# THE ASSOCIATION BETWEEN ALTMETRIC, PLUMX METRICS AND CITATION COUNT OF PUBLICATIONS: A CROSS-SECTIONAL STUDY AMONG TOP CHILD AND ADOLESCENT PSYCHIATRY JOURNALS

**Sadettin Burak Açıkel[1,*] & Abdulbaki Artık[2]**

[1] *MD, Department of Child and Adolescent Psychiatry, Ankara University Faculty of Medicine, Ankara, TURKEY*
[2] *MD, Department of Child and Adolescent Psychiatry, University of Health Sciences Turkey,*
*Gülhane Training and Research Hospital, Ankara, TURKEY*
*\* Corresponding author*

## Summary

**Background:** *Altmetric Attention Score (AAS) and PlumX Metrics are becoming important to evaluate the impact of the publication in addition to classical scientific rating method such as citation count and impact factor. These metrics collect data about publications' tweet count, Facebook interaction count and other social interactions. In this study, it is aimed to examine the association between AAS, PlumX Metrics and citation count of top child and adolescent psychiatry.*

**Methods:** *We identified the five journals and retrospectively analysed the publications published in 2019. All the original research articles, met analysis, and reviews were analysed. The articles were divided into two groups as original articles/research articles and meta-analysis/systematic review. We have hypothesized that there could be a positive correlation between AAS and PlumX Metrics data and citation count among these journals and there could be a difference between AAS, PlumX scores and citation count between original articles/research articles and meta-analysis/systematic review as their reading potential is different.*

**Results:** *We have found a significant positive correlation between citation count, AAS and PlumX Metrics. This association continued after controlling the journal impact factor. In linear regression analysis, type of publication, total count of tweets, and Mendeley reads predicted the citation count.*

**Conclusion:** *In addition to the classical methods measuring the quality of the articles such as the total citation count and impact factor, the importance of AAS and PlumX Metrics has been increasing. It is important to share scientific publications on these platforms in order to increase the impact of the articles.*

**Keywords:** *internet, Twitter, Altmetrics, Facebook, share*

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## INTRODUCTION

Social media and the Internet have become one of the main communication tools in the 21st century. Extensive use of social media platforms is not only limited to communication. Social media is becoming an increasingly important platform to share articles and data in the scientific field. In the classical scientific rating method, the number of citations of articles and related measures such as author Hirsch index (h-index) and impact factor of journals (IF) have been the most used measure of academic quality. In many countries, these variables are used to determine the quality of publications, funding, and academic promotion (Greenhalgh et al. 2016)

Sharing scientific publications via social media platforms could accelerate the dissemination of scientific knowledge, reaching audiences and discussing the publication (Dol et al. 2019). Therefore, the use of social media has becoming a source to evaluate the impact levels of scientific publications recently (Davidson et al. 2014). Altmetric attention score (AAS) is one of the most used tools to evaluate the popularity of publications in social media (Elmore 2018). AAS is a tool that calculates all the attention a publication gets on social media, news outlets, blogs, policy agreements, citation software (i.e., Mendeley) and Wikipedia. AAS measures the extent of the spread of scientific publications across social media and the community. In addition to AAS, PlumX Metrics is another metric tool that measures the popularity of scientific publications (Plum Analytics 2021). Although there are several methodological limitations of these methods, they are listed as promising methods that might be used more frequently in the future (García-Villar C 2021).

Evaluating publications' AAS and PlumX Metrics has been a popular research issue in recent literature. Several studies have investigated the association between AAS, PlumX Metrics, and scientific publications. These researches suggest that journals with a higher impact factor

were more likely to use a greater number of social media platforms (Mobarak et al. 2021, Wei et al. 2021). In a recent study evaluating top psychiatry journals, a significant correlation has been found between AAS and citation count (Dagar & Falcone 2021). A systematic review conducted about this issue suggests that there is a positive correlation between research studies' social media mentions and increased citation count (Bardus et al. 2020). Moreover, a prospective randomized controlled trial suggest that the tweeted articles received 9.5 times higher citations than non-tweeted articles (Luc et al. 2021). These findings suggest the possible association between AAS, PlumX Metrics, and citation metrics.

Twitter is a social media service where text-based messages are shared and it used by nearly 230 million users, tweeting almost 500 million tweets per day. Twitter has an important impact on AAS and PlumX Metrics. Twitter is also an important social media platform for mental health and psychiatry. Moreover, some studies use Twitter as a screening and early intervention tool for psychiatric disorders (Reece et al. 2017). Based on these data, we could assume that Twitter is a social media platform where psychiatry and mental health data are shared commonly. This common use of Twitter would be an effective method in spreading academic publications (Ozkent et al. 2021), especially for child psychiatry and psychiatry journals.

