Data Description

This study investigates the impact of character strengths on mental health and self-efficacy during the Covid-19 lockdown. The data was collected from 944 Italian respondents, with an average age of 37.24 years (SD = 14.50), through an online survey conducted one month after the lockdown began.

The survey explored character strengths, psychological distress, and Covid-19-related self-efficacy. Four-character strength factors were identified using principal component analysis: transcendence, interpersonal, openness, and restraint.

The regression models revealed that transcendence strengths were inversely related to psychological distress and positively associated with self-efficacy. Among individual strengths, hope, zest, prudence, love, and forgiveness were most associated with distress, while love and zest were most related to self-efficacy. Zest was also linked to general mental health.

Interestingly, the openness factor and appreciation of beauty showed a direct relation with psychological distress, contrary to expectations. These findings provide new insights into the association of character strengths, particularly transcendence strengths, with mental health and self-efficacy during a pandemic. The results contribute to the field of positive psychology by highlighting the protective role of character strengths in maintaining mental health during challenging times.

The dataset includes the following variables covering a good range of sections such as demographic info & response variables to study:

1. Participant Information:

- Participants: Participant number

2. Character Strengths Factors (Extracted via PCA):

- Openness
- Restraint
- Transcendence
- Interpersonal

3. Dependent Measures:

- DASS_21: Depression Anxiety and Stress Scale
- GHQ_12: General Health Questionnaire
- SEC: Self-efficacy for Covid-19

4. Demographic Variables:

- Age
- Gender
- Work: Represents the perceived work change subsequent to lockdown
- Student: Indicates whether the participant is a student or not
- Day: The number of days passed when the participant responded since the day the survey was opened

Factor Analysis

Determining number of retained factors:

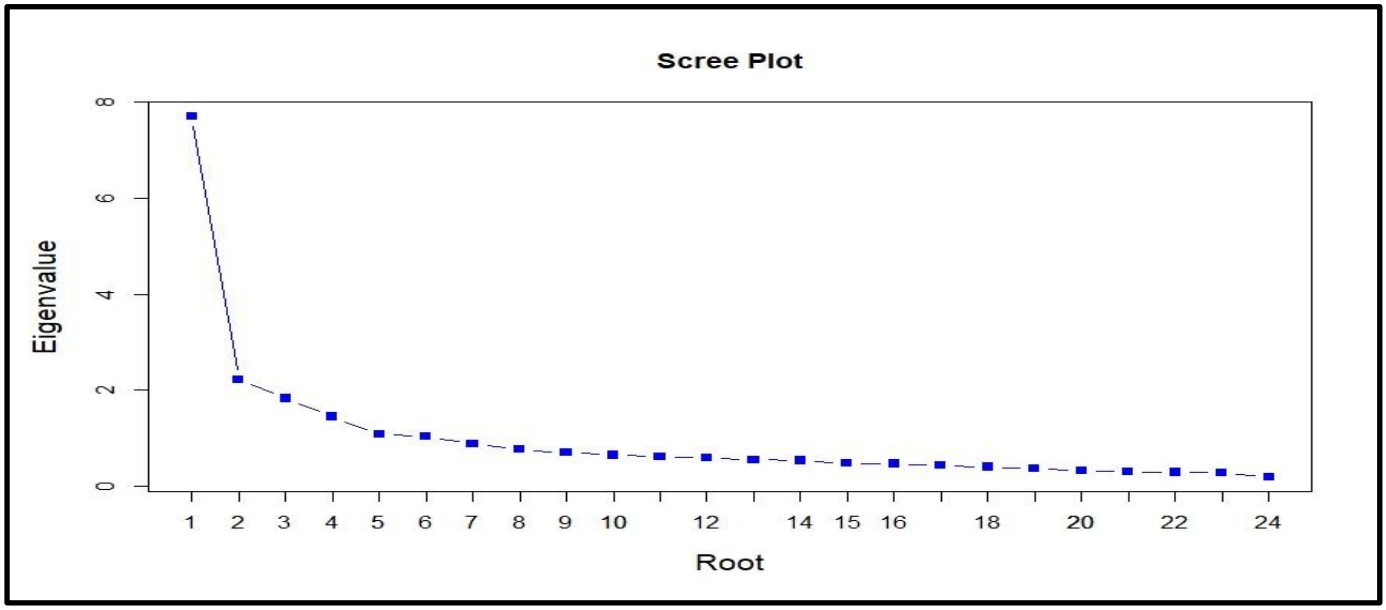

Figure 1: Scree plot of the factors.

From **Figure 1**, we can conclude that:

- There could be one breakpoint at factor 2.
- If we retain only one factor, we will get only 32% of variations in the original variables which is very small variations and not satisfactory for us but if we retain the first five factors, we will get almost 60% of the variations in the original variables which is satisfactory for us.

Based on Kaiser Guttman method, we will extract 6 factors as their eigen values are greater than 1 but this is not the best method for extraction, so we will depend on total variation explained and scree plot.

First, we will apply the factor analysis without making Rotation to see the results and build our upcoming steps based on that.

Table 1: Unrotated five-factors solution for the Selected Sample without Rotation.

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	h2	Uniqueness
Hope	**0.73**	-0.27	0.02	-0.25	0.14	0.68	0.32
Spirituality	0.54	-0.10	-0.16	-0.28	0.10	0.41	0.59
Zest	**0.77**	-0.40	-0.05	-0.16	0.02	0.77	0.23
Gratitude	**0.69**	-0.06	-0.17	-0.26	0.21	0.63	0.37
Perseverance	**0.61**	-0.05	0.23	-0.37	-0.47	0.78	0.22
Self-regulation	0.45	0.15	0.19	-0.26	-0.01	0.33	0.67
Love	0.53	-0.03	-0.12	-0.05	0.07	0.30	0.70
Fairness	0.54	0.35	-0.32	0.21	-0.08	0.57	0.43
Kindness	**0.63**	0.17	-0.37	0.20	0.03	0.60	0.40
Teamwork	0.50	0.25	-0.33	0.03	-0.13	0.44	0.56
Leadership	**0.60**	0.14	-0.16	0.25	-0.23	0.52	0.48
Humility	0.25	0.46	-0.22	-0.12	-0.03	0.34	0.66
Forgiveness	0.36	0.15	-0.29	-0.19	0.12	0.28	0.72
Appreciation of beauty	0.55	0.05	-0.08	0.14	0.20	0.37	0.63
Creativity	0.56	-0.28	0.25	0.24	0.08	0.52	0.48
Bravery	0.51	-0.29	0.20	0.20	-0.27	0.50	0.50
Curiosity	**0.70**	-0.37	0.13	0.02	0.07	0.65	0.35
Humor	0.42	-0.23	-0.08	0.28	0.02	0.31	0.69
Social intelligence	**0.63**	0.01	0.01	0.22	0.02	0.45	0.55
Love of learning	0.44	-0.12	0.16	0.07	0.05	0.24	0.76
Prudence	0.32	**0.66**	0.39	-0.16	0.10	0.73	0.27
Judgment	0.43	0.39	0.52	0.13	0.12	0.63	0.37
Perspective	0.49	0.21	0.36	0.17	0.14	0.46	0.54
Honesty	0.58	0.16	0.06	-0.02	-0.23	0.42	0.58
Proportion of Variance	**0.32**	**0.09**	**0.08**	**0.06**	**0.04**		

h2=communality & **Bold** = higher than or equal 0.60

From **table 1**, we can conclude that:

- The first unrotated factor loads on Hope, Zest, Gratitude, Perseverance, Kindness, Curiosity, Leadership and Social intelligence.
- The second unrotated factor loads on Prudence.
- If we use the unrotated factors, we can find that the loadings of factors on the original variables are completely close to each other which make the interpretation complicated.

