# Pearson correlation coefficient between article processing charges and journal indicators for gold open access articles by Indian authors: a statistical analysis

Gulam Jilani[1] and Swapna Banerjee[2]
jilanilibrarian@gmail.com ORCID: 0000-0003-2226-638X
sbanerjee63@yahoo.co.in ORCID: 0000-0001-7043-9658

*Many Indian authors publish their research in open access journals through the gold access route and paying the Article Processing Charge (APC) to the publishers. In view of this, there can be the Pearson correlation coefficient between APCS and journal indicators. This study evaluates the Pearson correlations of APC with journal indicators for gold open access (OA) articles published by Indian authors. Furthermore, the relationship between APCs and CiteScore, SNIP, and SJR is established through the statistical description. The study followed the quantitative and qualitative methodology. Data were extracted from Scopus about the CiteScore, SNIP, SJR, citations, and the APCs charges were obtained from the journal's websites. The final obtained data of 22308 gold OA articles published in the total 1946 OA journals indexed in Scopus were included in the study. Its CiteScore, SNIP, and SJR were obtained from the Scopus citation database to study the relationship between the APCs and indicators. The data were analyzed using SPSS and MS Excel to find the Pearson correlations of APCs with the journal's indicators. The mean (average) and median of APCs for gold OA articles are USD 1682.63 and USD 1029.604, respectively. The study revealed that 'Health Sciences' contributed the highest number of articles and spent the highest amount of APCs, followed by 'Physical Science.' Pearson correlation coefficient recorded a negative correlation for APC to the number of articles and positive and statistically highly significant correlation of APCs with citations, CiteScore, SNIP, and SJR. In contrast, the correlation of CiteScore with SNIP and SJR has a very high positive correlation as ($r = 0.785$, $p < 0.001$) and ($r = 0.827$, $p < 0.001$), respectively. The limitation of the study is actual APC paid by Indian authors to the OA journals, which is not available. Only APCs mentioned on the journal's website are a source of information. The correlation between APCs and SJR is a positive and highly significant relationship, and the relationship of SJR with CiteScore and SNIP is also highly positive.*

**Keywords:** Article Processing Charge, Gold Open Access, Open Access, CiteScore, SNIP, SJR, India, Pearson Correlation, Journal Indicators

## 1 Introduction

The Indian authors publish the gold OA articles in the OA journals of various publishers that charge APC. The huge amount of APCs is spent on research publications in OA journals, impacting the research project due to a lack of research funding. Sometimes it becomes a hindrance and confines the authors rather than gold OA because of limited funds and rare funding assistance for publishing charges. Researchers and government funding agencies carry out research in various subjects and provide funds for research. In this case, policymakers must know which topics have more research and publish gold OA articles by paying the APCs. The authors linked to well-funded agencies / institutions are able to afford APCs, mostly in the developed countries leading to skewing knowledge dissemination. The study can play a vital role to the Indian authors and researchers elsewhere as they need to be aware about the relationship between APCs and journal indicator for robust decision-making while submitting the research works in gold open access journals. This is also the case in countries like South Africa as it is involved in transformative agreements with publishers for researchers to publish gold OA.

CiteScore is a measurement indicator and product of the Scopus citation database that discusses the average citations of received citations in three years and mentions the results straightforwardly without hiding any details and algorithms. This presents the accurate indicators of a journal's impact on an annual basis. Like any metric such as the JIF, CiteScore has some academic interest and value. It is certainly interesting to know how a journal is performing relative to another journal within a field of study and how its citations are evolving over time (Teixeira da Silva 2020). The CiteScore includes

1. Gulam Jilani is Assistant Librarian at Indian Maritime University, India
2. Swapna Banerjee is Professor in the Department of Library and Information Science at University of Calcutta

other indicators like SNIP (Source Normalized Impact per Paper), SJR (SCImago Journal Rank), citation and document count, and percentage cited.

Researchers would prefer to disseminate the research to a broad audience and seek more citations to increase the research's credibility. In this case, Indian authors need to select the journals for publishing their research papers after minutely analysis of their CiteScore, Sources Normalized Impact per Paper (SNIP), SCImago Journal Rank (SJR), Impact Factors (IF), etc. While the Indian authors publish their papers in the OA journals by paying APCs, journal indicators can be useful to find quality journals. Walters (2017)  suggested that authors consider a broad range of factors when deciding where to submit their work. Colledge, James, Azoulay et al. (2017) stated that CiteScore could be used to evaluate the citation impact of titles within the same subject field. CiteScore Percentile can be suitable for comparing the citation impact of titles in different areas. CiteScore is a result of the journal's citation process and has become a journal's-based metric that can be used as a quality indicator cautiously in the selection of journals for submitting the papers as higher CiteScore indicates a superior journal (Teixeira da Silva 2020). Other research revealed no link between these expenses and the journal's performance as measured by numerous metrics. Therefore, when submitting publications to OA or hybrid journals, researchers and institutions with limited financing should take these findings into account (Minta, Vacek & Kaliaperumal 2023).

