, we see that the standard deviations are similar. This supports the idea of equal variances. We can also check this using a test for variances. Based on these observations, the two-sample t-test appears to be an appropriate method to test for a difference in means.

Sample size Average Standard Deviation

Men 30 23.033308 2.731549

Women 30 21.00551 2.7659016

Without doing any testing, we can see that the averages for men and women in our samples are not the same. But how different are they?

Are the averages “close enough” for us to conclude that mean death is the same for the larger population of men and women during Covid.

Or are the averages too different for us to make this conclusion?

Average(men) – average(women) = 2.0277

Sp^2 = 7.532

Sqrt(Sp^2) = 2.744

T = 2.811

Df = 56

A = 0.05 and 56 degrees of freedom is 2.811

2.811> 2.00

We reject the null hypothesis that the deaths in men are more than women’s deaths and conclude that we have evidence in the number of deaths in women and men are equal.