Table 2: correlation matrix among the Unrotated common factors.

Factors	Factor1	Factor2	Factor3	Factor4	Factor5
Factor1	1	**-0.64**	-0.13	-0.05	-0.04
Factor2	**-0.64**	1	0	0	0
Factor3	-0.13	0	1	0	0
Factor4	-0.05	0	0	1	0
Factor5	-0.04	0	0	0	1

From **table 2**, we can conclude that:
There is a high negative correlation between **factor 1** and **factor 2** so we should not ignore it and we should apply the Oblimin Rotation.

So, we have done the following in factor analysis:

We have applied factor analysis on the Selected sample using R, the number of the factors have been extracted is 5 factors **using the total variation explained method to extract these five factors and using the scree plot** this as the total of variance explained by them is 59% but if we extracted 2 factors or less the total of variance explained will be less than 60%, so we have decided to extract 5 factors, we have used the Oblimin Rotation method because of the correlation between factor 1 and factor 2, have used the Principle factor method to extract the factors and using the regression to find the scores of these factors, the **table 3** shows the extracted rotated factors, the loading matrix , the communalities and the uniqueness of each variable.

Table 3: Rotated five-factors solution for the Selected Sample using Oblimin Rotation.

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	h2	Uniqueness
Hope	**0.77**	-0.06	0.04	0.06	0.11	0.68	0.32
Spirituality	**0.61**	0.07	-0.03	-0.16	0.07	0.41	0.59
Zest	**0.70**	0.05	-0.12	0.18	0.19	0.77	0.23
Gratitude	**0.75**	0.12	0.06	-0.15	-0.03	0.63	0.37
Perseverance	0.13	0.02	0.06	-0.03	**0.80**	0.78	0.22
Self-regulation	0.28	-0.05	0.32	-0.21	0.24	0.33	0.67
Love	0.39	0.22	0.03	0.01	0.01	0.30	0.70
Fairness	-0.05	**0.76**	0.06	-0.04	-0.01	0.57	0.43
Kindness	0.19	**0.69**	-0.02	0.02	-0.1	0.60	0.40
Teamwork	0.06	**0.61**	-0.03	0.14	0.11	0.44	0.56
Leadership	-0.09	**0.65**	0.00	0.19	0.18	0.52	0.48
Humility	0.00	0.4	0.16	-0.37	0.04	0.34	0.66
Forgiveness	0.38	0.25	0.00	-0.29	-0.06	0.28	0.72
Appreciation of beauty	0.35	0.3	0.17	0.14	-0.19	0.37	0.63
Creativity	0.3	0.02	0.16	0.53	0.00	0.52	0.48
Bravery	0.01	0.15	-0.04	0.5	0.35	0.50	0.50
Curiosity	0.55	-0.01	0.04	0.38	0.1	0.65	0.35
Humor	0.17	0.28	-0.1	0.37	-0.06	0.31	0.69
Social intelligence	0.18	0.37	0.15	0.29	0.01	0.45	0.55
Love of learning	0.25	0.02	0.16	0.25	0.05	0.24	0.76
Prudence	-0.03	0.01	**0.81**	-0.24	0.08	0.73	0.27
Judgment	-0.03	0.00	**0.77**	0.2	0.01	0.63	0.37
Perspective	0.1	0.08	**0.60**	0.26	-0.05	0.46	0.54
Honesty	0.02	0.33	0.17	0.05	0.36	0.42	0.58
Proportion of Variance	**0.32**	**0.09**	**0.08**	**0.06**	**0.04**		

Bold=loading higher than or equal 0.60 & **h2**=communality

From **table 3** we can conclude:

- The **first rotated factor** can be interpreted using the variables (Hope, Zest, Spirituality and Gratitude)**.**
- The **second rotated factor** can be interpreted using the variables (Fairness, Kindness, Leadership and Teamwork)**.**
- The **third rotated factor** can be interpreted using the variables (Prudence, Perspective and Judgment)**.**
- The **fourth rotated factor** does not load on any variables
- The **fifth rotated factor** can be interpreted using the variable Perseverance**.**

From the above we should delete factor 4 and try to apply the analysis only on extracting 4 factors rather than 5.

Table 4: four-factors solution for the Selected Sample without Rotation.

Variable	Factor1	Factor2	Factor3	Factor4	h2	Uniqueness
Hope	**0.73**	-0.27	0.02	-0.28	0.68	0.32
Spirituality	0.54	-0.09	0.16	-0.29	0.41	0.59
Zest	**0.77**	-0.4	-0.04	-0.17	0.78	0.22
Gratitude	**0.69**	-0.06	-0.16	-0.28	0.58	0.42
Perseverance	0.58	-0.03	0.17	-0.23	0.41	0.59
Self-regulation	0.45	0.15	0.19	-0.27	0.34	0.66
Love	0.53	-0.03	-0.11	-0.06	0.30	0.70
Fairness	0.54	0.35	-0.32	0.23	0.57	0.43
Kindness	**0.63**	0.17	-0.36	0.2	0.60	0.40
Teamwork	0.51	0.24	-0.32	0.05	0.43	0.57
Leadership	**0.60**	0.13	-0.16	0.26	0.47	0.48
Humility	0.25	0.46	-0.23	-0.12	0.34	0.66
Forgiveness	0.36	0.15	-0.28	-0.19	0.27	0.73
Appreciation of beauty	0.55	0.04	-0.06	0.11	0.32	0.68
Creativity	0.56	-0.28	0.26	0.22	0.51	0.49
Bravery	0.5	-0.28	0.18	0.21	0.41	0.59
Curiosity	**0.70**	-0.38	0.18	0.01	0.65	0.35
Humor	0.42	-0.23	-0.07	0.27	0.31	0.69
Social intelligence	**0.63**	0.01	0.02	0.22	0.45	0.55
Love of learning	0.44	-0.12	0.16	0.05	0.23	0.77
Prudence	0.32	**0.67**	0.39	-0.18	0.73	0.27
Judgment	0.42	0.39	0.52	0.11	0.61	0.39
Perspective	0.49	0.21	0.36	0.14	0.43	0.57
Honesty	0.57	0.16	0.05	0.01	0.36	0.64
Proportion of Variance	**0.32**	**0.09**	**0.08**	**0.06**		

Bold=loading higher than or equal 0.60 & **h2**=communality

From **table 4**, we can conclude that:

- The **first unrotated factor** loads on Hope, Zest, Gratitude, Perseverance, Kindness, Curiosity, Leadership and Social intelligence.
- The **second unrotated** factor loads on Prudence.
- If we use the unrotated factors, we can find that the loadings of factors on the original variables are completely close to each other which make the interpretation complicated.