We are not aware of any study conducted regarding the relationship between APCs and journal articles published as gold OA by Indian authors. However, many publications are available revealing APCs as a hindrance to OA publishing and funding agencies mandated to publish funded research publications through the green OA model. Authors pay a huge amount as fees for a publication that demands to analyze the cites core, impact factors, SJR, and SNIP to judge the quality of the journals and whether it is beneficial for them to pay such a huge amount. In lower and middle-income countries like India, the publication cost has been a major issue because of the fund crisis and the study's need to conclude about the correlation of the APCs with Journals Indicators.

The publishers levy APCs to publish the articles in the OA journals. Some journals charge APCs for some articles in the journals, which are called Hybrid OA, which may also be gold OA in its nature. In contrast, some journals charge APC for publishing as gold OA to make immediately available without any financial, legal, or copyright issues. In such a way, APCs become a significant issue while selecting journals for publishing gold OA articles. SNIP measures the contextual citation impact by weighting citations based on the total number of citations within a subject field, enabling direct comparison of journals in different subject areas. The SNIP enables a direct comparison of journals in different subject fields and helps authors to identify which journals are performing best within their subject field, thereby helping them to decide where to publish.

SCImago works as a platform for indicators developed by SCImago from the widely known algorithm Google Page - Rank. This indicator shows the visibility of journals in the Scopus citation database from 1996. The indicator can be used to assess and analyze scientific domains that compare the Journals and can be analyzed separately and grouped by subject area, category, or country - (http://www.scimagojr.com).

## 2 Purpose and objectives of the study

This study evaluates the Pearson correlations of APC with journal indicators for gold OA articles published by Indian authors, with the view to establish the relationship between APCs and CiteScore, SNIP, and SJR through the statistical description. The specific objectives are to:

- analyze the co-relationship between APCs with articles publishing and citations
- investigate the co-relationship between APCs and CiteScore, SNIP, and SJR
- analyze the Subject-wise average expenditure of APCs for gold OA of Indian authors

## 3 Review of the literature

Many studies were reviewed to extract the views about the APC, SNIP, and SJR. Brown and Gutman (2018) found that CiteScore, SNIP, and SJR scores are significantly correlated and that a variety of available bibliometric measures could be used to yield a more comprehensive assessment of journals and article ranking than only impact factors (IF). Björk and Solomon (2015) surveyed APC of OA journals indexed in Scopus and revealed a moderate (0.40) correlation between APC and SNIP by measuring citation rates. Regarding article volumes, there were significantly higher correlations (0.67) between price and quality. The relation sensitized the authors for the relationship between price and quality when they chose the article publishing in OA journals. The journal with better quality to APCs ratio brings higher publications volume. Health science is a major category in the core subjects that attracts the highest OA articles in cardiology and cardiac surgery publishing OA articles with substantial APCs (Vervoort, Luc, Sá & Etchill 2021). Borrego (2023) found two major concerns

in relation to APCs; the inability of poorly funded authors to publish their results and their potential negative impact on the quality of journals.

Fernandez-Llimos (2018) found differences between the CiteScore and Journal Impact Factors for pharmacy journals that remain in the third and fourth quartile in journals impact factors distribution while Citescore exists with true quartile distribution. Falagas, Kouranos, Arencibia-Jorge et al. (2008) stated that SJR indicator is a novel instrument for evaluation for scientific journals and emerging as a challenge for the established premiership of Journal Impact Factors. Okagbue, Bishop and Oguntunde et al. (2019) found modified CiteScore 1.938 was able to reduce the effect of self - citation and that can be applied in impact determination, the ranking of authors, their institutions, and the evaluation of scientists for a grant award; and also report the effect Self - Citation on CiteScore.