In this study, it is aimed to examine the association between AAS, PlumX Metrics and citation count of top journals that publish articles about child and adolescent psychiatry area. We have hypothesized that there could be a positive correlation between AAS and PlumX Metrics data and citation count among these journals. Additionally, we have also hypothesized that there could be a difference between AAS, PlumX scores and citation count between original articles/research articles and meta-analysis/systematic review as their reading potential is different. Meta-analysis/systematic reviews could be read and cited more commonly. To our best knowledge, there are no studies investigating this subject among published articles about child and adolescent psychiatry area.

## METHODS

We have identified the five journals with the highest impact factor in child and adolescent psychiatry using Journal Citations Reports (Journal Citation Reports 2021) and retrospectively analysed the publications published in 2019. All the original research articles, met-analysis, and reviews published in these journals were analysed. These five journals have been chosen for this study due to the fact that they were listed in the Q1 category and published specifically about child and adolescent psychiatry and psychology. The articles were divided into two groups as original articles/research articles and meta-analysis/systematic review. Short communications, communications, letters, and case reports were excluded because of its confounding effect and small numbers. We have used the Web of Science database to determine citation reports, AAS, and PlumX Metrics to find out the social media popularity. We accessed this information between January 26th, 2021, and February 24th, 2021. The total count of citations was recorded from the Web of Science database. Total altmetric score, number of tweets and tweeters, the total number of followers reached, Facebook page, news outlets, and Mendeley reads were recorded from AAS. The total number of tweets and Facebook shares, likes and comments were recorded from PlumX Metrics via Scopus.

Altmetric is the metric and qualitative data that include mentions on social networks such as Twitter, discussions on research blogs, mainstream media coverage, bookmarks on reference managers like Mendeley, and citations on Wikipedia and in public policy documents. Altmetric could represent data about how often journal articles and other scholarly outputs like datasets are discussed and used around the world (Digital Science, 2021). PlumX Metrics also provide data about various interactions of research outputs (articles, conference proceedings, book chapters, etc.) with individuals in the online environment. PlumX Metrics are divided into five categories (Citations, Usage, Captures, Mentions, and Social Media) to help make sense of the huge amounts of data involved. AAS presents detailed information about tweets, news outlets, Mendeley reads about publication, whereas PlumX Metrics presents detailed information about Facebook data (shares, likes, and comments) and tweets.

### Statistical Analyses

SPSS 24.0 has been used for analyses, and descriptive analyses have been used for frequencies of tested variables. Moreover, Mann-Whitney U test has been used to evaluate the differences of citation count, AAS and PlumX Metrics scores between original articles/research articles, and meta-analysis/systematic review. Spearman correlation analysis has been used to examine the relations between citation numbers, AAS and PlumX Metrics scores, and related subdomains. Linear regression analysis has been used to determine the predictors of citation count. In all analyses $p < 0.05$ (two-tailed) is determined for a statistical significance.

## RESULTS

The journals that have been included in the study are Journal of Child Psychology and Psychiatry, Journal of American Academy of Child and Adolescent Psychiatry, European Child & Adolescent Psychiatry, Molecular Autism, and Clinical Child and Family Psychology Review. The characteristics of journals are presented in Table 1.

A total of 407 publications have been analysed, and 322 original articles/research articles and 85 meta-analyses/systematic reviews have been included. The median citation count of all publications was 5 (IQR=6). Among altmetric data, median AAS score was 8 (IQR=18), the number of tweets was 9 (IQR=22), the number of tweeters was 8 (IQR=17), the number of the Facebook page where the publication was mentioned was 0 (IQR=1), and the number of Mendeley reads was 50 (IQR=39). Among PlumX data, the median number of tweets was 9 (IQR=20), and the median number of Facebook interactions was 0 (IQR=10).

The median of citation count of meta-analysis/systematic reviews was 8 (IQR=11) and original articles/ research articles was 5 (IQR=5). There was a significant difference between groups in terms of the number of citation ($U=9534, p<0.001$). The median of Total AAS was 13 (IQR=18) for meta-analysis/systematic reviews and 6 (IQR=18) for original articles/research articles. There was a significant difference between groups in terms of the total AAS ($U=10916, p=0.004$). A statistically significant difference between groups has been found in terms of the number of tweets, the number of tweeters, Mendeley reads and PlumX Twitter score additionally. This data is presented in table 2.