Table 5: correlation matrix among the unrotated 4 common factors.

Factors	Factor1	Factor2	Factor3	Factor4
Factor1	1	**-0.64**	-0.14	-0.02
Factor2	**-0.64**	1	0	0
Factor3	-0.14	0	1	0
Factor4	-0.02	0	0	1

From table 5, we can conclude that:

There is a high negative correlation between **factor 1** and **factor 2** so we should not ignore it and we should apply the Oblimin Rotation.

Table 6: Rotated four-factors solution for the Selected Sample using Oblimin Rotation.

Variable	Factor1	Factor2	Factor3	Factor4	h2	Uniqueness
Hope	**0.83**	-0.03	0.03	0.02	0.68	0.32
Spirituality	**0.63**	0.09	-0.03	-0.19	0.41	0.59
Zest	**0.82**	0.05	-0.12	0.14	0.78	0.22
Gratitude	**0.68**	0.18	0.02	-0.17	0.58	0.42
Perseverance	0.57	-0.07	0.26	0.00	0.41	0.59
Self-regulation	0.44	-0.08	0.38	-0.11	0.34	0.66
Love	0.38	0.25	0.01	-0.01	0.30	0.70
Fairness	-0.1	**0.79**	0.06	-0.03	0.57	0.43
Kindness	0.07	0.7	-0.07	0.01	0.60	0.40
Teamwork	0.1	0.59	0.01	-0.15	0.43	0.57
Leadership	0.03	**0.61**	0.06	0.18	0.47	0.48
Humility	-0.01	0.39	0.21	-0.36	0.34	0.66
Forgiveness	0.29	0.29	-0.02	-0.30	0.27	0.73
Appreciation of beauty	0.19	0.38	0.08	0.13	0.32	0.68
Creativity	0.3	0.07	0.1	0.52	0.51	0.49
Bravery	0.27	0.09	0.03	0.46	0.41	0.59
Curiosity	**0.61**	0.02	0.00	0.35	0.65	0.35
Humor	0.12	0.32	-0.16	0.35	0.31	0.69
Social intelligence	0.16	0.41	0.12	0.29	0.45	0.55
Love of learning	0.28	0.05	0.13	0.25	0.23	0.77
Prudence	-0.01	0.02	0.48	-0.18	0.73	0.27
Judgment	-0.04	0.04	**0.73**	0.25	0.61	0.39
Perspective	0.06	0.13	0.00	0.28	0.43	0.57
Honesty	0.24	0.27	0.27	0.06	0.36	0.64
Proportion of Variance	**0.32**	**0.09**	**0.08**	**0.06**		

Bold=loading higher than or equal 0.60 & **h2**=communality

From **table 6** we can conclude:

- The **first rotated factor** can be interpreted using the variables (Hope, Zest, Spirituality, Curiosity and Gratitude)**.**
- The **second rotated factor** can be interpreted using the variables (Fairness and Leadership)**.**
- The **third rotated factor** can be interpreted using the variable (Judgment)**.**
- The **fourth rotated factor** does not load on any variables

The results are the same as in table 3, So we could try the varimax Rotation rather than Oblimin Rotation to improve the loadings of factors on the original variables.

Table 7: Rotated four-factors solution for the Selected Sample using varimax Rotation.

Variable	Personal abilities	Happiness	Sociability	Judgmental abilities	h2	Uniqueness
Hope	0.41	**0.69**	0.14	0.09	0.68	0.32
Spirituality	0.15	0.57	0.25	0.02	0.41	0.59
Zest	0.55	**0.67**	0.17	-0.03	0.78	0.22
Gratitude	0.23	**0.64**	0.35	0.09	0.58	0.42
Perseverance	0.27	0.50	0.10	0.29	0.41	0.59
Self-regulation	0.08	0.41	0.10	**0.93**	0.34	0.66
Love	0.25	0.36	0.31	0.07	0.30	0.70
Fairness	0.16	0.07	**0.72**	0.15	0.57	0.43
Kindness	0.28	0.19	**0.69**	0.04	0.60	0.40
Teamwork	0.09	0.21	**0.61**	0.09	0.43	0.57
Leadership	0.37	0.11	0.54	0.15	0.47	0.53
Humility	-0.23	0.14	0.47	0.22	0.34	0.66
Forgiveness	-0.06	0.34	0.38	0.02	0.27	0.73
Appreciation of beauty	0.34	0.22	0.37	0.15	0.32	0.68
Creativity	**0.67**	0.19	0.04	0.16	0.51	0.49
Bravery	**0.60**	0.18	0.05	0.1	0.41	0.59
Curiosity	**0.64**	0.47	0.07	0.08	0.65	0.35
Humor	0.5	0.09	0.22	-0.08	0.31	0.69
Social intelligence	0.48	0.18	0.37	0.2	0.45	0.55
Love of learning	0.39	0.22	0.07	0.18	0.23	0.77
Prudence	-0.16	0.11	0.19	**0.81**	0.73	0.27
Judgment	0.24	0.00	0.1	**0.74**	0.61	0.39
Perspective	0.34	0.08	0.15	0.53	0.43	0.57
Honesty	0.26	0.27	0.33	0.32	0.36	0.64
Proportion of Variance	**0.32**	**0.09**	**0.08**	**0.06**		

Bold=loading higher than or equal 0.60 & **h2**=communality

From **table 7**, we can conclude that:

- The **first rotated factor** can be interpreted using the variables (Bravery, Creativity and Curiosity), it can be called as **Personal abilities.**
- The **second rotated factor** can be interpreted using the variables (Hope, Zest and Gratitude), it can be called as **Happiness.**
- The **third rotated factor** can be interpreted using the variables (Fairness, Kindness and Teamwork), it can be called as **Sociability.**
- The **fourth rotated factor** can be interpreted using the variables (Self-regulation, Prudence and Judgment), it can be called as **Judgmental abilities**.

Table 8: shows the proportion of total variation of each variable explained by the common factors and by the variable itself.

Variable	Uniqueness	Communality	interpretation
Hope	0.32	0.68	68% of total variation of Hope explained by the common factors and 32% explained by the variable itself.
Spirituality	0.59	0.41	41% of total variation of Spirituality explained by the common factors and 59% explained by the variable itself.
Zest	0.22	0.78	78% of total variation of Zest explained by the common factors and 22% explained by the variable itself.