Pearce (2022) states that it is unfortunate, OA journals with low APCs have no high impact factors equal to CiteScore, reducing the chance of selecting OA journals. Budzinski, Grebel, Wolling and Zhang (2020) revealed the imbalance between drivers of APCs and did not reflect researchers' institution and relations between publishers and researchers in successfully disseminating scientific insights in reputed journals. Maddi and Sapinho (2022) demonstrated in their study that high APCs do not always increase the impact of publications; it was also discovered that the correlation between APCs and impact is moderate, indicating that health science is the most significant contributor to gold OA articles. Yuen, Muquit and Whitfield (2019) investigated Correlation analysis between APCs and SJR and found the Pearson Correlation Coefficient ($r = 0.332$) and the associated p-value is $<0.015$. The p-value is less than 0.05, indicating a highly significant relationship. Ahmad, Abdel-Magid and Hussain (2017) found a Pearson correlation between JIF and SJR for ranking of Environmental engineering journals positive and statistically highly correlation coefficient ($r = 0.853$, $p < 0.001$) as evidence.

Jamorabo, Koulouris, Briggs, et al. (2021) SJR was calculated as 1.82 vs. 0.83, p 0.001 for US/UK journals were higher than non-US/UK journals, and it was discovered that 21.6% of US/UK journals and 32.6% of non-US/UK journals had mandatory processing and publication fees. This led researchers to draw the conclusion that publication fees prevent authors from smaller or socioeconomically disadvantaged institutions and countries from publishing and disseminating their work in open access journals. Maddi and Sapinho (2022) found that the most expensive publishers are not always the ones with the greatest influence, and vice versa for publishers with the highest APCs. Finally, the correlation between APCs and impact is moderate. SJR highlights various scholarly publishing facets that may be influenced by marketing tactics supported by the largest commercial publishers (Ruggiero 2023).

## 4 Research methodology

The study was conducted on the extracted data from the Scopus citation database on 12th August 2022. The same data had been used in another study for different objectives; however, the present study is conducted for different objectives and hypotheses. The search results were limited to only the publication year of 2021 by using the search strategy "AFFILCOUNTRY (India) AND PUBYEAR = 2021 AND ( LIMIT-TO ( OA, "publisher full gold" ) ) AND ( LIMIT-TO ( DOCTYPE, "ar" ) ) AND ( LIMIT-TO ( SRCTYPE, "j" ) ) AND ( LIMIT-TO ( PUBSTAGE, "final" ) ) AND ( LIMIT-TO ( LANGUAGE, "English" ) )" and resulted in 28259 gold OA publications which were refined and deleted the 30 OA publications due to incomplete information and finally got 28229 gold OA publications.

The data about Journals Indicators extracted with the search strategy of basic search resulted in 28229 gold OA articles in 2798 OA journals, including each article having even a single or any number of Indian authors for which the APCs were checked from the websites of the journals. It is found from the scrutinizing of the APCs that 5921 gold OA articles from 852 Journals were published without any APCs and excluded from the study. The remaining data of 22308 gold OA articles published in the total 1946 OA journals indexed in Scopus were included in the study. Its CiteScore, SNIP, and SJR were obtained from the Scopus citation database to study the relationship between the APCs and indicators. The average APCs expenditure for publishing gold OA articles published by Indian authors and the Karl Pearson Correlation Coefficient were also checked through Statistical Package for the Social Sciences (SPSS) to test the hypothesis. The cost expenditure for the subject category is calculated based on mean value as base APCs for single gold OA articles published by Indian authors.

The data were analyzed using the SPSS statistical software and MS Excel to represent tables and figures. The SPSS is used to find the relationship and other statistical measurements as mean (average) and standard deviation (SD) of the APCS, CiteScore, SNIP, and SJR to test the hypothesis and analyze the objectives of the study.

## 6 Data analysis

This section of the study analyses the data collected.

## 6.1 Statistical analysis: descriptive statistics of all variables

Descriptive statistics were used to summarize the data for means, standard deviation, skewness, and kurtosis using the SPSS and to analyze Pearson's Correlation Coefficient between APCs and Journals Indicators. The significance and level of relations were investigated. Table-1 shows the descriptive statistics of the variables included in the study and shows that the mean statistics of the APCs for gold OA articles published by the Indian authors is USD 1682.63 and indicates the average value of the number of articles, citations, CiteScores, SNIP and SJR.

