TEST OF SIGNIFICANCE OF CORRELATION COEFFICIENT IN SCIENCE AND EDUCATIONAL RESEARCH

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ABSTRACT: *This study demonstrated and compared the use of t-distribution, z-transformation and the Statistical Package for Social Sciences (SPSS) methods in testing the significance of the correlation coefficients. The study utilized data extracted from Eze (2019). The findings revealed that the significance of the correlation coefficient by the Fisher z-transformation and t-distribution methods were not at variance with that of SPSS. Results also showed that the SPSS approach appears to be the best method since it saves time, reveals the correlation coefficient and p-value for decision making. Results further showed that the t-distribution can be used for both large and small sample sizes since it approximates the z-distribution as the data tends to infinity. Based on the findings of the study, it was recommended among others that the SPSS approach should be adopted by researchers and data analysts for testing the significance of correlation coefficients because it is not only robust, but it is easier, saves time and energy; and users of SPSS in computing correlation should not go further to convert the derived correlation coefficient using either the t-distribution or the z-transformation to test a hypothesis to minimize the risk of computational errors, wrong decisions, time wastage and to avoid unnecessary repetition.*

KEYWORDS: Pearson, Spearman, Correlation, Significance, Relationship.

INTRODUCTION

The term correlation refers to a bivariate measure of the relationship that exists between two variables simultaneously. Correlation can also be defined as a bivariate measure of association (strength) of the relationship between two variables (Adeleke, 2010). In science and educational research and statistics, the correlation (relationship) between two variables can be measured using different statistical tools. These include the Pearson Product Moment Correlation (r) which is commonly used in research when there are two continuous variables), Spearman Rank Order Correlation (r_s) which is usually used when there are two ordinal variables, Kendall Rank Correlation, popularly known as Kendal Tau (Kt) and Rank Biserial Correlation (r_{rb}) which are usually used to correlate an ordinal variable with a dichotomous variable, Point Biserial Correlation (r_{pb}) which is usually used to correlate a continuous variable with a true dichotomy or to correlate a nominal data and an internal data, and Phi Coefficient of Correlation (r_ϕ) which is used to correlate two variables that are dichotomous. However, in the concept of this study, the

Pearson Product Moment Correlation and Spearman's Rank Order Correlation are briefly discussed.

The Pearson Product Moment Correlation and Spearman Rank Order Correlation are statistical tools used to determine the magnitude and direction of the relationship or association between two variables (bivariate). They determine whether the two variables are directly or inversely related or not. The variables correlated are known as covariates. This implies that the idea of independent and dependent variables is not considered in this regard. However, two variables are said to be related if the changes in one variable lead to changes in the other variable. The degree of relationship between or among the correlated variables is shown by the coefficient of correlation. In other words, the correlation coefficient is a quantitative expression of the mutual relationship that exists between two variables. Also, the coefficient of correlation can be used to indicate the extent to which the values of one variable may be predicted from known values of another variable (Nzeneri, 2010). Correlation coefficient values range from -1 to +1. A correlation coefficient of +1 indicates perfect positive (direct) correlation (relationship) meaning that high scores on the one variable are very much associated with high scores on the other variable, whereas -1 indicates perfect negative (inverse) correlation (relationship) which means that high scores on the one variable are very much associated with low scores on the other variable and vice versa. On the other hand, a coefficient of zero (0) indicates no correlation or association. According to Best and Kahn (2007), a frequently used method of evaluating the magnitude of a correlation is the crude criterion, where coefficient (r) ranging from .00 to .20 is negligible, .20 to .40 is low, .40 to .60 is moderate, .60 to .80 is substantial and from .80 to 1.00 is high or very high.

Pearson Product Moment Correlation (r)

The Pearson correlation is a statistical tool that uses interval or ratio data. The raw score method for the computation of Pearson's correlation (r) is computed using the formula below.

$$r = \frac{N\sum XY - \left(\sum X\right)\left(\sum Y\right)}{\sqrt{N\sum X^2 - \left(\sum X\right)^2}.\sqrt{N\sum Y^2 - \left(\sum Y\right)^2}}$$

Where

$\sum X$ = sum of all X scores of the sample;

$\sum X^2$ = sum of all squared X scores of the sample;

$\sum Y$ = sum of all Y scores of the sample;

$\sum Y^2$ = sum of all squared Y scores of the sample;

$\sum XY$ = sum of the products of paired X and Y scores of the sample;

N =Number of paired scores.

