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A Modified Ratio Estimator in the Presence of Tri-Mean and Interquartile Range for the Estimation of Population Variance

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ABSTRACT

In this paper, a modified ratio estimator in the presence of tri-mean and interquartile range, for estimating the population variance is suggested. Studied the estimator proposed by Yadav et al. (2017) where they made use of information on the tri-mean and inter-quartile range of the auxiliary variable to improve the estimate and efficiency of the variance estimator for estimating the population variance. The bias and mean squared error of the presented estimator were derived up to the first order of approximation and conditions for which the proposed estimator was more efficient than other estimators considered in the study were also established. The numerical illustration was conducted using Murthy (1967) and Singh and Chaudhary (1986) datasets. It was shown that the proposed revised ratio estimator performs better than some existing related ratio estimators.

Keywords: Auxiliary variable, Bias, Efficiency, Mean squared error, Study variable.

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INTRODUCTION

Background

Variability estimation is necessary to know how widely spread one set of values in a group varies from a set of values in another group. Variance is one of the variability measures used in statistics to ascertain the extent of variability present in a dataset. The commonly used method to obtain the estimator for population variance is simple random sampling without replacement (SRSWOR) when there is no auxiliary variable available. Some techniques use the auxiliary information of the study characteristics. If there exists an auxiliary variable X which is correlated with the study variable Y, then several estimators such as ratio, modified ratio, and so on and their modifications are widely available for estimation of replacement variance of the study variable Y.

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Objectives

The objective of this study is to develop a modified ratio estimator in the presence of tri-mean and interquartile range of X, for estimating population variance. Derive bias and mean square error of the proposed estimator. Check for the efficiency of the proposed estimator through the efficiency comparison and numerical analysis.

LITERATURE REVIEW

Background Theory

Let us have N distinct and identifiable units in the finite simple population under consideration and let (x_i, y_i), $i = 1, 2, ..., n$ be a finite sample size of n taken on bivariate paradigm (X, Y) using a SRSWOR scheme. Let $\bar{X}$ be the population mean of the auxiliary variable and $\bar{Y}$ be the population means of the study variable respectively and let ρ be the correlation coefficient between X and Y and $Q_r = Q_3 - Q_1$ be the interquartile range, semi–interquartile range, $Q_d = 2^{-1}(Q_3 - Q_1)$, and quartile average $Q_a = 2^{-1}(Q_3 + Q_1)$ of the auxiliary variable X. We propose a ratio type estimator using tri-mean $TM = 4^{-1}(Q_1 + Q_3 + 2Q_2)$ and first quartile Q_1.

Previous Studies

For estimating population variance, the most appropriate and often used estimator is the sample variance given by:

$$t_0 = s_y^2 \tag{1}$$

Where, it is an unbiased estimator of population variance of the study variable and up to the first order of approximation its variance is:

$$Var(t_0) = \lambda S_y^2(\lambda_{04} - 1) \tag{2}$$

Where, $\lambda_{rs} = \dfrac{\mu_{rs}}{\mu_{20}^{\frac{r}{s}} \mu_{02}^{\frac{s}{2}}}$, $\mu_{rs} = \dfrac{1}{N-1}\sum_{i=1}^{N}(Y_i - \bar{Y})^r (X_i - \bar{X})^s$ ($r = 0,1,2,3,4$, $s = 0,1,2,3,4$),

$\gamma = \dfrac{(1-f)}{n}$ and $f = \dfrac{n}{N}$

Isaki (1983) used the positively correlated auxiliary information and presented the following usual ratio estimator of population variance of the study variable as:

$$t_R = s_y^2\left[\frac{S_x^2}{s_x^2}\right] \tag{3}$$

Where $s_x^2 = \dfrac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2$, $S_x^2 = \dfrac{1}{N-1}\sum_{i=1}^{N}(X_i - \bar{X})^2$ $\bar{X} = \dfrac{1}{N}\sum_{i=1}^{N}X_i$, $\bar{Y} = \dfrac{1}{N}\sum_{i=1}^{N}Y_i$ $\bar{x} = \dfrac{1}{n}\sum_{i=1}^{n}x_i$,

$\bar{y} = \dfrac{1}{n}\sum_{i=1}^{n}y_i$.