**Table 1: Descriptive statistics**

| Variables | N Statistic | Min. Stats. | Max. Stats. | Mean Stats. | Std. Deviation Stats. | Skewness | | Kurtosis | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Stats. | Std. Error | Stats. | Std. Error |
| APC Charges | 1946 | 3 | 6000 | 1682.63 | 1029.604 | 0.537 | 0.055 | 0.489 | 0.111 |
| No. of Article | 1946 | 1 | 952 | 11.46 | 37.165 | 12.79 | 0.055 | 252.885 | 0.111 |
| Citation | 1946 | 0 | 3669 | 33.59 | 138.238 | 14.618 | 0.055 | 315.314 | 0.111 |
| CiteScore | 1920 | 0.1 | 60.6 | 4.395 | 3.935 | 3.8 | 0.056 | 32.45 | 0.112 |
| SNIP | 1889 | 0.002 | 11.931 | 1.174 | 0.793 | 4.83 | 0.056 | 47.505 | 0.113 |
| SJR | 1824 | 0.101 | 13.313 | 0.844 | 0.897 | 5.316 | 0.057 | 47.222 | 0.115 |
| Valid N (listwise) | 1809 | | | | | | | | |

## 6.2 Average APC expenditure for published gold OA article in India

The Indian authors affiliated with Indian organizations/institutions have published gold OA articles on various subjects. All the sub-subjects are categorized into the core subjects of 'Health Science,' 'Physical Sciences,' 'Life Sciences,' 'Social Sciences,' and 'Multidisciplinary.' The Table-2 shows that "Health Science" is the highest contributor (43.38%) among all the subjects for gold OA articles, and the average APC expenditure was found to be USD 1,62,84,493.14, followed by "Physical Sciences" with the 2nd highest contribution of 29.61% for gold OA articles. The average APC expenditure for "Physical Sciences" was found to be USD 1,11,12,088.52. Clearly, 'Health Sciences' and 'Physical Sciences' are the major fields of research in India and consume a lot of financial resources in terms of APCs expenditure.

**Table 2: Average APC expenditure for publishing gold OA article in India**

| Ranks | Core Subjects | No. of Articles | % | Average APC Expenditure |
|---|---|---|---|---|
| 1 | Health Science | 9678 | 43.38 | 16284493.14 |
| 2 | Physical Sciences | 6604 | 29.61 | 11112088.52 |
| 3 | Life Science | 3939 | 17.66 | 6627879.57 |
| 4 | Social Sciences | 1834 | 8.23 | 3085943.42 |
| 5 | Multidisciplinary | 253 | 1.14 | 425705.39 |
| | | 22308 | 100 | 37536110.04 |

## 6.3 Gold OA articles of subjects with APC range

Figure 1 shows that authors from Indian authors prefer to publish their gold OA articles in journals that charge the APCs range of USD 2000 - 2500 followed by the APCs range of USD 0000 - 0500. It is found from figure 1 that the majority of the gold OA articles from "health sciences" are published in the APC range of USD 0000–0500 and secondly, in the APC range of USD 2001–2500, whereas physical sciences produce the majority of the gold OA articles in the journals of the APC range of USD 2001–2500 and secondly, in the journals of the APC range of USD 1501–2000. However, the figure indicates that the majority of the gold OA articles of all the subjects are published in journals of the APCs range of USD 0000 - 3000; and shows that authors rarely prefer to publish their research as gold OA beyond the APCs of USD 3000.
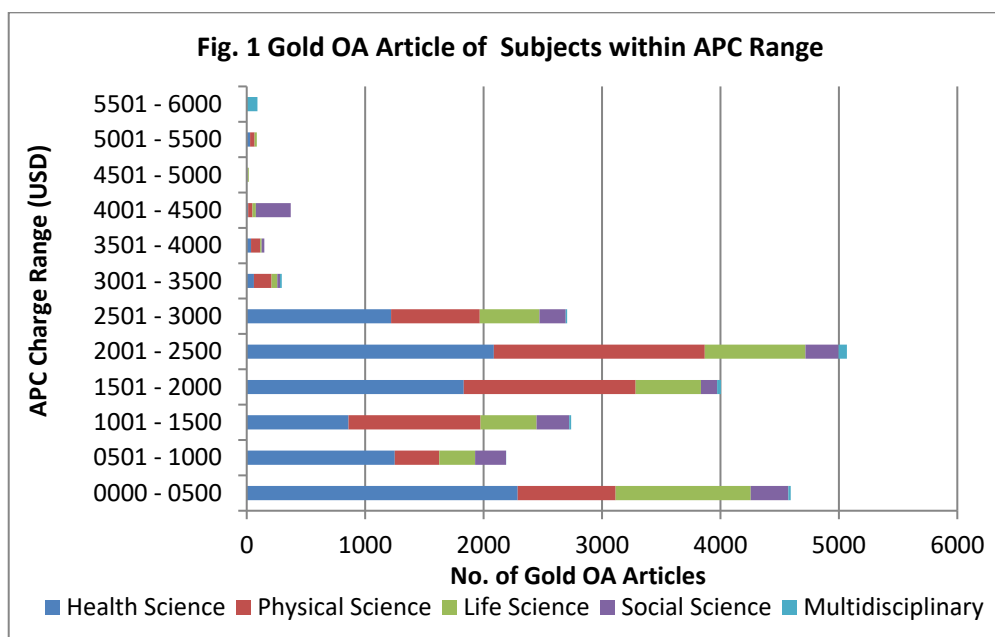
**Figure 1: Gold OA article of subject within APC range**