For proper use of the Pearson correlation for data analysis, the following requirements or conditions are necessary:

i. Subjects (respondents) should be selected at random.
ii. The measurement scale should be interval or ratio in nature.
iii. Data should be normally distributed
iv. How a hypothesis is stated should be such that it can be tested.

As an illustration and application, the data used for the study extracted from Eze (2019) which studied the Junk food intake and its resultant implication on bodyweight amongst junior secondary school students in Obio/Akpor Local Government Area of Rivers State. A total of 385 JSS 3 students took part in the study. The ages of the students, body weights and heights among other variables were quantified. Using the height (meters) and weights (Kg) of the students, the Body Mass Index (BMI) of the students was derived. Having the following parameters, a correlation between the ages (X) in years and BMI(Y) of the students was computed using the Pearson correlation formula, thus:

$\sum X = 5425 \quad \sum X^2 = 77095 \quad \sum Y = 7718 \quad \sum Y^2 = 160109 \quad \sum XY = 108995$

N =385.

$$r = \frac{385(108995) - (5425)(7718)}{\sqrt{385(77095) - (5425)^2}.\sqrt{385(160109) - (7718)^2}} \quad (1)$$

$$r = 0.130$$

The Rank Order Correlation (ρ)

The Spearman rank-order correlation, (ρ) is a unique form of Pearson product-moment correlation which is normally used with two ordinal values. The paired variables are presented as ranked or ordinal values instead of interval or ratio data. The formula for the computation of the Spearman correlation (ρ) is shown below.

$$\rho = \frac{6\sum D^2}{N\left(N^2 - 1\right)} \quad (2)$$

Where
D = the difference between paired ranks
$\sum D^2$ = sum of squared differences between ranks

N =Number of paired ranks.

For proper use of the Spearman rank-order correlation coefficient for data analysis, these requirements or conditions are necessary:

i. Subjects (respondents) should be randomly selected.
ii. The sample size should be small.
iii. Data should be discrete
iv. The measurement scale should be ordinal.
v. How a hypothesis is stated should be such that it can be tested.

Best and Kahn (2007) however, warned that the coefficient does not mean a cause-and-effect relationship between the considered variables. High correlation is not a result of causality and neither does a zero correlation (or negative) imply the impossibility of causation. The sample size influences the value of the coefficient of correlation. Furthermore, the correlation coefficient could be interpreted concerning variance. This is achieved by computing the coefficient of determination (r^2). This is the percentage of explained variance or percentage reduction in error of prediction. The percentage of unexplained variance (percentage of error of prediction) is given by $1-r^2$.

Some Characteristics/ Properties of Correlation Coefficient

i. The correlation coefficient value is not easily affected by the unit or dimension of the measuring scale or by positive and negative signs.
ii. The correlation coefficient ranges from -1 to +1, where -1 signifies a perfect negative relationship and +1 signifies a perfect positive relationship.
iii. The correlation coefficient does not connote cause-and-effect relationship between the two considered variables.
iv. The correlation coefficient could be interpreted regarding variance.

Problem specification

A School of Thought (SoT-1) argues that the Pearson or Spearman correlation cannot be used to answer a research question but to test a hypothesis since it is an inferential statistic. They further argued that when Statistical Package for Social Sciences (SPSS) is used in the computation of the correlation coefficient, it becomes unnecessary to do further transformations of the computed correlation coefficient since the SPSS provides the probability values used for the test of significance and decision making. Another School of Thought (SoT-2) however is of a contrary view. They argue that the transformation is needed for the test of significance of the computed coefficient and that the computed correlation coefficient shows the magnitude and direction of the existing relationship (if any) and hence could be used to answer a research question probing the description of the nature of the relationship between two variables correlated. The SoT-2 further argued that when combined with the z-transformation or the t-transformation, relating to the sample size (large or small sizes) and degrees of freedom, it could as well be used to test a hypothesis.

The transformations are aimed at testing the significance of the computed correlation coefficient. This could be achieved by comparing the computed z or t value with the critical/table values. This study, therefore, compared the results of three methods utilized in testing the significance of the correlation coefficient. It shows three approaches to testing a hypothesis using the t-transformation

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as well as the z-transformation. The study also demonstrates how the SPSS could be utilized to calculate the correlation coefficient, the probability value, to make a decision or to test a hypothesis using the generated probability value and recommend the way forward to create an understanding between these two Schools of Thought regarding the use of correlations, transformations and tests of hypothesis.