The Bias and Mean Squared Error of above estimator, up to the first order of approximation, are given by:

$$Bias(t_R) = \gamma S_y^2 \left[(\lambda_{04} - 1) - (\lambda_{22} - 1) \right] \quad (4)$$

$$MSE(t_R) \gamma S_y^4 \left[(\lambda_{04} - 1) + (\lambda_{04} - 1) - 2(\lambda_{22} - 1) \right] \quad (5)$$

Upadhyaya and Singh (1999) used the information on the population coefficient of kurtosis of auxiliary variable and proposed the following ratio type estimator of population variance:

$$t_1 = s_y^2 \left[\frac{S_x^2 + \lambda_{04}}{s_x^2 + \lambda_{04}} \right] \quad (6)$$

The Bias and Mean Squared Error of the above estimators, up to the first order of approximation, are given by:

$$Bias(t_1) = \gamma S_y^2 R_1 \left[R_1 (\lambda_{04} - 1) - (\lambda_{22} - 1) \right] \quad (7)$$

$$MSE(t_1) = \gamma S_y^4 \left[(\lambda_{40} - 1) + R_1^2 (\lambda_{04} - 1) - 2R_1 (\lambda_{22} - 1) \right] \quad (8)$$

Where, $R_1 = \frac{S_x^2}{S_x^2 + \lambda_{04}}$

Kadilar and Cingi (2006) proposed the following three ratio-type estimators of population variance using the coefficient of variation and population coefficient of kurtosis of auxiliary variable:

$$t_2 = s_y^2 \left[\frac{S_x^2 + C_x}{s_x^2 + C_x} \right] \quad (9)$$

$$t_3 = s_y^2 \left[\frac{S_x^2 \lambda_{04} + C_x}{s_x^2 \lambda_{04} + C_x} \right] \quad (10)$$

$$t_4 = s_y^2 \left[\frac{S_x^2 C_x + \lambda_{04}}{s_x^2 C_x + \lambda_{04}} \right] \quad (11)$$

The Bias and Mean Squared Error of above estimator, up to the first order of approximation, are given by:

$$Bias(t_i) = \gamma S_y^2 R_i \left[R_i (\lambda_{04} - 1) - (\lambda_{22} - 1) \right], (i = 2, 3, 4) \quad (12)$$

the $MSE(t_i) = \gamma S_y^4 \left[(\lambda_{40} - 1) + R_i^2 (\lambda_{04} - 1) - 2R_i (\lambda_{22} - 1) \right], (i = 2, 3, 4)$ (13)

Where, $R_2 = \frac{S_x^2}{S_x^2 + C_x}$, $R_3 = \frac{S_x^2 \lambda_{04}}{S_x^2 \lambda_{04} + C_x}$, $R_4 = \frac{S_x^2 C_x}{S_x^2 C_x + \lambda_{04}}$

Subramani and Kumarapandiyan (2012) suggested the following ratio-type estimators of population variance using quartiles and functions of quartiles of auxiliary variables:

$$t_5 = s_y^2 \left[\frac{S_x^2 + Q_1}{s_x^2 + Q_1} \right] \quad (14)$$

$$t_6 = s_y^2\left[\frac{S_x^2+Q_3}{s_x^2+Q_3}\right] \quad (15)$$

$$t_7 = s_y^2\left[\frac{S_x^2+Q_r}{s_x^2+Q_r}\right] \quad (16)$$

$$t_8 = s_y^2\left[\frac{S_x^2+Q_d}{s_x^2+Q_d}\right] \quad (17)$$

$$t_9 = s_y^2\left[\frac{S_x^2+Q_a}{s_x^2+Q_a}\right] \quad (18)$$

The Bias and Mean Squared Error of the above estimators, up to the first order of approximation, are given by:

$$Bias(t_i) = \gamma S_y^2 R_i\left[R_i(\lambda_{04}-1)-(\lambda_{22}-1)\right], (i=5,6,7,8,9) \quad (19)$$

$$MSE(t_i) = \gamma S_y^4\left[(\lambda_{40}-1)+R_i^2(\lambda_{04}-1)-2R_i(\lambda_{22}-1)\right], (i=5,6,7,8,9) \quad (20)$$

Where, $R_5 = \frac{S_x^2}{S_x^2+Q_1}$, $R_6 = \frac{S_x^2}{S_x^2+Q_3}$, $R_7 = \frac{S_x^2}{S_x^2+Q_r}$, $R_8 = \frac{S_x^2}{S_x^2+Q_d}$, $R_9 = \frac{S_x^2}{S_x^2+Q_a}$.