## 6.4 Pearson correlation coefficient of APCs with journals indicators

### The problem:
This is to investigate the relationship between APCs and Journals Indicators like the number of gold OA articles, received citations, CiteScore, SNIP, and SJR.

### Hypothesis:
H1: There is positive and highly significant relationship between APCs and no. of articles
H2: There is positive and highly significant relationship between APCs and Citation
H3: There is positive and highly significant relationship between APCs and CiteScore
H4: There is positive and highly significant relationship between APCs and SNIP
H5: There is positive and highly significant relationship between APCs and SJR

### Reporting Pearson Correlation:
The testing of the hypothesis is interpreted for the relationship between APCs and each of the variables (number of articles, citations, CiteScore, SNIP and SJR) based on the available Pearson Correlation Coefficient and significance level from Table-3.

The Pearson correlation coefficient between APCs and the number of articles published by Indian authors is -0.011 and the associated p-value is 0.638. Since the p-value of the test (0.638) is greater than 0.05, the relationship is not statistically significant. Therefore, it rejects the null hypothesis H1, as there is no evidence of a significant relationship between APCs and the number of articles. The variable APCs and the number of articles published by Indian authors were negatively and non-significantly correlated (r = -0.011, N = 1946, p > 0.001).

The Pearson correlation coefficient between APCs and citations is 0.085 and the associated p-value is <0.001. The p-value of the test is less than 0.01, indicating a statistically highly significant relationship. Therefore, it supports the hypothesis H2, suggesting there is a positive and statistically highly significant relationship between APCs and number of citations after assessment of sufficient evidence (r = 0.085, p < 0.001).

The Pearson Correlation coefficient between APCs and CiteScore is 0.478 and associated p-value is <0.001. The p-value of the test is less than 0.01, indicating a statistically highly significant relationship. Therefore, it supports the hypothesis H3, suggesting there is a positive and statistically highly significant relationship between APCs and CiteScore after assessment of sufficient evidence (r = 0.478, p < 0.001).

The Pearson Correlation coefficient between APCs and SNIP is 0.411 and the associated p-value is <0.001. The p-value is less than 0.01, indicating a statistically highly significant relationship. Therefore, it supports hypothesis H4, and

suggests a positive and highly significant relationship between APCs and SNIP after assessment of sufficient evidence (r = 0.411, p < 0.001).

The Pearson correlation coefficient between APCs and SJR is 0.536 and the associated p-value of the test is <0.001. The p-value is less than 0.01, indicating a highly significant relationship. Therefore, it supports the hypothesis H5 and suggesting a positive and statistically highly significant relationship between APCs and SJR after assessment of sufficient evidence (r = 0.536, p < 0.001)

In summary, based on the available correlation coefficient and significance level, it finds support for hypothesis H2, H3, H4, and H5, indicating that there are positive and statistically highly significant relationship between APCs and the number of citations, CiteScore, SNIP and SJR. However, there is no support for hypothesis H1, as there is no significant relationship between APCs and the number of articles.