Aim and objectives of the study

The overarching goal of this study is to test the significance of a correlation coefficient. Specifically, the study compared the following methods of testing the significance of a correlation coefficient:

1. t distribution
2. z-transformation
3. SPSS

METHODOLOGY

Testing the Significance of Correlation Coefficient

Test of significance could be defined as the statistical test that attempts to determine whether or not an observed difference indicates that the given characteristics of two or more groups are the same or different; or whether a relationship exists between two or more variables (Bamgboye, Lucas, Agbeja, Adewale, Ogunleye & Fawole, 2006). The significance of the correlation coefficient could be tested by simply comparing the calculated correlation coefficient with the critical (table) value. The significance can also be tested with the use of t-transformation, z-transformation and the use of Statistical Package for Social Sciences (SPSS). Obilor and Amadi (2018) explored the test of the significance of Pearson correlation using the t-distribution, the z-transformation and the Statistical Package for Social Packages (SPSS). This study, however, adopted the z-transformation approach as suggested by Devore (2004) with a rule of thumb (a correlation is weak if 0≤/r/≤.5, strong if .8≤/r/≤1 and moderate otherwise), which facilitated the z-transformation. The word distribution and transformation are used interchangeably in this study. This exploration focuses on comparing the results obtained when using the three approaches mentioned above. We can transform the computed correlation coefficient to t-distribution using the formula below:

$$t = \frac{r}{\sqrt{\frac{1-r^2}{N-2}}} \qquad (3a)$$

The equation (3a) is simply written as:

$$t = r\sqrt{\frac{N-2}{1-r^2}} \qquad (3b)$$

or

$$t = \rho\sqrt{\frac{N-2}{1-\rho^2}} \tag{3c}$$

Where:

N=sample size

r=computed Pearson correlation coefficient

ρ= computed Spearman correlation coefficient

t=computed t-value required for the test

$\sqrt{\frac{1-r^2}{N-2}}$ = The estimated standard error

Kpolovie (2018) stated that in converting the computed r to t when the sample size is small, equation (3) could be used. However, the exact size of the small sample was not stated. Kpolovie further noted that given a zero correlation (r=0) in a given population as hypothesized in a null hypothesis, with sample correlations of numeration samples of same size randomly drawn from the population, there will be a normal distribution with a mean of 0 and a standard deviation of $\frac{1}{\sqrt{N}}$ for a large sample size. This implies that the t-distribution for a large sample may be given by the formula:

$$t = \frac{r}{\sqrt{N}} \tag{4}$$

Nwankwo (2016) supported equation (3) and demonstrated its application in the transformation hypothesis testing and also stressed that to apply it, the sample size should be less than or equal to 49 and further suggested a formula for the z-test for sample sizes of 50 and above (equation 5) for the Pearson r. It was also suggested that when N≤ 30 the rho (ρ) table should be used for the test of significance but N>30 the equation (5c) should be used. The process of utilization of equation (5) could be utilized in the transformation and hypothesis testing is vital. It is unclear if the sample size (N) has any influence on the calculated t or z given a derived r.

$$z = \frac{\frac{r}{1}}{\sqrt{N-1}} \tag{5a}$$

$$z = \frac{r}{\sqrt{N-1}} \tag{5b}$$

$$z = \frac{\frac{\rho}{1}}{\sqrt{N-1}} \tag{5c}$$

$$z = \frac{\rho}{\sqrt{N-1}} \tag{5d}$$

A study by Ekwebelem and Oladayo (2012) transformed the computed r to z for test of hypotheses regarding the significance of r. The study investigated whether teacher quality is related to their job performance in public primary schools in Rivers State. In application, however, the transformation yielded higher values of z greater than 1.960 in four variables out of the five variables investigated about teacher job performance. The researchers rejected the null hypothesis in each of the four cases. A closer look at the equation (5) shows that with the large sample sizes, such as N=698, it is unlikely for any computed r to yield a derived z greater than 1.960, to necessitate the rejection of the null hypothesis at .05 level of significance as suggested by Nwankwo (2016) when equation (5) is used. This implies that the null hypothesis (H_0: ρ=0) could also be rejected at .05 when z ≤ ±1.960 with equation (5).