Khan and Shabbir (2013) presented the following estimator using the correlation coefficient between the study variable and auxiliary variable and the third quartile of the auxiliary variable:

$$t_{10} = s_y^2\left[\frac{S_x^2\rho+Q_3}{s_x^2\rho+Q_3}\right] \quad (21)$$

The Bias and Mean Squared Error of above estimator, up to the first order of approximation, is given by:

$$Bias(t_{10}) = \gamma S_y^2 R_{10}\left[R_{10}(\lambda_{04}-1)-(\lambda_{22}-1)\right] \quad (22)$$

$$MSE(t_{10}) = \gamma S_y^4\left[(\lambda_{40}-1)+R_{10}^2(\lambda_{04}-1)-2R_{10}(\lambda_{22}-1)\right] \quad (23)$$

Where, $R_{10} = \frac{S_x^2\rho}{S_x^2\rho+Q_3}$.

Maqbool and Javaid (2017) suggested the following estimator using the tri-mean and semi-interquartile average of the auxiliary variable:

$$t_{11} = s_y^2\left[\frac{S_x^2+(TM+Q_a)}{s_x^2+(TM+Q_a)}\right] \quad (24)$$

The Bias and Mean Squared Error of above estimator, up to the first order of approximation, is given by:

$$Bias(t_{11}) = \gamma S_y^2 R_{11}\left[R_{11}(\lambda_{04}-1)-(\lambda_{22}-1)\right] \quad (25)$$

$$MSE(t_{11}) = \gamma S_y^4\left[(\lambda_{40}-1)+R_{11}^2(\lambda_{04}-1)-2R_{11}(\lambda_{22}-1)\right] \quad (26)$$

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Where, $R_{11} = \dfrac{S_x^2}{S_x^2 + (TM + Q_a)}$.

Yadav et al. (2017) proposed the following ratio type estimator of population variance using tri-mean and interquartile range of auxiliary variables:

$$t_{12} = s_y^2 \left[\frac{S_x^2 + (TM + Q_r)}{s_x^2 + (TM + Q_r)} \right] \tag{27}$$

The Bias and Mean Squared Error of above estimator, up to first order of approximation, is given by:

$$Bias(t_{12}) = \gamma S_y^2 R_{12} \left[R_{12} \left(\lambda_{04} - 1 \right) - \left(\lambda_{22} - 1 \right) \right] \tag{28}$$

$$MSE(t_{12}) = \gamma S_y^4 \left[\left(\lambda_{40} - 1 \right) + R_{12}^2 \left(\lambda_{04} - 1 \right) - 2 R_{12} \left(\lambda_{22} - 1 \right) \right] \tag{29}$$

Where, $R_{12} = \dfrac{S_x^2}{S_x^2 + (TM + Q_r)}$

METHODOLOGY

Data

For the empirical justification of the results, we consider two sets of data. The performance of the proposed estimator is justified by comparing its percentage relative efficiency (PRE) to those of some existing estimators considered in the study. PRE is computed using the relation

$$PRE(t_j) = \frac{MSE(t_0)}{MSE(t_j)} \times 100 \quad \text{Where, } (j = 0, R, 1, 2, \ldots\ldots, 12, M), t_M = \hat{t}_n$$

Murthy (1967)

Population 1: X = Fixed cost and Y= Number of Output of 80 factories

$$N = 80, n = 20, \bar{Y} = 51.8264, \bar{X} = 11.2646, \rho = 0.9413, S_y = 18.3569,$$
$$S_x = 8.4563, C_y = 0.3542, C_x = 0.7507, \lambda_{04} = 2.8664, \lambda_{40} = 2.2667,$$
$$\lambda_{22} = 2.2209, Q_1 = 5.15, Q_2 = 10.3, Q_3 = 16.975, Q_a = 11.0625,$$
$$Q_d = 5.9125, Q_r = 11.825, TM = 10.68125$$

Singh and Chaudhary (1986)