**Table 3: Pearson correlations coefficient**

| Variables | Relations | APC Charges | No. of Article | Citation | CiteScore | SNIP | SJR |
|---|---|---|---|---|---|---|---|
| APC Charges | Pearson Correlation | 1 | -0.011 | .085** | .478** | .411** | .536** |
| | Sig. (2-tailed) | | 0.638 | <.001 | <.001 | <.001 | <.001 |
| | N | 1946 | 1946 | 1946 | 1920 | 1889 | 1824 |
| No. of Article | Pearson Correlation | -0.011 | 1 | .878** | 0.003 | -0.018 | -0.021 |
| | Sig. (2-tailed) | 0.638 | | <.001 | 0.894 | 0.442 | 0.362 |
| | N | 1946 | 1946 | 1946 | 1920 | 1889 | 1824 |
| Citation | Pearson Correlation | .085** | .878** | 1 | .124** | .096** | .080** |
| | Sig. (2-tailed) | <.001 | <.001 | | <.001 | <.001 | <.001 |
| | N | 1946 | 1946 | 1946 | 1920 | 1889 | 1824 |
| CiteScore | Pearson Correlation | .478** | 0.003 | .124** | 1 | .784** | .827** |
| | Sig. (2-tailed) | <.001 | 0.894 | <.001 | | <.001 | <.001 |
| | N | 1920 | 1920 | 1920 | 1920 | 1884 | 1820 |
| SNIP | Pearson Correlation | .411** | -0.018 | .096** | .784** | 1 | .790** |
| | Sig. (2-tailed) | <.001 | 0.442 | <.001 | <.001 | | <.001 |
| | N | 1889 | 1889 | 1889 | 1884 | 1889 | 1812 |
| SJR | Pearson Correlation | .536** | -0.021 | .080** | .827** | .790** | 1 |
| | Sig. (2-tailed) | <.001 | 0.362 | <.001 | <.001 | <.001 | |
| | N | 1824 | 1824 | 1824 | 1820 | 1812 | 1824 |
| **. Correlation is significant at the 0.01 level (2-tailed). | | | | | | | |

Table 4 shows correlations of a variable APC charge with different variables and depicts the lower and upper Confidence Intervals, and gives status with a 95 percent confidence interval; there is only a 5% chance of being wrong. There is a 95% chance that the confidence interval of [-0.055, 0.034] contains the true population correlation coefficient between APCs and the number of articles for gold OA of Indian authors.

In terms of the relationship of APCs with CiteScore, SNIP, and SJR, a 95% Confidence Interval of the mean [0.0443, 0.512], [0.373, 0.447] and [0.503, 0.568] for CiteScore, SNIP and SJR respectively show an actual population correlation coefficient of APCs with CiteScore, SNIP, and SJR. Each index does not contain a null hypothesis value indicating results are statistically significant. If those intervals overlap, they conclude that the difference between groups is not statistically significant. If there is no overlap, the difference is substantial. The correlation between SJR and APC charges is moderately high positive and 95% confidence interval of the mean [0.503, 0.568] with an actual population correlation coefficient. In contrast, the relationship of SJR with CiteScore and SNIP is very positive at 0.827 and 0.79, and at 95% confidence intervals of the mean [0.812, 0.841] and [0.772, 0.807], respectively, that shows statistically significant.

Fisher's r-to-z transformation may be used to find the confidence intervals for both r and differences between correlations and most probably are used to test the significance of the difference between two correlation coefficients, $r_1$,

and $r_2$, from independent samples. If $r_1$ is larger than $r_2$, the z-value will be positive; if $r_1$ is smaller than $r_2$, the z-value will be negative.

