*International Journal of Engineering Science Invention (IJESI)*
*ISSN (Online): 2319-6734, ISSN (Print): 2319-6726*
*www.ijesi.org ||Volume 10 Issue 11 Series II || November 2021 || PP 30-37*

# Applying principal component to study the Yemeni students in Aurangabad immunity against covid-19

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***ABSTRACT***
*This paper aims to explore the role of Principal Component Analysis in the theory and applied study because there is a large number of available measurements. It is natural to look for where they can be replaced by fewer measurements or functions, in the analysis and the interpretation of data, without sacrificing many details for convenience. The principal components of the measurements that are linear functions are suggested for this Intention. Therefore, it is important to analyse in what sense the primary component analysis offers. The researcher is aiming for decreasing in data without any loss of information from the data. This paper aims to study the Yemeni students in Aurangabad immunity against covid-19 with the assistance of Principal Component Analysis. A study conducted on a group of Yemeni students in Aurangabad.*

***KEYWORDS:*** *Principal Component, Statistic, Improvement.*

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Date of Submission: 10-11-2021 Date of Acceptance: 25-11-2021

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## I. INTRODUCTION

At the end of 2019, a new form of coronavirus named 2019-nCoV (or Covid-19) was identified by the scientists in Wuhan. [1] It is a harmful virus that causes significant damage to the respiratory system of the body. The principal components are basically a data reduction approach that seeks to minimise data. A small number of derived variables are generated that can be used in place of the to simplify the subsequent analysis of the results, the greater number of original variables Singh et al. (2014, p.67).[2] Sometimes, it is hard to locate the roots of such statistical techniques. The technique of principal components analysis was first described by Karl Pearson (1901). He believed this was the best approach to Any of the topics that at that time were of concern to biometricians, Even though he did not suggest realistic measurement method for more than Two factors or three .and the second was Hoteling (1933) presented explanations of the system now referred to as Principal Component Analysis (PCA) as cited in Muirhead (1982) [3]. The PCA is one of the simplest multivariate analyses. The number of Yemeni students and their immunity against Covid-19 in Aurangabad India is considered in this study using principal component analysis.

## II. METHODS

The study aims to take P variables x1, x2, x3, .., xp And find combinations of these to create Y1, Y2, Y3,…, Yp indices, which are In order of their meaning, uncorrelated, and which explains the variance in the results.

A multivariate if the data set is visualised in high-dimensional data space (1 axis per axis) as a set of coordinates. variable), PCA can provide a lower-dimensional image to the user, a "shadow" of this Item from the most insightful point of view when present. This is accomplished by using only the Characteristic of PCA. A maximum sum of the total variation in the measured variables is accounted for by the first component derived in the principal component analysis. Under normal conditions, this means that at least some of the variables observed will be associated with the first factor. It could be related to all of them. There will be two significant features of the second portion extracted. First, the full amount of variation in the data set that the first component did not account for would be compensated for by this component. The second feature of the second element is that the first component would be uncorrelated. Literally, that correlation would be zero if you were to compute the correlation between components 1 and 2. The remaining components extracted in the study show the same two characteristics: each component accounts for a maximum amount of variance not accounted for by the previous components in the variables observed, and all the preceding components are uncorrelated. In this way, with each new component accounting for increasingly smaller and smaller quantities of variation, the main component analysis continues (this is why only the first few components are typically maintained and interpreted). The resulting components show varying degrees of correlation with the observed variables when the study is complete are completely uncorrelated with each other.

## III. PRINCIPLE COMPONENT DEFINE

"Hotteling transform" or "Karhunen-leove (KL) Method" is often referred to as the principal component analysis. One of the most commonly used multivariate data analytics is Theory Component Analysis (PCA). Principle Component Analysis can be regarded as a method of projection that projects observations from a p-dimensional space with p variables to a k-dimensional space (where $k < p$) in order to preserve the maximum amount of information (information is determined here by the total variance of the scatter paul et al. (2013, p.32) [4].