Correlation analyses have been used to investigate the association between citations and AAS and PlumX Metrics components. In this analysis, it has been found that there is a positive correlation between the total citation count and the total AAS ($r=0.425$, $p<0.001$), the total count of tweets mentioned in Altmetrics ($r=0.332$, $p<0.001$), the total count of tweeters ($r=0.305$, $p<0.001$), news outlet ($r=0.399$, $p<0.001$), altmetric Mendeley reads ($r=0.680$, $p<0.001$), PlumX tweet count ($r=0.436$, $p<0.001$), and PlumX Facebook interactions

**Table 1.** Characteristics of Journals

| Journal | IF | AAS | | PlumX Twitter | | PlumX Facebook | |
|---|---|---|---|---|---|---|---|
| | | Median | IQR | Median | IQR | Median | IQR |
| Journal of Child Psychology and Psychiatry | 7.035 | 10.50 | 20 | 16 | 31 | 0 | 6 |
| Journal of American Academy of Child and Adolescent Psychiatry | 6.936 | 20 | 48 | 18 | 25 | 9 | 32 |
| Molecular Autism | 5.869 | 9 | 23 | 14 | 21 | 8 | 56 |
| European Child & Adolescent Psychiatry | 3.941 | 2 | 6 | 2.5 | 6 | 0 | 1 |
| Clinical Child and Family Psychology Review | 3.468 | 8.5 | 13 | 3.5 | 11 | 0 | 0 |

IF: Impact Factor, AAS: Altmetric Attention Score

**Table 2.** Comparison of variables between different article types

| | Meta-analysis/systematic reviews | | Original articles/ research articles | | U | p |
|---|---|---|---|---|---|---|
| | Median | IQR | Median | IQR | | |
| Total Citation | 8 | 11 | 5 | 5 | 9534 | <0.001 |
| Total AAS Score | 13 | 18 | 6 | 18 | 10916 | 0.004 |
| AAS-Tweet | 14 | 30 | 8 | 21 | 11278 | 0.012 |
| AAS-Tweeters | 11 | 24 | 7 | 15 | 11403 | 0.018 |
| AAS-Mendeley | 62 | 52 | 47 | 34 | 9210 | <0.001 |
| AAS-Facebook | 0 | 1 | 0 | 2 | 13135 | 0.507 |
| PlumX-Tweet | 14 | 23 | 8 | 21 | 11829 | 0.049 |
| PlumX-Facebook | 0 | 11 | 0 | 9 | 13457 | 0.791 |

AAS: Altmetric Attention score, IQR: Interquartile range

**Figure 1.** Correlation of Total AAS and Citation Count
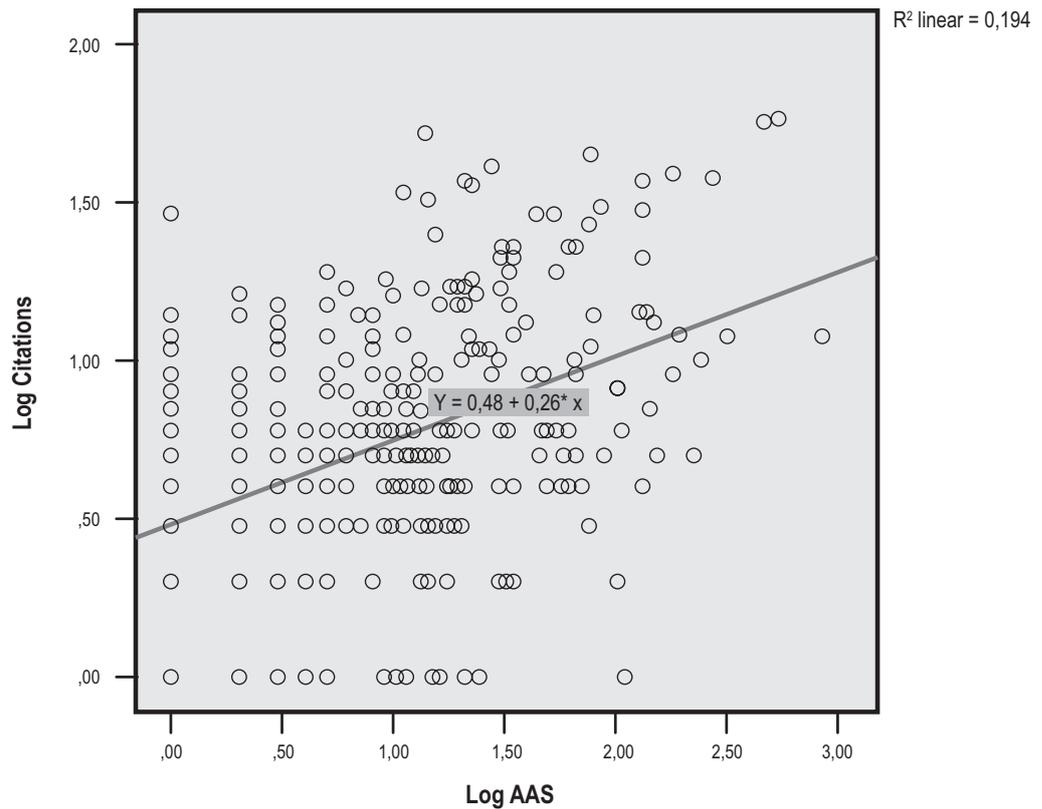


count(r=0.229, p<0.001). This data is presented in Table 3. Besides, Figure 1 presents the correlation between Total AAS and citation count.