Gratitude	0.42	0.58	58% of total variation of Gratitude explained by the common factors and 42% explained by the variable itself.
Perseverance	0.59	0.41	41% of total variation of Perseverance explained by the common factors and 59% explained by the variable itself.
Self-regulation	0.66	0.34	34% of total variation of Self-regulation explained by the common factors and 66% explained by the variable itself.
Love	0.70	0.30	30% of total variation of Love explained by the common factors and 70% explained by the variable itself.
Fairness	0.43	0.57	57% of total variation of Fairness explained by the common factors and 43% explained by the variable itself.
Kindness	0.40	0.60	60% of total variation of Kindness explained by the common factors and 40% explained by the variable itself.
Teamwork	0.57	0.43	43% of total variation of Teamwork explained by the

			common factors and 57% explained by the variable itself.
Leadership	0.53	0.47	47% of total variation of Leadership explained by the common factors and 53% explained by the variable itself.
Humility	0.66	0.34	34% of total variation of Humility explained by the common factors and 66% explained by the variable itself.
Forgiveness	0.73	0.27	27% of total variation of Forgiveness explained by the common factors and 73% explained by the variable itself.
Appreciation of beauty	0.68	0.32	32% of total variation of Appreciation of beauty explained by the common factors and 68% explained by the variable itself.
Creativity	0.49	0.51	51% of total variation of Creativity explained by the common factors and 49% explained by the variable itself.
Bravery	0.59	0.41	41% of total variation of Bravery explained by the common factors and 59%

			explained by the variable itself.
Curiosity	0.35	0.65	65% of total variation of Curiosity explained by the common factors and 35% explained by the variable itself.
Humor	0.69	0.31	31% of total variation of Humor explained by the common factors and 69% explained by the variable itself.
Social intelligence	0.55	0.45	45% of total variation of social intelligence explained by the common factors and 55% explained by the variable itself.
Love of learning	0.77	0.23	23% of total variation of Love of learning explained by the common factors and 77% explained by the variable itself.
Prudence	0.27	0.73	73% of total variation of Prudence explained by the common factors and 27% explained by the variable itself.
Judgment	0.39	0.61	61% of total variation of Judgment explained by the common factors and 39% explained by the variable itself.

Perspective	0.57	0.43	43% of total variation of Perspective explained by the common factors and 57% explained by the variable itself.
Honesty	0.64	0.36	36% of total variation of Honesty explained by the common factors and 64% explained by the variable itself.

Table 9: shows the Proportions explained by the factor, variance of each factor and their cumulative.

Factors	Variance	Cumulative Variance	Proportion explained
Factor1	0.32	0.32	0.29
Factor2	0.09	0.41	0.26
Factor3	0.08	0.49	0.26
Factor4	0.06	0.55	0.19

From **table 9** we can conclude that:

- The first factor has the highest variance than the other factors.
- Almost 55% of total variation in the data can be explained by the four extracted factors.
- The first, second and third factors have the most explained proportion of total variation in the data.

Table 10: the correlation matrix among the rotated common factors.

Factors	Factor1	Factor2	Factor3	Factor4
Factor1	1	0.13	-0.40	-0.37
Factor2	0.13	1	-0.27	-0.41
Factor3	-0.40	-0.27	1	-0.27
Factor4	-0.37	-0.41	-0.27	1

From **table 10** we can conclude that:

- The most correlated rotated factors are Factor 2 and Factor 4.
- The lowest correlated rotated factors are Factor 1 and Factor 2.

Table 2 Four-factor solution for the VIA-IS 120

	Transcendence	Interpersonal	Openness	Restraint	h^2
Hope	**0.77**	−00.10	**0.33**	−0.06	0.71
Spirituality	**0.74**	0.04	0.02	−0.17	0.52
Zest	**0.71**	−0.01	**0.47**	−0.20	0.78
Gratitude	**0.69**	0.15	0.11	−0.06	0.63
Perseverance	**0.64**	−0.20	0.16	0.25	0.54
Self-regulation	**0.54**	−0.17	−0.10	**0.41**	0.49
Love	**0.41**	0.22	0.15	−0.04	0.36
Fairness	−0.16	**0.86**	0.01	0.07	0.66
Kindness	0.01	**0.77**	0.16	−0.09	0.65
Teamwork	0.07	**0.73**	−0.08	−0.02	0.54
Leadership	−0.11	**0.66**	0.28	0.06	0.56
Humility	0.07	**0.55**	**−0.47**	0.25	0.51
Forgiveness	**0.39**	**0.43**	−0.29	−0.12	0.43
Appreciation of beauty	0.10	**0.38**	0.28	0.06	0.38
Creativity	0.14	−0.06	**0.71**	0.09	0.59
Bravery	0.13	−0.07	**0.68**	0.03	0.51
Curiosity	**0.50**	−0.10	**0.61**	−0.06	0.67
Humor	−0.05	**0.33**	**0.58**	−0.24	0.47
Social intelligence	0.03	**0.36**	**0.44**	0.14	0.51
Love of learning	0.18	−0.05	**0.40**	0.15	0.28
Prudence	−0.03	0.08	−0.27	**0.88**	0.76
Judgment	−0.16	−0.02	0.17	**0.84**	0.71
Perspective	−0.13	0.05	**0.34**	**0.63**	0.57
Honesty	0.20	0.22	0.15	**0.32**	0.41
Variance	0.16	0.14	0.15	0.10	

Bold = loading higher than .30
h^2 = communality

Figure2: shows the factor analysis in the original study.

From **Figure2**, we can conclude that:

- The first rotated factor can be interpreted using the variables (Hope, Zest Spirituality, Gratitude, Perseverance, Self-regulation, Love, Forgiveness and Curiosity), **so it could be called Transcendence.**
- The second rotated factor can be interpreted using the variables (Fairness, Kindness, Teamwork, Leadership, Forgiveness, Humility, Appreciation of beauty, Humor and Social intelligence), **so it could be called Interpersonal.**
- The third rotated factor can be interpreted using the variables (Prudence, Judgment, Hope, Zest, Humility, Bravery, Creativity, Curiosity, Humor, Social intelligence, Love of learning and Perspective), **so it could be called Openness.**
- The fourth rotated factor can be interpreted using the variables (Self-regulation, Prudence, Judgment, Perspective and Honesty), **so it could be called Restraint.**

Table 11: shows the proportion of total variation of each variable explained by the common factors and by the variable itself in the original study.