## 6.5 APC range category relations with the subject category

Figures 2 and 3 for the APC range categories and subject categories show the relations through Histograms with the journal's frequency. Figure 2 indicates that most journals of 'Health Sciences' and 'Physical Sciences' charge the APC range of USD 1501 -2000. Similarly, Figure 3 depicts that 'Health Sciences' and 'Physical Sciences' are the major subjects that disseminate most research work through journals with the APC range category 1 – 12. It indicates the preference of the journals by the authors to publish their gold OA articles by paying the APCs between USD 0000 - 3000, which is affordable for them. The authors select journals with low to medium APCs for publishing their gold OA articles. It is also seen in Figures 2 & 3 that medium APC charges (0000 - 2500 USD) range are selected for publishing articles which average (means) the value of APCs is 1682.63 USD.
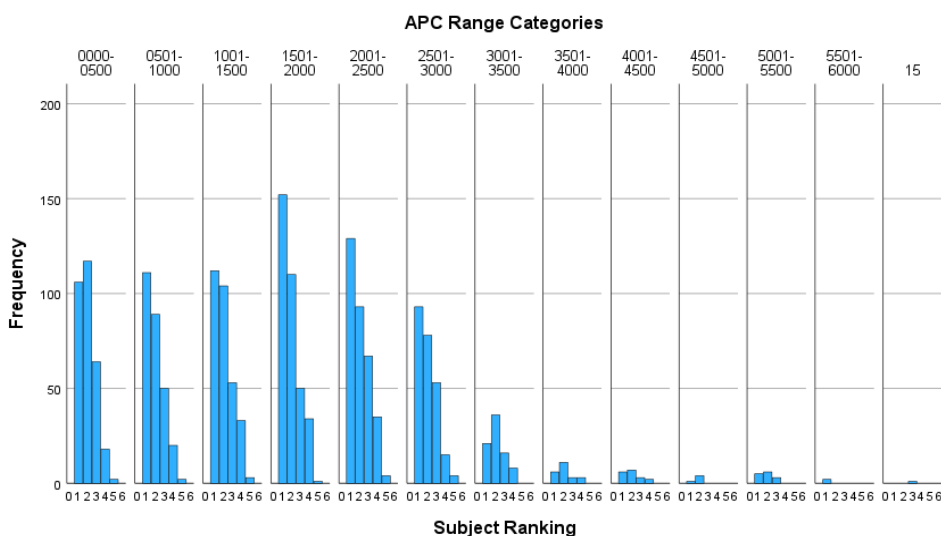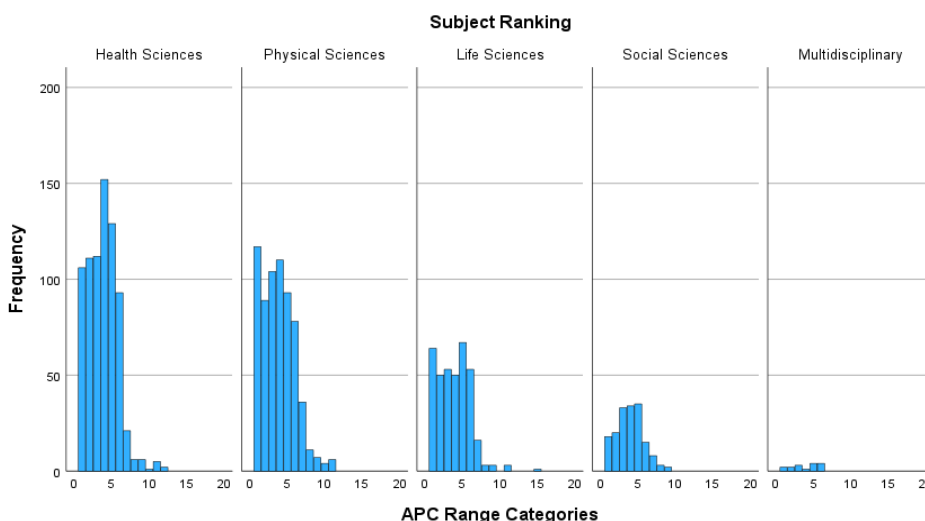


**Figure 2: APC range categories**



**Figure 3: Subject ranking**

## 7 Discussions

The study was conducted to analyze the relationships between Journals Indicators and average APC expenditure by subject categories for the published gold OA articles by Indian authors. The descriptive statistics of the journals indicators obtained as average (mean) APC is USD 1682.63, and the standard deviation is USD 1029.604 for article publishing with 0.537 skewness statistics and 0.489 kurtosis statistics. According to Pinfield and Middleton (2016), the mean APC paid by UK authors for 2007–2008 and 2013–2014 were USD 1853 and USD 2259, respectively, showing an increase in APCs, which

is higher than the average mean APC paid by Indian authors, and they prefer to publish their research publications as gold open access in journals that charge low or moderate APCs and rarely prefer the higher APCs; the authors conclude that high fees are also a problem because of low per capita income and institutions. Other study also indicating that writers choose to publish in more expensive journals, the global average APC per journal climbed somewhat, from 906 USD to 958 USD, while the average APC per article increased, from 904 USD to 1,626 USD ( Morrison, Luan and Zhao, *et al.* 2021).

From the study, it is obtained that 'Health Sciences' is the top core subject that produced the highest number of gold OA articles, followed by 'Physical Science,' which shows that Indian authors engage themselves in Medicine and Physical Sciences with high production of research. Asai (2020) revealed in his study that the 'Health Science' journals of BMC (BioMed Central) series reduce their APCs; publishers can earn a large amount of APCs revenue by publishing many articles, indicating the maximum research in medicine. Pinfield and Middleton (2016) revealed in their study regarding gold OA published by the UK that Health and Life Sciences utilized more funds as APCs than other subjects, and adoption of OA is mounting in the UK.