The primary analysis of components is a multivariate statistical technique that uses to convert multiple associated observed variables into orthogonal transformation into the number of linearly uncorrelated variables defined as Principle components is smaller the weighted average δ is a standardised linear combination (SLC).
$\delta^T X = \sum_{j=1}^{p} \delta_j X_j$ Where $\delta$ is a Vector of length 1 i.e $\sum_{j=1}^{p} \delta^2{}_j = 1$ As cited in Hrardle,W.K.,& Simar, L.(2003)[5].
Maximizing the variance of $\delta^T X$ leads to the choice $\delta = \gamma_1$ the eigenvector corresponding to the largest eigenvalue □1 of β = Var (X).
This is a projection of Xs into the one-dimensional space, where the components of X are weighted by the elements of $\gamma_1$

$$Y_1 = \gamma_1{}^T (X - u)$$

is called the first principal component (PC). As cited in Hrardle,W.K.,& Simar, L.(2003)[5].
With regard to a certain basis, A has a matrix β. Consider the ( β – I □) matrix; The identity matrix, where **I** identify matrix. A polynomial function of is then set ( β – **I** □ ) By
This polynomial disappears at a complex value, the basic theorem of algebra,
This polynomial vanishes at a complex value. Therefor is such that ( β – □**I**) v =0
βv = □**I**v
β v = □ v
Av = □ v
Where □ is an eigenvalue. In addition, we also know that is real & A: V → V is a self-adjoint linear map,
Let the random vector X' == [ X1, X2,…………., XP] have the covariance matrix β with eigenvalues
□1 ≥ □2 ≥ …….≥ □p > 0

Consider the linear combinations
$Y1 = u11X1 + u21X2 + \ldots + um1Xp$
$Y2 = u12X1 + u22X2 + \ldots + um2Xp$
$Y3 = u13X1 + u23X2 + \ldots + um3Xp$
…………………………………………………
$Ym = u1pX1 + u2pX2 + \ldots + umpXp$

$$\text{Then} \quad Y = \begin{pmatrix} u_{11} & \cdots & u_{m1} \\ \vdots & \ddots & \vdots \\ u_{1p} & \cdots & u_{mp} \end{pmatrix} \begin{pmatrix} x_1 \\ \vdots \\ x_p \end{pmatrix} = AX$$

The symmetric matrix X of any pp square can be written as a product of with two matrices. A and Q, so that.
X = QAQ'
Where Q is asymmetrical orthogonal matrix of pp square containing the eigenvectors of the Matrix X. And the diagonal matrix A of pp comprises the X matrix's eigenvalues.
Q'Q = QQ '= I
The Covariance Matrix Spectral Decomposition Since β the symmetric matrix of a square. It is possible to write its spectral decomposition as
β = QA Q'

"Where A is a diagonal matrix whose components are the eigenvalues □1 ≥ □2 ≥ …….≥ □p of the symmetric matrix β. And Q is an orthogonal matrix pp of which the eigenvector correspond is the column. Adding to the eigenvalue of jth. And so on.
Values of the new .... Scores of the variable or principal components are given by the
E= XQ matrix. And the covariance matrix of the scores of the main components is given by E(E'E) = E(XQ)'(XQ)
= E (X'XQ'Q)
= Q'βQ
Substituting matrix β for covariance! We're having
$\beta_{Z1}$ = Q'QA Q'Q = A
Like Q'Q = I The new variables, thus Y1, Y2, …………., Yp uncorrelated with variations equal to □1, □2, ……………., □p respectively.
We can also see that the β trace is given by

$$Tr(\beta) = \sum_{j=1}^{p} \sigma_{jj}^{2}$$

Where $\sigma_{jj}^{2}$ is the variation of the variable jth. It is also possible to describe the trace of β as
tr(β) = tr (QAQ ')
= tr (Q 'QA)
= tr (A)
= tr(βz)

That is equal to the covariance matrix's β sum of the eigenvalues. The total variance of the original variables is the same as the total variance of the new variables, showing that. In conclusion, the analysis of principle components reduce the finding of eigenvalues and eigenvectors Covariance matrix, or the original data matrix X finding, or obtaining and acquiring the covariance matrix spectral decomposition. As cited in JOHNSON, R.A.(1998)[6].

## IV. DATASET

In a study conducted for a group of Yemeni students in Aurangabad city from May 2020 to March 2021 to study the immunity against covid-19 there are one death and five students have been affected by Covid-19 symptoms, data were collected for the characteristics of the students and the behaviour they perform to obtain immunity against covid-19, Age, length, weight, waist, walking distance, income, food per day, Liquid per day and sleep (h) per day according to the following table.