Population 2: X = Number of workers and Y= Number of Output of 70 factories

$$N = 70, n = 25, \bar{Y} = 96.7, \bar{X} = 175.2671, \rho = 0.7293, S_y = 60.7140,$$
$$S_x = 140.8573, C_y = 0.6279, C_x = 0.8037, \lambda_{04} = 7.0952, \lambda_{40} = 4.7596,$$
$$\lambda_{22} = 4.6038, Q_1 = 80.15, Q_2 = 121.5, Q_3 = 225.025, Q_a = 152.5875,$$
$$Q_d = 72.4375, Q_r = 144.875, TM = 137.04375$$

Model Development

Motivated by the work of Yadav et al. (2017), we propose a modified ratio estimator of population variance in the presence of a tri-mean and interquartile range of auxiliary variables:

$$\hat{t}_n = 2^{-1}(1+z)s_y^2\left(\frac{S_x^2+(TM+Q_r)}{s_x^2+(TM+Q_r)}\right) \quad (30)$$

Properties (Bias and MSE) of the proposed estimators

To derive the bias and MSE of the proposed estimator, we use the following definitions of sampling errors as

$e_0 = \dfrac{s_y^2 - S_y^2}{S_y^2}$ and $e_0 = \dfrac{s_y^2 - S_y^2}{S_y^2}$ such that $s_x^2 = S_x^2(1+e_1)$ and $s_x^2 = S_x^2(1+e_1)$,

$E(e_0) = E(e_1) = 0$,

Bias and MSE of $\hat{t}_n$

Expressing (30) in terms of sampling errors, we have

$$\hat{t}_n = 2^{-1}(1+z)S_y^2(1+e_0)\left(\frac{S_x^2+(TM+Q_r)}{S_x^2(1+e_1)+(TM+Q_r)}\right) \quad (31)$$

$$\hat{t}_n = 2^{-1}(1+z)S_y^2(1+e_0)\left(\frac{S_x^2+(TM+Q_r)}{S_x^2+(TM+Q_r)+S_x^2e_1}\right) \quad (32)$$

$$\hat{t}_n = 2^{-1}(1+z)S_y^2(1+e_0)(1+\phi e_1)^{-1} \quad (33)$$

Where, $\phi = \dfrac{S_x^2}{S_x^2+(TM+Q_r)}$,

By simplifying (33) up to first-order approximation, we have

$$\hat{t}_n = 2^{-1}(1+z)S_y^2(1+e_0)(1-\phi e_1+\phi^2 e_1^2) \quad (34)$$

By expanding, simplifying, and subtracting S_y^2 from both sides of (34), we have

$$\hat{t}_n - S_y^2 = S_y^2\left((1+z)\left(\frac{1+e_0-\phi e_1+\phi^2 e_1^2-\phi e_0 e_1}{2}\right)-1\right) \quad (35)$$

Taking the expectation of both sides of (35), gives the bias of the estimator t as

$$E(\hat{t}_n - S_y^2) = S_y^2 E\left((1+z)\left(\frac{1+e_0-\phi e_1+\phi^2 e_1^2-\phi e_0 e_1}{2}\right)-1\right) \quad (36)$$

$$Bias(\hat{t}_n) = S_y^2\left(2^{-1}(1+z)\left[1+\gamma\left(\phi^2(\lambda 04-1)-\phi(\lambda_{22}-1)\right)\right]-1\right) \quad (37)$$

By squaring both sides of (35) and taking expectations, we obtain the MSE of $\hat{t}_n$ as

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$$MSE\left(\hat{t}_n\right)=S_y^4\left(\begin{array}{l}1+(1+z)^2\left(\dfrac{1+\gamma\left[\left(\lambda_{40}-1\right)+3\phi^2\left(\lambda_{04}-1\right)-4\phi\left(\lambda_{22}-1\right)\right]}{4}\right)\\-(1+z)\left[1+\gamma\left(\phi^2\left(\lambda_{04}-1\right)-\phi\left(\lambda_{22}-1\right)\right)\right]\end{array}\right) \quad (38)$$

By differentiating (38) with respect to z and equate to zero, solving for z , we obtain

$$z==\frac{2A}{B}-1, \quad (39)$$

where,

$A=1+\gamma\left[\phi^2\left(\lambda_{04}-1\right)-\phi\left(\lambda_{22}-1\right)\right]$ and $B=1+\gamma\left[\left(\lambda_{40}-1\right)+3\phi^2\left(\lambda_{04}-1\right)-4\phi\left(\lambda_{22}-1\right)\right]$.