The relationship between APCs and the citations received is positive and highly significant correlations ($r = 0.085$, $p < 0.001$). Regarding the subject category, the relationship of APCs with SNIP and SJR are moderately high positive relations that show a high ranking of the journals moderately affects the fixation of APCs and the impact of the research moderately affects the APC charges. However, there are highly positive correlations of CiteScore with SNIP, and SJR is 0.784, 0.827, and the relationship is statistically significant as $p < 0.001$. Similarly, Yuen, Muquit and Whitfield (2019) investigated the impact factor, SJR, and article influence score and found very strong correlations with each other (Pearson coefficient > 0.90) and also stated that the APCs in OA journals have almost no correlation to their impact; in this case, authors and funders should consider the ranking of journals very carefully while submitting their research. Rather than the CiteScore of Scopus, in a web of science, both JCR (Journal Citation Report) and SJR are completely transparent regarding the sources they include, and JCR's impact factor and SJR are highly correlated with the GSM H-index (Delgado-López-Cózar and Cabezas-Clavijo, 2013). Okagbue and Teixeira da Silva (2020) investigated the Spearman's rank coefficient for correlation between CiteScore and APCs for the 107 journals indexed in Scopus was $r = 0.64$, $p < 0.0001$ that, showing moderately high positive correlations.

The relationship between APCs and CiteScore is found positive and statistically highly significant ($r = 0.478$, $p < 0.001$). However, it was investigated in another study and found that the relationship between APCs and CiteScore is a mild positive correlation between journal CiteScore and OA fees ($r = 0.297$, $P = 0.045$). It indicates that there is no very high positive correlation between APCs and the journal's CiteScore (Vacek and Kaliaperumal, 2022). It was also found that rather than impact factor or CiteScore, the journal's performance and article's performance have equal value and give the most legitimate approach to assess the influence and importance of an acceptable research issue. It should not only rely on a sound journal in its respective disciplines (Roldan-Valadez, Yoselin Salazar-Ruiz and Ibarra *et al.* 2019). Okagbue and Teixeira da Silva (2020) analyzed the nexus between APCs and coverage by indexing services (the CiteScore or IF) was determined only for a single OA publisher. However, it would be interesting to determine if similar associations exist for other stand-alone OA mega journals or OA publishers. Björk and Solomon (2015) stated that the APC of OA journals indexed in Scopus has a moderate (0.40) correlation between APC and SNIP by measuring citation rates. Regarding article volumes, there were highly significant correlations (0.67) between price and quality. The relation sensitized the authors for the relationship between price and quality when they chose the article publishing in OA journals.

The histogram through Fig 2 and Fig 3 depicted that 'Health Sciences' and 'Physical Sciences' are the major subjects that have the highest frequencies among all the subjects as 'Health Sciences' and 'Physical Sciences' contribute the majority of the articles published in the journals that levied the APCs range between USD 0000 – 3000. Similarly, another study indicated that 'Health sciences' is a major subject category that contributes the highest gold OA articles, as seen in the cardiology and cardiac surgery publishing OA articles with substantial APCs   (Vervoort, Luc, Sá & Etchill, 2021; Maddi & Sapinho 2022)

## 8 Limitations of the study

This study has limitations to the gold OA publications published by Indian authors during 2021 to investigate the relationship and subject-wise expenditure of APCs for all gold OA articles. The data about the APCs were obtained from the OA journal's websites only, and there is no other source of data for APCs expenditure incurred for the gold OA articles published by Indian authors. In this case, the study is only based on the APCs mentioned on websites and can be assumed by calculating the available data on journal websites. This is a general study of all the gold OA articles by Indian authors that can be extended to more years. The journal impact factors are based on Web of Science rather than CiteScore from Scopus, and other indicators are used for all OA business models. It can be useful for researchers, scientists, funding agencies, journal

publishers, and policymakers to reach the decision of which factors are more important and how the Indian authors think in the selection of OA journals for gold OA publishing.

## 9 Conclusion

The study was based on an impact evaluation of article processing charges. It also looked at the correlations between APCs and journal indicators like citations, Citescore, SNIP, and SJR. It found that the relationship of APCs with the number of gold OA articles is negative and statistically negligible correlations ($r = -0.011$, $p > 0.001$). However, the Pearson correlation coefficient APCs with the Citations, CiteScore, SNIP, and SJR is positive and statistically highly significant. In contrast, the relationship between CiteScore, SNIP, and SJR is positive and statistically highly significant showing that the increase or decrease in APCs affects the citation benefits and preference of publishing the gold OA articles by the Indian authors. In contrast with Asai's (2020) opinion, the increase in APC revenues by raising APCs is larger than the decrease in APC revenues by reducing APCs, which also increases the economic burden on authors. Researchers found that Indian authors and publishers are only able to afford low or moderate APCs, and that they do not consider CiteScore, Citations, SJR, or SNIP when publishing their research articles in OA journals, as measured by a statistical measurement of the Journals Indicators with low or moderate correlations among APCs and indices.

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