**Table1.** collected sheet for the characteristics of the students and the behaviour they perform to obtain immunity against covid-19

| S | Age | Length/cm | Weight/kg | Waist/in | Walking exercise/km | Expenses in thousand rupees | Food/ day | Liquid/ day | Sleep(h)/ day |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 38 | 175 | 66 | 34 | 3 | 20 | 3 | 2 | 6 |
| 2 | 25 | 171 | 85 | 38 | 2 | 10 | 3 | 3 | 7 |
| 3 | 30 | 160 | 65 | 32 | 2 | 12 | 2 | 4 | 8 |
| 4 | 39 | 158 | 85 | 36 | 5 | 16 | 4 | 5 | 6 |
| 5 | 27 | 168 | 64 | 32 | 5 | 17 | 3 | 2 | 10 |
| 6 | 35 | 167 | 64 | 34 | 2 | 15 | 1.5 | 3 | 7 |
| 7 | 35 | 165 | 85 | 36 | 5 | 18 | 2 | 4 | 6 |
| 8 | 40 | 175 | 86 | 36 | 2 | 23 | 3 | 3 | 6 |
| 9 | 35 | 171 | 68 | 34 | 1 | 18 | 3 | 3 | 5 |
| 10 | 39 | 172 | 66 | 32 | 5 | 18 | 1 | 2 | 7 |
| 11 | 42 | 176 | 75 | 36 | 3 | 12 | 2 | 1 | 6 |
| 12 | 41 | 168 | 81 | 36 | 1 | 13 | 3.5 | 4 | 6 |
| 13 | 36 | 182 | 90 | 40 | 2 | 25 | 2 | 2 | 8 |
| 14 | 43 | 168 | 85 | 38 | 3 | 21 | 1 | 3 | 10 |
| 15 | 26 | 160 | 72 | 36 | 3 | 10 | 3 | 4 | 7 |
| 16 | 35 | 170 | 85 | 38 | 1 | 25 | 3 | 2 | 8 |
| 17 | 38 | 160 | 64 | 32 | 2 | 15 | 3 | 3 | 7 |
| 18 | 25 | 171 | 82 | 36 | 7 | 15 | 2 | 3 | 8 |
| 19 | 30 | 164 | 59 | 32 | 2 | 18 | 3 | 4 | 8 |
| 20 | 34 | 169 | 70 | 34 | 3 | 15 | 3 | 3 | 7 |
| 21 | 28 | 170 | 57 | 32 | 1.5 | 15 | 1.5 | 2 | 7 |
| 22 | 30 | 160 | 59 | 30 | 1 | 15 | 3 | 2 | 10 |
| 23 | 35 | 159 | 74 | 34 | 1 | 14 | 1 | 2 | 6 |
| 24 | 38 | 164 | 59 | 25 | 2 | 10 | 3 | 1 | 6 |
| 25 | 35 | 180 | 80 | 38 | 2 | 8 | 2 | 2 | 7 |
| 26 | 40 | 179 | 65 | 36 | .5 | 12 | 3 | 2 | 7 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 27 | 24 | 178 | 90 | 35 | 4 | 20 | 1 | 5 | 6 |
| 28 | 24 | 150 | 60 | 35 | 2 | 7 | 1 | 2 | 7 |
| 29 | 40 | 170 | 70 | 30 | 4 | 12 | 2 | 3 | 5 |
| 30 | 41 | 185 | 88 | 45 | 2 | 7 | 1 | 3 | 6 |
| 31 | 43 | 165 | 74 | 40 | 2 | 7 | 1 | 2 | 6 |
| 32 | 34 | 172 | 75 | 35 | 10 | 8 | 2 | 3 | 7 |
| 33 | 34 | 169 | 77 | 38 | 3 | 15 | 2 | 3 | 7 |
| 34 | 35 | 170 | 65 | 30 | 4 | 7 | 2 | 2 | 7 |
| 35 | 32 | 169 | 79 | 36 | 5 | 7 | 2 | 3 | 7 |
| 36 | 40 | 170 | 70 | 35 | 4 | 5 | 1 | 2 | 8 |
| 37 | 34 | 180 | 70 | 36 | 2 | 6 | 2 | 2 | 7 |
| 38 | 40 | 149 | 73 | 38 | 4 | 5 | 3 | 4 | 6 |
| 39 | 36 | 168 | 70 | 37 | 1 | 21 | 2 | 2 | 6 |
| 40 | 30 | 160 | 73 | 20 | 10 | 7 | 1.5 | 5 | 8 |
| 41 | 44 | 167 | 70 | 33 | 5 | 15 | 3 | 2 | 7 |
| 42 | 36 | 170 | 64 | 36 | 2.5 | 14 | 3 | 2 | 7 |
| 43 | 39 | 162 | 71 | 36 | 5 | 42 | 2 | 2 | 7 |
| 44 | 34 | 176 | 80 | 36 | 5 | 7 | 2 | 1 | 8 |
| 45 | 30 | 164 | 73 | 32 | 2 | 15 | 1 | 1.5 | 8 |
| 46 | 28 | 160 | 65 | 32 | 3 | 15 | 3 | 2 | 8 |
| 47 | 39 | 173 | 67 | 35 | 2 | 22 | 2 | 3 | 8 |
| 48 | 27 | 170 | 83 | 36 | 3 | 13 | 1 | 4 | 6 |
| 49 | 33 | 162 | 64 | 33 | 2.5 | 11 | 2.5 | 3 | 7 |
| 50 | 38 | 159 | 83 | 35 | 4 | 13 | 4 | 4 | 6 |
| 51 | 28 | 167 | 62 | 33 | 5 | 17 | 4 | 3 | 9 |
| 52 | 34 | 165 | 65 | 33 | 3 | 15 | 2.5 | 2 | 8 |
| 53 | 35 | 163 | 83 | 35 | 6 | 16 | 3 | 4 | 6 |
| 54 | 41 | 174 | 84 | 36 | 3 | 21 | 2 | 3 | 6 |
| 55 | 42 | 166 | 73 | 41 | 2.5 | 6 | 2 | 2 | 6 |
| 56 | 33 | 173 | 74 | 33 | 9 | 8 | 2.5 | 3 | 7 |
| 57 | 34 | 165 | 76 | 34 | 3 | 14 | 2.4 | 2.5 | 5 |
| 58 | 36 | 171 | 64 | 31 | 3 | 7 | 3 | 2 | 7 |
| 59 | 33 | 166 | 78 | 37 | 2 | 7 | 2 | 4 | 6 |
| 60 | 41 | 172 | 71 | 33 | 3 | 6 | 3 | 2 | 8 |
| 61 | 33 | 181 | 72 | 34 | 3 | 8 | 2 | 1 | 6 |
| 62 | 41 | 142 | 72 | 35 | 5 | 7 | 3 | 2 | 7 |
| 63 | 36 | 167 | 73 | 36 | 2 | 19 | 2 | 3 | 8 |
| 64 | 32 | 161 | 72 | 21 | 11 | 8 | 1.5 | 4 | 6 |