In all, Kpolovie (2018) strongly advised that since there are critical values for correlation coefficients, it is straightforward to directly determine the significance of the correlation coefficient by comparing the calculated correlation coefficient with the critical values at the chosen level of significance and degrees of freedom. This approach is easier, better and less time-consuming. It, therefore, becomes unnecessary to convert the calculated correlation coefficient to t-distribution for the test of significance of the coefficient. Nevertheless, Obilor and Amadi (2018) used two separate formulas for computing the t-distribution and the z-transformation in an attempt to test the significance of the computed correlation coefficient. The derived r was compared with the SPPS results. The present study however used a slightly different formula for the z-transformation which is anchored on a transformation of R known as the Fisher transformation. The transformation is applied with a large sample size (n) for valid approximation (Devore, 2004)

There is a difference between the t-statistic and z-statistic for the test of difference in the mean of the measured response variable based on a dichotomous factor, when the sample size is small and when the sample size is large. It is, however, outside the scope of this study. An exploration geared toward clarifying how the t-distribution and the z-transformation of computed coefficients of relationship are utilized to test the significance of the computed correlation coefficients is worthwhile and timely. Coolidge (2006) stated that the t-transformation formula (3a) is used only to test whether r=0 and that it cannot be used to test whether it is likely to be equal to any other number different from zero. The t-distribution is most commonly used to test for the significance of the difference between two group means, but it could also be used to test for the significance of the correlation coefficient. Coolidge further made it clear that the t-distribution approximates z-distribution as the data tends to infinity and they are similar in a data set involving several hundred numbers. This implies that the formula (3a) could be used for both large and small sample sizes. Therefore, at large sample sizes, it becomes a matter of interest to use the letter t or z. Thus,

$$t \approx z = \frac{r}{\sqrt{\frac{1-r^2}{N-2}}} \tag{6a}$$

The above formula could simply be rewritten in the from below:

$$t \approx z = r\sqrt{\frac{N-2}{1-r^2}} \tag{6b}$$

The computed r is obtained from a sample. Then ρ is the population correlation coefficient. It is assumed that r roughly approximates ρ. The null and the alternative hypotheses are given below:

H0: ρ=0
Ha: ρ≠0

Test Procedure

t-distribution
For the application of t-distribution in testing the significance of correlation coefficient, the two-tailed test which is a non-directional hypothesis is considered as it is done in most studies. Given the conventional level of significance, p=.05 and degree of freedom (df=N-2), the final step is to determine whether the computed t is greater than the critical values (table values) obtained from the t-distribution. Using the example as demonstrated under the Pearson Product Moment Correlation above where n=385 and r=0.310, and substituting the values in equation 3a, we have:

$$t = \frac{0.130}{\sqrt{\frac{1-0.130^2}{385-2}}}$$

$$= \frac{0.130}{\sqrt{\frac{0.9831}{383}}}$$

$$t = \frac{0.130}{\sqrt{0.0026}}$$

$$t = \frac{0.130}{0.0510}$$

$$t = 2.560$$

Given, H_0: ρ=0:
There is no significant relationship between age and Body Mass Index (BMI)

For a two-tailed test of significance at p=.05, with a degree of freedom, df=385-2=383, the critical values are +1.960 and -1.960. If the computed t is greater than t=+1.960 or less than -1.960, then the null hypothesis will be rejected. In this example, the computed t=2.560 which is greater than critical t=+1.960; therefore the null hypothesis is rejected at .05 level of significance. We,, therefor,e, conclude that r=0.310 indicates a significant relationship. This finding could also be reported thus: that there was a strong positive relationship found between age and Body Mass Index (BMI). The correlation was statistically significant since the derived t=2.560 >critical t=1.960.

z-transformation

Fisher's z-transformation is given by the formula below. The equation (7) was utilized to demonstrate the transformation of son's r for the test of significance of r.

$$z = \frac{1}{2}\log_e\left(\frac{1+|r|}{1-|r|}\right) \tag{7}$$

where:
Log_e = Natural logarithm
/r/ = modulus of the computed r
Fisher developed this z-transformation method to normalize the distribution of the correlation coefficients and to allow average correlations and standard deviations to be calculated more accurately (Gorsuch & Lehmann, 2010).