Variable	Uniqueness	Communality	interpretation
Hope	0.29	0.71	71% of total variation of Hope explained by the common factors and 29% explained by the variable itself.
Spirituality	0.48	0.52	52% of total variation of Spirituality explained by the common factors and 48% explained by the variable itself.
Zest	0.22	0.78	78% of total variation of Zest explained by the common factors and 22% explained

			by the variable itself.
Gratitude	0.37	0.63	63% of total variation of Gratitude explained by the common factors and 37% explained by the variable itself.
Perseverance	0.46	0.54	54% of total variation of Perseverance explained by the common factors and 46% explained by the variable itself.
Self-regulation	0.51	0.49	49% of total variation of Self-regulation explained by the common factors and 51% explained by the variable itself.
Love	0.64	0.36	36% of total variation of Love explained by the common factors and 64% explained by the variable itself.
Fairness	0.34	0.66	66% of total variation of Fairness explained by the common factors and 34% explained by the variable itself.
Kindness	0.35	0.65	65% of total variation of Kindness explained by the common factors and 35% explained by the variable itself.
Teamwork	0.46	0.54	54% of total variation of Teamwork

			explained by the common factors and 46% explained by the variable itself.
Leadership	0.44	0.56	56% of total variation of Leadership explained by the common factors and 44% explained by the variable itself.
Humility	0.49	0.51	51% of total variation of Humility explained by the common factors and 49% explained by the variable itself.
Forgiveness	0.57	0.43	43% of total variation of Forgiveness explained by the common factors and 57% explained by the variable itself.
Appreciation of beauty	0.62	0.38	38% of total variation of Appreciation of beauty explained by the common factors and 62% explained by the variable itself.
Creativity	0.41	0.59	59% of total variation of Creativity explained by the common factors and 41% explained by the variable itself.
Bravery	0.49	0.51	51% of total variation of Bravery explained by the common factors and 49% explained

			by the variable itself.
Curiosity	0.33	0.67	67% of total variation of Curiosity explained by the common factors and 33% explained by the variable itself.
Humor	0.69	0.31	31% of total variation of Humor explained by the common factors and 69% explained by the variable itself.
Social intelligence	0.53	0.47	47% of total variation of social intelligence explained by the common factors and 53% explained by the variable itself.
Love of learning	0.72	0.28	28% of total variation of Love of learning explained by the common factors and 72% explained by the variable itself.
Prudence	0.24	0.76	76% of total variation of Prudence explained by the common factors and 24% explained by the variable itself.
Judgment	0.29	0.71	71% of total variation of Judgment explained by the common factors and 29% explained by the variable itself.

Perspective	0.43	0.57	57% of total variation of Perspective explained by the common factors and 43% explained by the variable itself.
Honesty	0.59	0.41	41% of total variation of Honesty explained by the common factors and 59% explained by the variable itself.

Compared to the results of the original study:

- the original study applied on the whole data but our analysis applied on a selected sample of size = 850 observations.
- The number of extracted factors in the original factors equal to four factors and also, we extracted four factors.
- 55% of total variation explained by the factors in the original study and also in our analysis, almost 55% of total variation explained by the extracted factors.
- In the original study the method which used to extract the factors was the principal component method but in our analysis was the principal factor method.
- in the original study the method which used for Rotation was Oblimin Rotation (Promax), but in our analysis, we try both Varimax Rotation (Orthogonal Rotation) and Oblimin Rotation (Oblique Rotation) and take the best results to interpret.
- The higher loadings in the original study were 0.30 but the higher loadings in our analysis were 0.60.

Cluster Analysis

We will perform cluster analysis on the 4 variables (transcendence, interpersonal, openness and restraint) to derive which number of clusters best distinguishes the observations, and that will be done through validating a number of clusters.

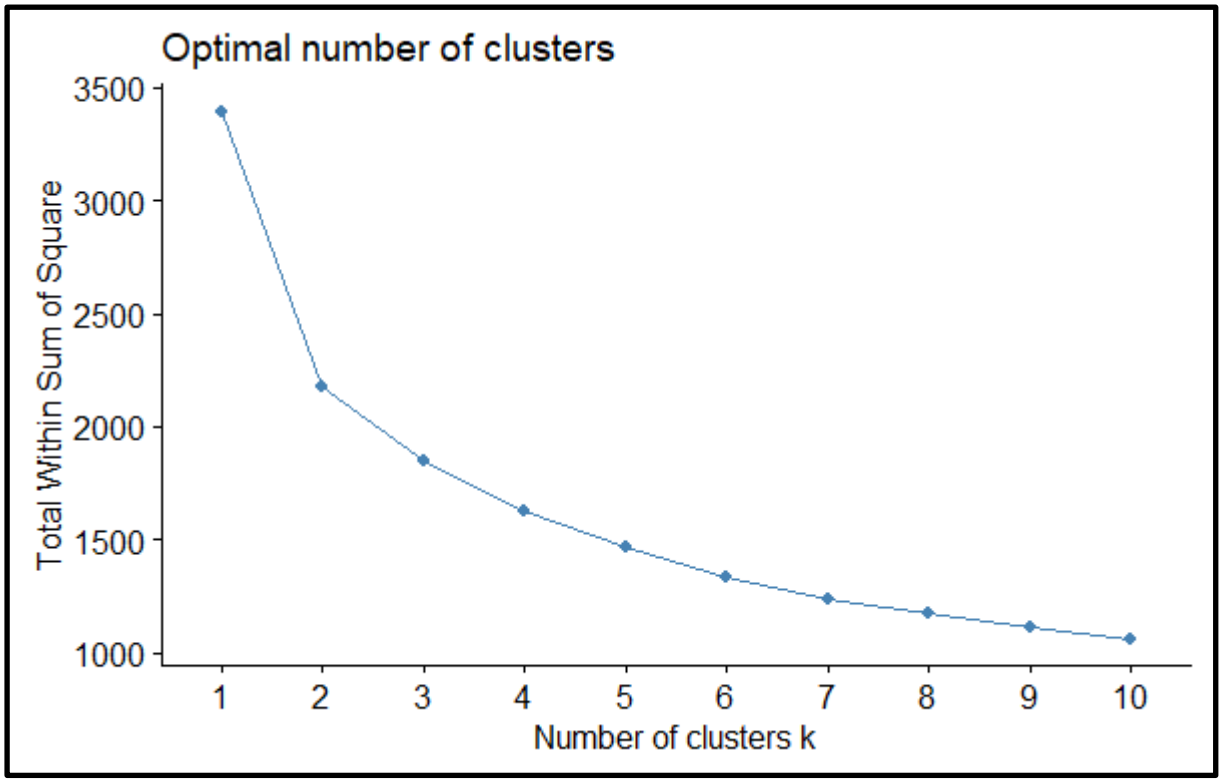

Figure 3: Elbow curve for optimal number of clusters on standardized variables.

Through the elbow curve above – which is like the scree plot in Factor analysis- we can notice that the leveling off happened at 2 clusters which means that this is the best number of clusters for based on our 4 variables, moreover, within cluster sum of squares (WCSS) is the sum of squared distances between each data point and its cluster centroid. The elbow curve shows where the WCSS starts to decrease rapidly, indicating that adding more clusters does not improve the model significantly.

However, we will check the scatter plot of the first two principal components to check whether we have any visible clusters or not.

Table 12: Summary measures for the principal components.