The Data spreadsheet for the characteristics of the students and the behaviour they perform to obtain immunity against covid-19 Indicators data in Table 1 contains nine (Age, Length, Weight, Waist, Walking exercise, Expenses in thousand rupees, Food per day, liquid per day, Sleep(h) per day ) variables relating to the characteristics of the students and the behaviour they perform to obtain immunity against covid-19.

## V. RESULT

Table 2. Descriptive Statistics of variables relating to the characteristics of the students and the behaviour they perform to obtain immunity against covid-19

| | Mean | Std. Deviation | Analysis N |
|---|---|---|---|
| Age | 34.89 | 5.164 | 64 |
| length | 167.7 | 7.8 | 64 |
| Wight | 72.88 | 8.561 | 64 |
| waist | 34.42 | 3.899 | 64 |
| Walking. Exercise | 3.41 | 2.212 | 64 |
| Expenses/day | 13.59 | 6.431 | 64 |
| Food/day | 2.29 | 0.815 | 64 |
| Liquid/day | 2.72 | 0.988 | 64 |
| Sleep(h)/day | 6.97 | 1.112 | 64 |

Table 3. Correlation Matrix of variables relating to the characteristics of the students and the behaviour they perform to obtain immunity against covid-19

| | | Age | length | weight | waist | walking Exercise | Expenses/ day | Food/day | Liquid/day | Sleep(h)/day |
|---|---|---|---|---|---|---|---|---|---|---|
| Correlation | Age | 1.000 | .097 | .129 | .254 | -.129 | .051 | .081 | -.221 | -.269 |
| | length | .097 | 1.000 | .288 | .294 | -.138 | .088 | -.199 | -.247 | -.047 |
| | weight | .129 | .288 | 1.000 | .504 | .137 | .128 | -.135 | .361 | -.250 |
| | waist | .254 | .294 | .504 | 1.000 | -.429 | .118 | -.069 | -.084 | -.125 |
| | Walking exercise | -.129 | -.138 | .137 | -.429 | 1.000 | -.169 | -.054 | .312 | .041 |
| | Expenses/day | .051 | .088 | .128 | .118 | -.169 | 1.000 | .083 | .028 | .134 |
| | Food /day | .081 | -.199 | -.135 | -.069 | -.054 | .083 | 1.000 | .108 | .031 |
| | Liquid/day | -.221 | -.247 | .361 | -.084 | .312 | .028 | .108 | 1.000 | -.174 |
| | Sleep/day | -.269 | -.047 | -.250 | -.125 | .041 | .134 | .031 | -.174 | 1.000 |

Table 2. Descriptive Statistics for the characteristics of the students and the behaviour they perform to obtain immunity against covid-19.