Substituting the value, r=.130 into the formula above, we have:

$$z = \frac{1}{2}\log_e\left(\frac{1+|0.130|}{1-|0.130|}\right)$$

$$= \frac{1}{2}\log_e\left(\frac{1.130}{0.870}\right)$$

$$= \frac{1}{2}\log_e(1.29885)$$

$$= \frac{1}{2}(0.26148)$$

$$z = 0.13074$$

The Fisher z-transformation (z-trans) = 0.131 for a two-tailed test and the corresponding z-critical value was found to be 1.960. Since the computed z (z-trans) = 0.131 < critical z=1.960, it implies that there is a significant relationship. We reject the null hypothesis and conclude that there is a significant relationship between the age of students and their Body Mass Index (BMI). Following equation (7), Devore, (2004) indicated that the procedure for testing H_0: $\rho=\rho_0$ when $\rho\neq 0$ is different from that of regression analysis procedure. The test statistic is anchored on a transformation of R known as the Fisher transformation. For a bivariate normal distribution, with a sample ($X_1, Y_1 \ldots X_n, Y_n$), the r_v is given by the relation:

$$V = \frac{1}{2}\ln\left(\frac{1+R}{1-R}\right) \tag{8}$$

The equation (8) has roughly a normal distribution with mean and variance

$$\mu_v = \frac{1}{2}\ln\left(\frac{1+\rho}{1-\rho}\right) \tag{9}$$

$$\sigma^2{}_v = \frac{1}{n-3} \tag{10}$$

The justification for the transformation is to derive a function of R having a variance independent of ρ; which obviously will not be the case with R. Devore, (2004) further suggested that the transformation should not be applied with a small sample size (n), else the approximation would be invalid. The test statistic for testing H_0: $\rho=\rho_0$ when $\rho_0\neq 0$ is given below:

$$Z = \frac{V - \frac{1}{2}\ln\left(\frac{1+\rho_0}{1-\rho_0}\right)}{\frac{1}{\sqrt{n-3}}} \tag{11}$$

Then, on the substitution of V in equation (11) we obtain equation (12) below:

$$Z = \frac{\frac{1}{2}\ln\left(\frac{1+R}{1-R}\right) - \frac{1}{2}\ln\left(\frac{1+\rho_0}{1-\rho_0}\right)}{\frac{1}{\sqrt{n-3}}} \tag{12}$$

Where the alternative Hypothesis and rejection region for the level alpha test are given below:

Alternative hypothesis Rejection region

H_a: $\rho>\rho_0$	$z \geq z_\alpha$
H_a: $\rho<\rho_0$	$z \leq -z_\alpha$
H_a: $\rho\neq\rho_0$	either $z \geq z_{\alpha/2}$ or $z \leq -z_{\alpha/2}$

To establish whether a correlation is strong or weak, Devore, (2004) opined that a reasonable rule of thumb is to say that a correlation is weak if $0\leq/r/\leq.5$, strong if $.8\leq/r/\leq1$ and moderate otherwise. It is worthy of note that when we regress x on y and if r=.5, then r^2=.25, which implies that the x contributes 25% of the observed changes in y which could be explained by the data whereas 75% of the observed variance are unexplained. Therefore, a moderate positive correlation could be said to be in the range: $.5<\rho<.8$, therefore, having r=.130 and n=385 we could derive z using equation (12) above and hence test the significance of the correlation coefficient. The test is H_0: ρ=.5 versus H_0: ρ>.5. The computed r=.130, therefore substituting in equation 12, we have:

$$Z = \frac{\frac{1}{2}\ln\left(\frac{1+.130}{1-.130}\right) - \frac{1}{2}\ln\left(\frac{1+.50}{1-.50}\right)}{\frac{1}{\sqrt{385-3}}}$$

$$= \frac{\frac{1}{2}\ln\left(\frac{1.130}{0.87}\right) - \frac{1}{2}\ln\left(\frac{1.50}{0.50}\right)}{\frac{1}{\sqrt{382}}}$$

$$= \frac{0.131-0.549}{\frac{1}{\sqrt{382}}}$$

$$= -0.418(19.54)$$

$$Z = -8.17$$

For a test of significance at p=.05 with df=383, the critical values of t are z=+1.645 and z=-1.645. If the computed t is greater than z=+1.645 or less than z=-1.645, then the null hypothesis will be rejected. In the above example, the computed z =-8.17 is less than z=-1.645 at .05. This is also true at .025 (-8.17<-1.960 at .025), we conclude that ρ<.5. The relationship has shown to be moderately strong. It may appear to be an astonishing conclusion because r=.130, however, when the sample size is large a small r could be derived.