	PC1	PC2	PC3	PC4
Standard deviation	1.5062	0.8712	0.7930	0.58612
Proportion of variance explained	0.5672	0.1898	0.1572	0.08589
Cumulative proportion	0.5672	0.7569	0.9141	1

We will use principal component analysis- on the standardized variables since PCA is sensitive to different scales - to observe if there are potential clusters in our data for these 4 variables to have 4 principal components, we will keep the first 2 principal components for the following reasons:

- Explain around 75% of the data variation
- Plot a Scatter plot for the 2 PC's
- Our main goal in this part is just to have an overview of the data to derive the probable number of clusters

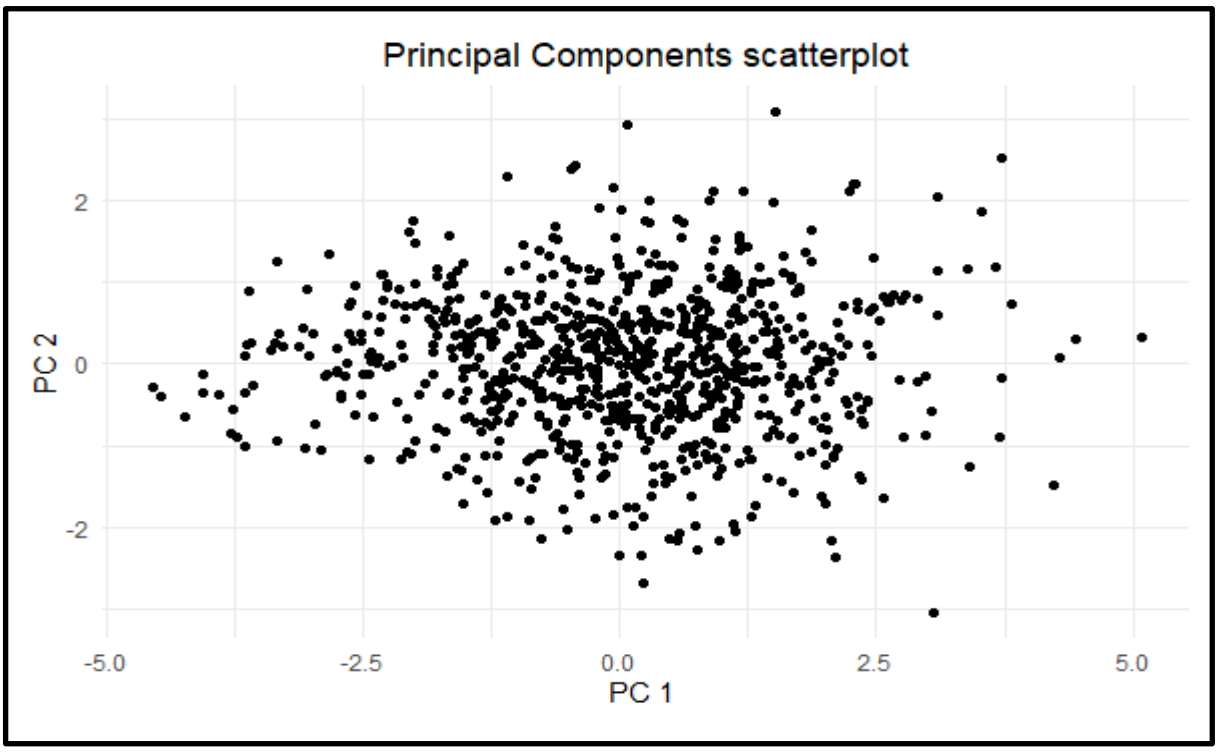

Figure 4: scatter plot of the first 2 principal components on the 4 standardized variables.

The plot above shows no clear indication of how many clusters we should have; therefore, we will compare the results of 3 and 2 cluster then choose the best one out of them.

We will start with k = 3:

Table 13: Final Centroids for the 3 clusters.

Group	transcendence	interpersonal	openness	restraint
1	100.2486	102.8249	95.84746	52.35593
2	143.6214	121.8066	123.04527	59.80658
3	123.0442	109.0953	107.04884	55.11163

From the table above we can notice that group 2 has the highest mean values for each variable, followed by group 3 and finally group 1, **hence** we will name each group as follows:

- **group 1** → Low character strength
- **group 2** → High character strength
- **group 3** → moderate character strength

Table 14: number of people in each group/cluster.

	High character strength	moderate character strength	Low character strength
Frequency	243	430	177

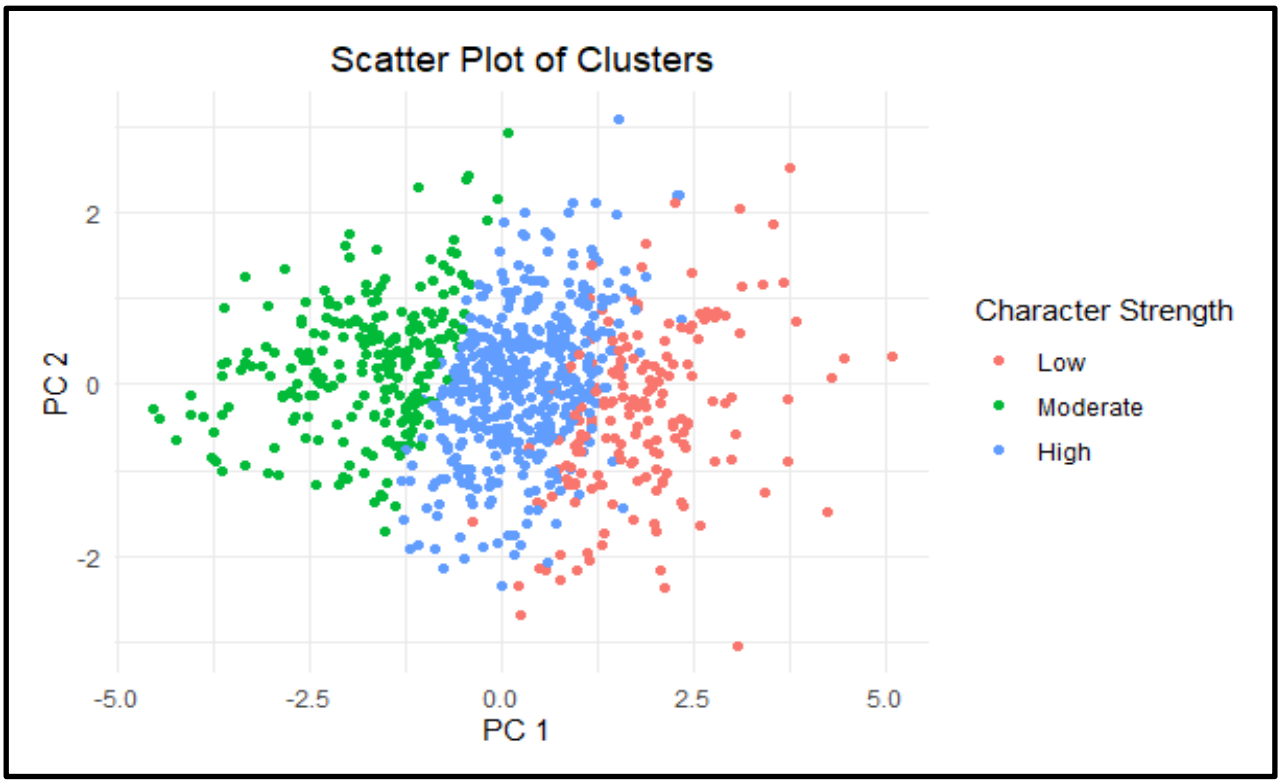

Figure5: Scatter plot between PC1 & PC2 for the 3 clusters.