For each of the rates, these statistics summarise the univariate distributions of rates. Categories for the improvement of the body's immunity to resist diseases. A data matrix of the correlation (included in the table 2. shows that the associations between the rates of the immunity and characteristics of the students and the behaviour they perform to obtain immunity against covid-19. Matrix indicates that some would be possible to simplify the data by means of principal component analysis. We want to evaluate the matrix of correlation here because of the variances in rates for different forms the matrix of the characteristics of the students and the behaviour they perform to obtain immunity against covid-19 very considerably. Acting alongside the correlation after standardising, the matrix amounts to using the characteristics of the students and the behaviour they perform to obtain immunity against covid-19. Predictor levels everyone has a standard unit deviation. This seems fair because without the standardisation of derived parts is likely to be dominated by single components Variables with major variances.

Table 4. Component Matrix of variables relating to the characteristics of the students and the behaviour they perform to obtain immunity against covid-19

| Component Matrix | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Raw | | | | Rescaled | | | |
| | Component | | | | Component | | | |
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| weight | 7.547 | 3.808 | -1.024 | -.676 | .882 | .445 | -.120 | -.079 |
| waist | 2.340 | .376 | -.004 | .954 | .600 | .096 | -.001 | .245 |
| Food/day | -.141 | .077 | .112 | .098 | -.173 | .095 | .137 | .120 |
| length | 5.296 | -5.682 | -.469 | -.440 | .679 | -.728 | -.060 | -.056 |
| Liquid/day | .119 | .488 | -.045 | -.290 | .121 | .494 | -.046 | -.294 |
| Walking Exercise | -.080 | .508 | -.477 | -.500 | -.036 | .230 | -.216 | -.226 |
| Expenses/day | 1.606 | .244 | 6.208 | -.376 | .250 | .038 | .965 | -.058 |
| Age | 1.159 | .032 | .248 | 4.959 | .224 | .006 | .048 | .960 |
| Sleep(h)/day | -.233 | -.148 | .209 | -.264 | -.209 | -.133 | .188 | -.238 |

Table 5. Total Variance Explained of variables relating to the characteristics of the students and the behaviour they perform to obtain immunity against covid-19

| Total Variance Explained | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Component | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
| | | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| Raw | 1 | 94.502 | 41.977 | 41.977 | 57.738 | 25.646 | 25.646 |
| | 2 | 47.513 | 21.105 | 63.082 | 40.598 | 18.033 | 43.68 |
| | 3 | 40.15 | 17.834 | 80.916 | 64.569 | 28.681 | 72.36 |
| | 4 | 26.706 | 11.862 | 92.778 | 45.967 | 20.418 | 92.778 |
| Rescaled | 1 | 1.801 | 20.009 | 20.009 | 1.576 | 17.512 | 17.512 |
| | 2 | 1.063 | 11.806 | 31.814 | 1.227 | 13.629 | 31.141 |
| | 3 | 1.055 | 11.719 | 43.533 | 1.182 | 13.129 | 44.27 |
| | 4 | 1.203 | 13.366 | 56.899 | 1.137 | 12.629 | 56.899 |

The output of the principal components in table 4. Show begins with a table called "Component Matrix." In this table, the coefficients define the linear function of the variables observed which defining every variable. The final table 5, called "Total Variance Explained," indicates how much of the total variance has been explained. The overall variance of the variables observed is explained by each of the primary elements. The first part of the principal (scaled eigenvector). The one that explains the larger part of the total variance has a variance by definition. 94.50 (eigenvalue); (eigenvalue) of 94.50 this constitutes 41.977% of the overall variance. The second principal component has a variance of about 47.51 and accounts for an additional 21.10 5% of the variance. And so forth. "The table's" Cumulative percent "column tells us how much of the overall variance is the first elements of k can be accounted for together. The first two, for instance, 63.08 percent (92.778 percent) of the overall variance accounts for (four) principal components.