The SPSS Approach

To obtain the bivariate correlations using the SPSS approach, these operations are done on the SPSS menus:

- Choose/ Click Analyze
- Correlate
- Bivariate...
- Select two or more numeric variables (in this case the age and BMI)

The following options are also available:

- Correlation Coefficients. For quantitative, normally distributed variables, choose the Pearson correlation coefficient or choose Kendall's tau-b or spearman for rank orders.
- Test of Significance. You can select two-tailed or one-tailed probabilities. If the direction of association is known in advance, select one-tailed. Otherwise, select two-tailed.
- Flag significant correlations. Correlation coefficients significant at the 0.05 level are identified with a single asterisk, and those significant at the 0.01 level are identified with two asterisks (SPSS, various versions).

Table 1: SPSS results for Pearson's correlation

		Age	BMI
Age	Pearson Correlation	1	.130*
	Sig. (2-tailed)		.010
	N	385	385
BMI	Pearson Correlation	.130*	1
	Sig. (2-tailed)	.010	
	N	385	385

*. Correlation is significant at the 0.05 level (2-tailed).

The result showed that the relationship between age and BMI was positive moderately low, but significant at .05 level of significance (r=.130, p=.010).

RESULTS

Table 1: Comparison of the test results and decisions based on the three methods

	Test method

	t-distribution	**z-transformation**	**SPSS**
Formula	$t \approx z = \dfrac{r}{\sqrt{\dfrac{1-r^2}{N-2}}}$	$Z = \dfrac{V - \frac{1}{2}\ln\left(\frac{1+\rho_0}{1-\rho_0}\right)}{\frac{1}{\sqrt{n-3}}}$	CORRELATIONS /VARIABLES=Age BMI /PRINT=TWOTAIL NOSIG /MISSING=PAIRWISE. (On SPSS menus: Click Analyze, Correlate, Bivariate..., Select the numeric variables)
Computed r or ρ	r=0.130	r=0.130	r=0.130
Computed t and z	t=2.560	Z=-8.17	-
Sample size	N=385	N=385	N=385
Degree of freedom	df=383	df=383	-
Critical	t=±1.960	z=±1.960	-
p-value	-	-	.010
Hypothesis	t=2.560 > t=1.960) Reject H_0: ρ=0	z= -8.17 < z=-1.960 Reject H_0:$\rho=\rho_0$, $\rho_0 \neq 0$	p=.010< p=.05 Reject H_0: p<.05
Decision	*The correlation was statistically significant, r(383)=.130, p<.05.*	*The correlation was statistically significant (Z=-8.17).*	*The correlation was statistically significant (r=.130, p=.010).*

Source: Researchers' Data Computation, 2020.

Table 1 shows the result of the comparison of the three methods, the t-distribution, z-transformation and SPSS used in the test of the significance of the correlation coefficient as demonstrated under the test procedure above. It shows the result of the correlation between age of students and their BMI. The computed Pearson correlation coefficient was 0.130 and the sample size (N) was 385. This implies that the degree of freedom (df=N-2=385-2=383). The result further shows that in the use of the t-transformation (equation 3a), the computed t= 2.560 whereas the z-transformation (equations 11 & 12) yielded z=-8.17. Since the sample size is large (above 120), the critical value of z=±1.960. The SPSS method yielded a correlation coefficient of 0.130 and a probability (p) value of .010.

DISCUSSION

The result from Table 1 showed that the three methods explored yielded similar results. The null hypothesis H_0: ρ=0 was rejected, suggesting that the correlation was statistically significant, while using the t-distribution (t=2.560 > t=1.960), the z-transformation (z=-8.17< z=-1.960) and the SPSS (p=.010< p=.05). This indicated that there is a significant relationship between the age of the students and their BMI. A close peer at the procedures adopted while testing for the significance of the correlation coefficients using the three methods discloses that the SPSS approach is the easiest. This was followed by the t-transformation (equation 3a). The z-transformation approach (equation 11) is tricky. The users of the method must know that the

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natural logarithm (ln or $\log_e$) of a number is different from the logarithm to base 10 of the same number. Secondly, users of the z-statistic should be conversant with Fisher's assumptions guiding the test of hypothesis, which when satisfied the t-transformation is preferable: H_a: (i) $r_o \neq r_h$ (ii) $r_1 \neq r_2$ (iii) $r \neq 0$ where r_o=observed correlation coefficient and r_h= hypothetical correlation coefficient; r_1 and r_2 are two sampled values of the correlation coefficient. This implies that the alternative hypothesis is tested.