The figure shows a quite good separation between the 3 cluster but we still can see some points with the other clusters like the red dots in the blue cluster (high character strength).

Validating the 3 clusters:

1. Testing **equal means** for the 3 clusters:

$$H_0 = \underline{\mu_1} = \underline{\mu_2} = \underline{\mu_3}$$

H0 will be rejected at α = 0.05 because the p-value was (2.2e-16), which means that there's at least one different mean vector between the 3 clusters.

Hence Discriminant analysis is appropriate in this case since we have different mean values for each cluster/group.

2. Testing **homogeneous variance covariance matrices** between the 3 cluster:

$$H_0 = \sum g1_1 = \sum g2_2 = \sum g3_3 = \sum$$

H_0 will be rejected at α = 0.05 because the p-value was (2.38e-12), which means that there's at least one different variance covariance matrix between the 3 clusters.

3. Testing normality:

H_0: The 4 variables follow multivariate normal distribution

H_0 will be rejected at α = 0.05 because the p-value was (2.085e-17), which means that we have no evidence that our variables follow MVN distribution **But** since we have a large sample (850 observations) which is greater than the threshold (20 * 4 = 80) to satisfy the (approximately MVN condition)

4. Discriminant analysis:

Table 10: Classification table for the 3 clusters.

	Predicted Groups		
True Groups	Low character strength	Moderate character strength	High character strength
Low character strength	152	0	25
Moderate character strength	0	221	22
High character strength	0	0	430

- 85.9% of the people were classified correctly into Low character strength group.
- 90.9465% of the people were classified correctly into moderate character strength group.
- 100% of the people were classified correctly into High character strength group.
- The percentage of correct classification is 94.5 %

For k = 2:

Table 15: Final centroids for the clusters.

Group	transcendence	interpersonal	openness	restraint
1	112.7896	105.7021	101.5500	53.71250
2	138.9568	118.8459	119.3297	58.69189

From the table above we can notice that group 2 has the highest mean values for each variable, followed by group 1, **hence** we will name each group as follows:

- **group 1** → Low character strength group
- **group 2** → High character strength group

Table 16: number of people in each group/cluster.

	High character strength	Low character strength
Frequency	370	480

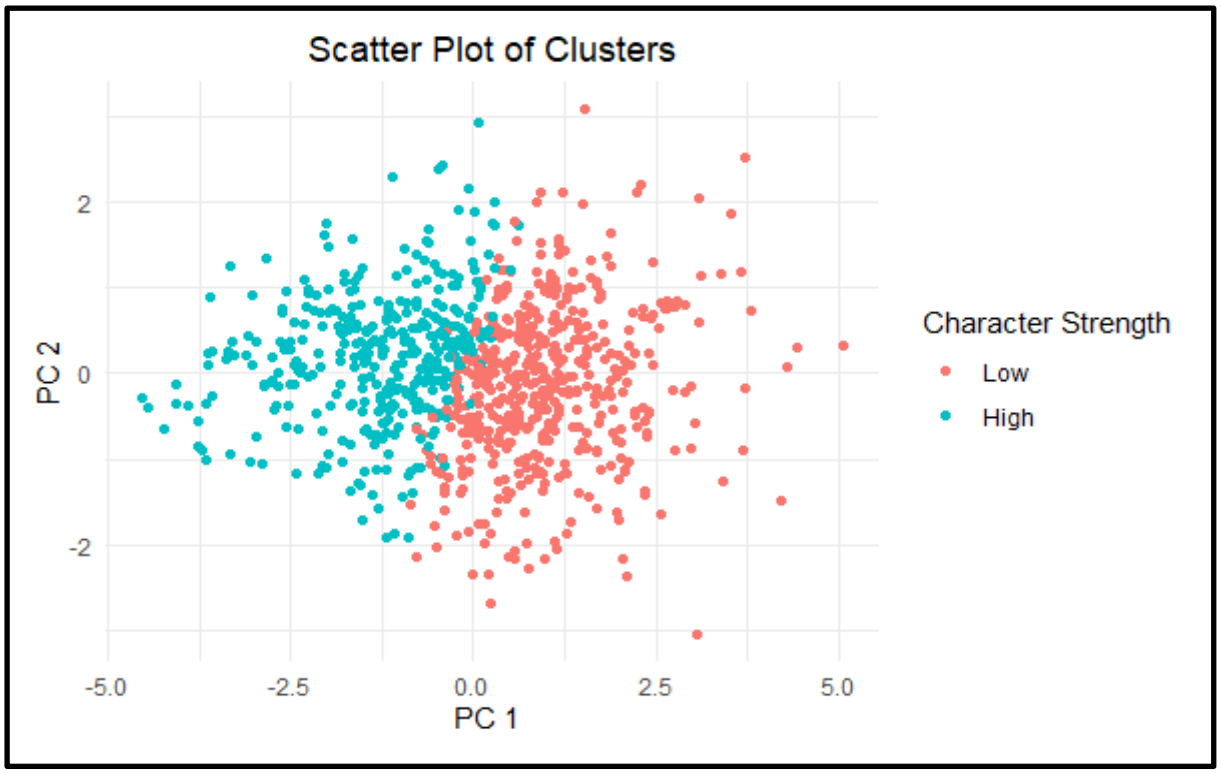

Figure6: Scatter plot between PC1 & PC2 for the 2 clusters.

This plot shows clearer separation between the 2 clusters unlike the k = 3 (figure 4) which initially indicates that this might be the suitable number of clusters.

Validating the 2 clusters:

1) Testing equal means for the 3 clusters:

$$H_0 = \underline{\mu_1} = \underline{\mu_2}$$

H0 will be rejected at α = 0.05 because the p-value was (2.2e-16), which means that there's at least one different mean vector between the 2 clusters.

Hence Discriminant analysis is appropriate in this case since we have different mean values for each cluster/group.

2) Testing homogeneous variance covariance matrices between the 2 cluster:

$$H_0: \sum g1_1 = \sum g2_2 = \sum$$

H0 will be rejected at α = 0.05 because the p-value was (6.276e-10), which means that there's at least one different variance covariance matrix between the 2 clusters.

3) Testing normality:

$$H_0: \textbf{The 4 variables follow multivariate normal distribution}$$

H_0 will be rejected at α = 0.05 because the p-value was (2.085e-17), which means that we have no evidence that our variables follow MVN distribution **but** since we have a large sample (850 observations) which is greater than the threshold (20 * 4 = 80) to satisfy the (approximately MVN condition).

4) Discriminant analysis:

Table 17: Classification table for the 2 clusters.

	Predicted Groups	
True Groups	Low character strength	High character strength
Low character strength	480	0
High character strength	19	351

- 100% of the people were classified correctly into Low character strength group.
- 94.86% of the people were classified correctly into High character strength group.
- The percentage of correct classification is 97.76 %

Final result:

After observing the values of correct classification for both (k = 2) & (k = 3) we can say that a number of 2 clusters is the most efficient number in separating between people based on the 4 variables we have (transcendence, interpersonal, openness and restraint), Also, that conclusion goes along with what we have seen in the elbow curve (figure 3).