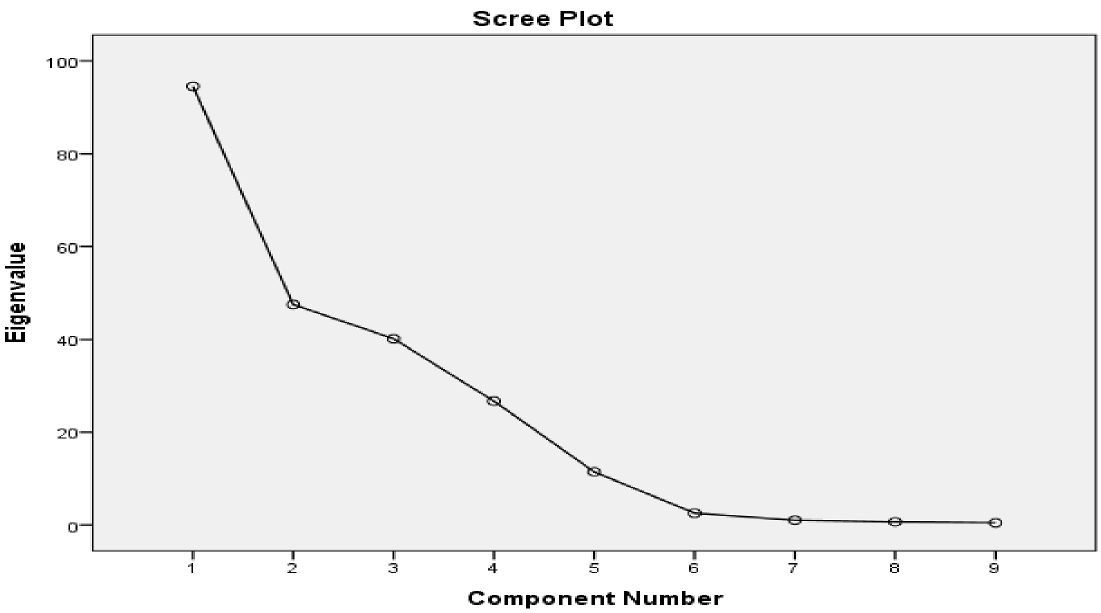


Figure 1. Distribution of variance among the scree plot.

This distribution of variance among the scree plot (figure 1.) demonstrates this distribution of variance among the Graphically elements. The corresponding for each Principle component the y-axis is plotted with its value. The variance of each variable by definition It's less than the previous one, but the "shape" of the "form" is what we are interested in dimensions. If the curve indicates an 'elbow' on the x-axis at a given value, this is also taken as suggesting that the principal components of higher-order lead to a decrease. There might be no need for extra variation and so. It appears here that after the second principal part, a marked decrease in a downward slope. This means that our nine variables will summarise the characteristics of the students and the behaviour they perform to obtain immunity against covid-19. Moreover, prevent damage to the variables of obesity by the first four primary elements. o simplifies matters, we must presume that the four components are the solution is necessary. Having decided on the four-component solution, we can return to the "Component Matrix" table to try to interpret both components. The first has a positive correlation with age, Length, Width, Expenses, and drinking liquid per day. Negatively correlated with food per day, walking exercise and sleep (h) per day. The second principal component is positively correlated with, Age, width, expenses, walking exercise, food per day & drinking liquid per day And negatively correlated with length and sleep (h) per day the third principal component positive define with Age, expenses, food per day and sleep (h) per day and Negative define with length, width, weight, walk Exercise and drinking liquid per day,


Figure 2. The principal components plot

The principal components plot given in Figure 2 the characteristics of the students and the behaviour they perform to obtain immunity against covid-19. . The components 1 contributes highly to Weight and Sleep (h) per day, while Component 2 contributes most to Length from this display.

## VI. CONCLUSION

This study concluded the PCA is Statistical measuring reduction the biggest data and keep the information. It is an array of the data and selects the most important data which the researcher get the same information and ignore the data which give small or shortage information. The biggest PCA get the most data ( give the biggest information) The researcher considers it the first PCA & the researchers conclude the Yemeni students have the best resistance against covid-19 because all the student young, they have the healthy bodybuilding; as they do exercises more often. Besides; they use enough quantity of good food and drinking liquidity; like water and juices. The study sample shows that they usually get enough hours of sleep. The researcher suggests to apply principal component for exploring the same study scope for a further group of people from different nationality, with various age stages.

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Ahmed M. AL-Hammadi, et. al, "Applying principal component to study the Yemeni students in Aurangabad immunity against covid-19." *International Journal of Engineering Science Invention (IJESI)*, Vol. 10(11), 2021, PP 30-37. Journal DOI- 10.35629/6734