The z-test or transformation formulae suggested by Nwankwo (2016) and Kpolovie (2018) as shown in equation (4) and equation (5) respectively are said to be useful when the sample size considered is large. However, it was unclear how these formulae could be used to test for the significance of the correlation coefficient and the gap was plugged by this study. Coolidge (2006) observed that at large samples or data set involving several hundreds; the t-distribution approximates z-distribution as the data tends to infinity. This finding is in agreement with Obilor and Amadi (2018) who explored the test of the significance of Pearson's correlation using the t-distribution, z-transformation and SPSS. The study also reported SPSS as the most useful method to test the significance of the correlation coefficient but a small data set (sample size below 20) was used to demonstrate the applicability of the methods. Following the advice of Devore, (2004) that the z-transformation (equation 11) should not be applied with a small sample size (n), else the approximation would be invalid; the present study demonstrated the applicability of equation (11) with a sample of 385 participants.

A review of the literature shows that the Pearson Product Moment Correlation could be used to answer a research question trying to determine the magnitude and direction of the relationship between two variables measured separately. If a hypothesis is derived by directly transforming the research question, the p-value could aid in testing the hypothesis when SPSS is used. The rationale for taking his position is that after deriving the coefficient of correlation (r) using equation (1), the size of the relation and the direction (direct or inverse) could be established. The computed r=0.130 was moderately low but a positive relationship was found between the two variables. We can go further to compute the coefficient of determination (r^2). This is the percentage of explained variance or percentage reduction in error of prediction. This value shows the percentage contribution of one variable to the other. This percentage of unexplained variance (percentage of error of prediction) is given by $1-r^2$. In the present example, the percentage reduction in error of prediction, r^2=.017. This shows that age contributed about 1.7% to the observed variance in the BMI. The percentage of error of prediction, $1-r^2$=0.983, indicating that about 98.3% of the changes in BMI is unexplained by the current data. In trying to test the hypothesis regarding the relationship between age and BMI, p=0.010 which is less .05 shows that the relationship between age and BMI was statistically significant at .05 level of significance.

CONCLUSION

The study demonstrated and compared the use of the t-distribution, the z-transformation and the SPSS methods to test for the significance of a correlation coefficient. The t-distribution, (equation 3a) is the most commonly used test of significance. The reason is that the t-distribution approximates the z-transformation as the data (sample size) tends to infinity. The equation (3a)

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could be used for both large and small sample sizes. This implies that when the sample size is large it becomes optional to use the letter t or z with the same formula. It, therefore, appears to be unnecessary to adopt any of the z-transformation formulae discussed when the equation (3a) could be easily used instead to achieve the same goal. In addition, the computational process and the decision rule involved in the test of hypothesis using the z-transformation are somewhat more complicated than the other two methods considered (t-distribution & SPSS). . The use of SPSS appears to be the simplest approach for the test of significance of the correlation coefficient due to ease of use, robustness, time optimization and ability to indicate (*) a significant correlation based on the computed coefficient and probability value which form part of the output. This permits a decision to be made regarding the magnitude, direction and significance of the relationship between the two variables correlated from the same output. Also, the use of SPSS minimizes the risk of computational errors and wrong decisions.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. The SPSS approach should be adopted by researchers in data analysis for testing the significance of a correlation coefficient because it is easier, saves time and energy, and is robust.
2. Users of the SPSS in computing correlation should not go further to convert the derived correlation coefficient using either t-distribution or z-transformation methods to test a hypothesis to minimize the risk of computational errors, wrong decisions and to optimize time and avoid unnecessary repetition.
3. In the absence of SPSS, the t-distribution method (equation 3a) should be used to test for the significance of the computed correlation coefficient irrespective of the sample size of the study because the t-distribution approximates the z-transformation as the data tends to infinity

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