Multivariate regression

Finally, we will conduct Multivariate regression for the three dependent measures DASS21 (Depression Anxiety and Stress Scale) GHQ12 (General Health Questionnaire) SEC (Self-efficacy for Covid-19) and the explanatory variables are Age & Gender & student.

$$Y = X\beta + \epsilon$$

Table 18: Estimated Multivariate regression model.

Equation	R-S.E	Adjusted R-square	F	P-value	Equation
DASS21	4.35	0.05494	19.27	3.914e-12	DASS21
GHQ12	4.871	0.01343	5.28	0.001296	GHQ12
SEC	3.912	0.03711	13.11	2.151e-08	SEC

Response DASS depression:

$$\widehat{DASS\_depression} = \hat{\beta}_0 + \hat{\beta}_1 \text{Age} + \hat{\beta}_2 \text{Gender (Male)} + \hat{\beta}_3 \text{student(student)}$$

Table 15: Estimated Multivariate regression model with DASS as response.

	coefficient	Std. Err.	t	p>t
Intercept	7.21118	0.50730	14.215	2e-16
Age	-0.05606	0.01158	-4.842	1.51e-06
Gender(Male)	-0.64220	0.32510	-1.975	0.0485
student(student)	0.84101	0.40991	2.052	0.0405

$$\widehat{DASS\_depression} = 7.21118 - 0.05606\ \text{Age} - 0.64220\ \text{Gender (Male)} + 0.84101\ \text{student(student)}$$

Response GHQ_12:

$$\widehat{GHQ\_12}=\hat{\beta}_0+\hat{\beta}_1 Age+\hat{\beta}_2 Gender\ (Male)+\hat{\beta}_3 student(student)$$

Table 19: Estimated Multivariate regression model with GHQ_12 as response.

	coefficient	Std. Err.	t	p>t
Intercept	16.798323	0.568022	29.573	2e-16
Age	0.001189	0.012964	0.092	0.92693
Gender (Male)	-0.560117	0.364009	-1.539	0.12420
student(student)	1.460537	0.458972	3.182	0.00151

$$\widehat{GHQ\_12}=16.798323+0.001189 Age-0.560117 Gender\ (Male)+1.460537 student\ (student)$$

Response SEC:

$$\widehat{SEC}=\hat{\beta}_0+\hat{\beta}_{1Age}+\hat{\beta}_2 Gender\ (Male)+\hat{\beta}_3 student\ (student)$$

Table 20: Estimated Multivariate regression model with SEC as response.

	coefficient	Std. Err.	t	p>t
Intercept	13.67295	0.45625	29.968	2e-16
Age	0.03782	0.01041	3.632	0.000296
Gender (Male)	0.53590	0.29238	1.833	0.067139
Student(student)	-0.76605	0.36866	-2.078	0.037987

$$\widehat{SEC}=13.67295+0.03782 Age+0.53590\ Gender\ (Male)-0.76605 student\ (student)$$

$$\hat{Y}=X\hat{\beta}$$

$$\hat{\beta} = \begin{matrix} 7.21118 & 16.798323 & 13.6729 \\ -0.05606 & 0.001189 & 0.03782 \\ -0.64220 & -0.560117 & 0.5359 \\ 0.84101 & 1.460537 & -0.76605 \end{matrix}$$

- The three dependent variable **(DASS_21, GHQ_12&SEC)** are significant which means that there is at least one explanatory variable that is significant or has a significant effect on them.
- R-sq: the explanatory variables can explain about 5.5% of the variations in DASS_21 while they can explain about 1.3%of the variation in GHQ_12 and finally they can explain about 3.7% of the variations in SEC.

- **For the dependent variable DASS_21.**

  - Variable **(Gender)** is significant at α =0.05 which means that the mean value of DASS_21 for male is less than the mean value of DASS_21 for female by 0.64220, holding the other variable constant.

  - Variable **(AGE)** is a significant at α =0.05 which means that when AGE increase by one unit the mean value of DASS_21 increase by 0.05606, holding the other variable constant.

  -variable **(student)** is a significant at α =0.05 which means that the mean value Of DASS_21 for student is higher than the mean value of DASS_21 for Other by 0.84101, holding the other variable constant.

- **For the dependent variable GHQ_12**.
  - Variable **(Gender)** is insignificant at α =0.05.
  - Variable **(AGE)** is insignificant at α =0.05.
  - variable **(student)** is a significant at α =0.05 which means that the mean value Of GHQ_12for student is higher than the mean value of GHQ_12for Other by 1.460537, holding the other variable constant.

- **For the dependent variable SEC.**
  - Variable **(AGE)** is a significant at α =0.05 which means that when AGE increase by one unit the mean value of **SEC** increase by 0.037, holding the other variable constant.
  - Variable **(Gender)** is insignificant at α =0.05.
- variable **(student)** is a significant at α =0.05 which means that the mean value Of SEC for student is less than the mean value of SEC for Other by 0.76605, holding the other variable constant.

- If we ran a separate OLS regression for each outcome variable, we would get Exactly the same coefficient, standard errors- and p-values, and confidence

Intervals.

- One of advantages of using Multivariate regression is that we can conduct tests of the coefficients across the different outcome variables.
- As there are some of our explanatory variables are broadly significant, we will conduct multivariate test which take into consideration the covariance structure
  and for this reason, it may affect the significance of specific variables specially those which significant on border.
- The null hypothesis is the coefficients for the variable (β)are equal to 0 in all three equations, we will test the effect of each explanatory variable either it is

Significant on the three dependent variables at the same time or not (**test the jointly simultaneously at the same time**).

- The most important note is that we need **Multivariate regression** to get **Multivariate tests** (**jointly significant or jointly insignificant**).

Testing the significance of explanatory variables: -

H_0: β_{jk} =0 $\forall$ j=1,2,3 & k=1,2,3

(1) AGE	(2) Gender	(3) student
F (3,938) =13.3209	F(3,938)=1.6277	F(3,938)=3.4714
1.609e-08	0.18133	0.01573

1. p-value less than 0.05, then we will reject the null hypothesis that the coefficient for the variable **AGE** (β) are equal to 0 in all three equation, then **AGE is significant (has significant effect)** on at least one dependent variables. (**DASS21** (Depression Anxiety and Stress Scale) **GHQ_12** (General Health Questionnaire) **SEC** (Self-efficacy for Covid-19)).

2. p-value greater than 0.05, then we will don't reject the null hypothesis , then **Gender is insignificant (has insignificant effect)** on all the three dependent variables **(DASS21, GHQ_12 & SEC)**.

3. p-value less than 0.05, then we will reject the null hypothesis That the coefficient for the variable **student** (β) are equal to 0 in all Three Equation, then **student is significant (has significant effect)** on at least one dependent variables. **(DASS21, GHQ_12 & SEC)**.