By substituting (39) into (38) to obtain the minimum MSE of the estimator $\hat{t}_n$ as

$$MSE\left(\hat{t}_n\right)_{\min}=S_y^2\left(1-\frac{A^2}{B}\right) \quad (40)$$

DATA ANALYSIS AND RESULTS

Results

Table 1: Mean Square Errors (MSEs) and Percentage Relative Efficiencies (PREs) of Proposed Estimator and Existing Estimators Considering Population 1 and 2.

Estimators	**Population 1**		**Population 2**	
	MSE	*PRE*	*MSE*	*MSE*
Sample mean	5393.89	100	1313625.22	100
Isaki (1983)	2943.71	183.23	924946.48	142.02
Upadhyaya and Singh (1991)	2743.65	196.60	924321.91	142.12
Kadilar and Cingi (2006)	2887.46	186.80	924875.96	142.03
Kadilar and Cingi (2006)	2923.76	184.48	924936.54	142.02
Kadilar and Cingi (2006)	2685.47	200.85	924172.58	142.14
Subramani and Kumarapandiyan (2012)	2610.26	206.64	917976.12	143.10

Subramani and Kumarapandiyan (2012)	2181.58	247.25	905689.90	145.04
Subramani and Kumarapandiyan (2012)	2323.67	232.13	912437.82	143.97
Subramani and Kumarapandiyan (2012)	2570.24	209.86	918641.42	142.99
Subramani and Kumarapandiyan (2012)	2349.85	229.54	911783.22	144.07
Khan and Shabbir (2013)	2158.92	249.84	898795.40	146.97
Maqbool and Javaid (2017)	2093.98	257.59	909337.98	144.46
Yadav et al. (2017)	2083.15	258.93	900972.54	145.80
Proposed Estimator	**2051.19**	**262.96**	**887158.39**	**148.07**

Efficiency Comparisons

The proposed estimator $\hat{t}_n$ is more efficient than the existing estimators if the following conditions are satisfied

$MSE\left(\hat{t}_n\right)_{\min} < Var\left(t_0\right)$, if

$$\gamma^{-1}\left(1-\frac{A_i^2}{B_i}\right) < \left(\beta_{2(y)}-1\right) \quad (41)$$

$MSE\left(\hat{t}_n\right)_{\min} < MSE\left(t_R\right)$, if

$$\gamma^{-1}\left(1-\frac{A}{B}\right)-\left(\lambda_{40}-1\right) < \left(\left(\lambda_{04}-1\right)-2\left(\lambda_{22}-1\right)\right) \quad (42)$$

$MSE\left(\hat{t}_n\right)_{\min} < MSE\left(t_i\right), i = 2,3,.......,12$, if

$$\gamma^{-1}\left(1-\frac{A^2}{B}\right)-\left(\lambda_{40}-1\right) < R_i\left(R_i\left(\lambda_{04}-1\right)-2\left(\lambda_{22}-1\right)\right) \quad (43)$$

Analysis

Table 1 shows the numerical results of the proposed estimator and other existing estimators considered in the study, the proposed estimator has minimum MSE and maximum PRE by using the population data of Murthy (1967) and Singh & Chaudhary (1986). This implies that the proposed estimator has a high level of efficiency over others and can produce a better estimate of the population variance of the study variable.

CONCLUSION AND RECOMMENDATIONS

Conclusion

From the results of the empirical study, it was observed that the proposed estimator is more efficient than other estimators considered in the study, and therefore, it is recommended for use for estimating population variance when there is available information on the tri-mean and interquartile range of population auxiliary variable X.

Recommendation

The proposed estimator $\hat{t}_n$ is recommended for use in a tri-mean and interquartile range of X for estimating population variance.

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REFERENCES

[1] Isaki, C.T. (1983). Variance estimation using auxiliary information. *Journal of American Statistical Association*, 78: 117-123.

[2] Kadilar, C., & Cingi, H. (2006). Improvement in variance estimation using auxiliary information. Hacettepe *Journal of Mathematics and Statistics*, 35: 111-115.

[3] Khan, M., & Shabbir, J. (2013). A ratio Type Estimator for the Estimation of Population Variance using Quartiles of an Auxiliary Variable. *Journal of Statistics Application & probability*, 2(3): 319-325.

[4] Maqbool, S., and Javaid, S. (2017). Variance estimation using linear combination of tri-mean and quartile average, *American Journal of Biological and Environmental Statistics*, 3(1): 5-9.

[5] Murthy, M.N. (1967). Sampling Theory and Methods, *Statistical publishing Society Calcutta, India*.

[6] Singh, D., and Chaudhary, F.S. (1986). Theory and analysis of Sample survey designs, *New Age International publisher* New Delhi.

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[7] Subramani, J., and Kumarapandiyan, G. (2012). Variance estimation using quartiles and their functions of an auxiliary variable. International *Journal of Statistics and Applications*, 2: 67-72.

[8] Upadhyaya, L.N., and Singh, H.P. (1999). Use of auxiliary information in the estimation of population variance. *Mathematical forum*, 4: 33–36.

[9] Yadav, S.K., Mishra, S.S., Kumar, S. and Kadilar, C. (2016). A new improved class of estimators for the population variance *Journal of Statistics Application and Probability*, 5(3): 385–392.

[10] Yadav, S.K., Mishra, S.S. and Shukla, A.K. (2016). Use of correlation coefficient and Quartiles of Auxiliary Variable for Improved Estimation of Population Variance, *American Journal of Operational Research*, 6(2): 33–39.

[11] Yadav, S.K., Mishra, S., Mishram, S.S. and Khanal, S.P. (2017). Variance estimator using tri-mean and interquartile range of auxiliary variable. *Nepalese Journal of statistics*, 1: 83-91.

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LIST OF JOURNAL PUBLICATIONS

1. **Awwal Adejumobi**, Mojeed Abiodun Yunusa, Ahmed Audu (2022). Improved Modified classes of Regression Type Estimators of Finite Population Mean in the Presence of Auxiliary Attribute. *Oriental Journal of Physical Sciences*, 7(1): 41-47. https://dx.doi.org/10.13005/OJPS07.01.07
2. **Adejumobi, A.,** Audu, A., Yunusa, M. A. and Singh, R. V. K. (2022). On the Efficiency of Modified Generalized Imputation Scheme for Estimating Population Mean with Known Auxiliary Information. *Bayero Journal of Pure and Applied Sciences*, 15(1): 105-113. DOI: https://dx.doi.org/10.4314/bajopas.v15i1.14

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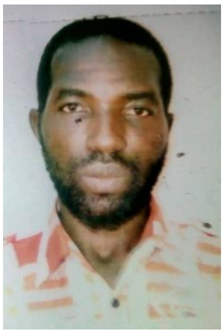

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LIST OF PUBLICATIONS
1. J. O. Muili, E. N. Agwamba, Y. A. Erinola, **M. A. Yunusa**, A. Audu and M. A. Hamzat (2020): Modified Ratio-cum-product Estimators of Finite Population Variance. International Journal of Advances in Engineering and Management, 2(4), 309-319. **DOI**: 10.35629/5252-0204309319
2. J. O. Muili1, E. N. Agwamba, Y. A. Erinola, **M. A. Yunusa**, A. Audu and M. A. Hamzat (2020): A Family of Ratio-Type Estimators of Population Mean using Two Auxiliary Variables. Asian Journal of Research in Computer Science. **DOI**: 10.9734/AJRCOS/2020/v6i130152
3. Awwal Adejumobi, **Mojeed Abiodun Yunusa** and Ahmed Audu (2022). Improved modified classes of regression type estimators of finite population mean in the presence of auxiliary attribute. *Oriental Journal of Physical Sciences*, 7(1): 41-47. **DOI:** https://dx.doi.org/10.13005/OJPS07.01.07
4. Adejumobi, A., Audu, A., **Yunusa, M. A.** and Singh, R.V.K. (2022). Efficiency of modified generalized imputation scheme for estimating population mean with known auxiliary information. *Bayero Journal of Pure and Applied Sciences*, 15(1): 105-113. **DOI:** https://dx.doi.org/10.4314/bajopas.v15i1.14

Adejumobi Awwal and **Mojeed A. Yunusa,** (2022, September). Some Improved Class of Ratio Estimators for Finite Population Variance with the Use of Known Parameters, *LC International Journal of Stem*, 3(3), 2708-7123. **DOI:** 10.5281/zenodo.7271392.