Partial correlation analysis has been used to control the potential confounding effect of journal quality on the association between the total citation count, AAS and PlumX Metrics. The impact factor has been determined as a controlling variable. The statistically significant association has continued for all variables after controlling the impact factor of journals. In partial correlation analysis, it has been found that there is a positive correlation between the total citation count and the total AAS (r=0.403, p<0.001), the total counts of tweets mentioned in Altmetrics (r=0.308, p<0.001), the total count of tweeters (r=0.279, p<0.001), news outlet (r=0.384, p<0.001), altmetric Mendeley reads (r=0.671, p<0.001), PlumX tweet count (r=0.410, p<0.001), and PlumX Facebook interactions count(r=0.214, p<0.001).

Linear regression analysis has been used to determine the predictors of citation count. The total citation count was listed as the dependent variable and the total count of tweets, PlumX Facebook metrics, AAS Mendeley reads and the type of publication (original articles=0, systematic reviews/meta-analysis=1) were listed as predictors. Because of the high correlation between the Total AAS and the total count of tweets, the Total AAS was not included in this analysis. A significant regression equation

has been found (F $(4,402)$=96.436, p<0.001) with an $R^2$ of 0.49. As a result of this analysis, it has been found out that the type of publication (β=1.63, p=0.031), the total count of tweets (β=0.11, p=0.009), and Mendeley reads (β=0.117, p<0.001) predicted the citation count.

## DISCUSSION

In this study, we have examined the association between social media interaction and citations among top child and adolescent psychiatry journals. We have found a significant positive correlation between the total citation count and the total AAS, the total count of tweets mentioned in Altmetrics, the total count of tweeters, news outlet, Mendeley reads, the total count of tweets, and Facebook interactions count mentioned in PlumX Metrics. We think that the scientific popularity of journals could be a confounding factor as this popularity might be the main source of both citations and social media interaction. For this reason, we have used partial correlation analysis and as a result, a significant positive correlation continued. Our study is the first that investigates this association among child and adolescent psychiatry journals. According to our results, it has been found that Twitter is the most popular social media tool for scientific publications. Facebook sharing is relatively low compared to

Twitter. Besides, the most significant difference and the most powerful correlation have been found between the citation count and AAS Mendeley reads. This data could be evaluated in such a way that open access and free citation tools like Mendeley are preferable for researchers. Systematic reviews/meta-analyses have more AAS and social media interaction than original articles. We think that as systematic reviews/meta-analysis present more general and comprehensive data about child and adolescent psychiatry area; they are shared more and cited more.

The main indicator showing the value and the popularity of scientific publications is the number of citations (Zhu et al. 2015). In the traditional system, a publication's scientific value primarily has been measured by its citations. The new metric systems such as AAS and PlumX have been increasingly recognized to evaluate the impact and the value of scientific publications and present real-time and continuously update data (Bardus et al. 2020). Several studies have investigated the social media interaction and the total citation count of publications in literature in recent years. In a recent review, a significant correlation has been found between traditional bibliometrics and social media metrics in health research. Authors have mentioned suggestive but still inconclusive evidence on the impact of using social media to increase the number of citations in health research (Bardus et al. 2020). A recent article investigating top psychiatry journals has found a significant but weak correlation between median AAS and median citations. This study has addressed the journal of publication, the article type, and the topics addressed in the article as significant predictors of an article's higher AAS (Dagar & Falcone 2021). Karimipour et al. have found an association between higher Altmetric scores and higher citation scores in their study which analysed 310 publications about eating disorders. Also, they suggest that a higher number of Facebook mentions has been uniquely associated with higher citation scores in multivariate analysis (Karimipour et al. 2020). Similar to these studies we have found a significant positive correlation between the citation counts, the Total AAS, and PlumX metrics. In partial correlation analysis, this association continues after controlling the journal quality. Our results are consistent with previous results.

In the literature, there are studies on AAS and PlumX Metrics in other fields besides psychiatry and mental health. For example, Punia et al. have examined several original articles in the field of neurology and, like us; they have found a high degree of engagement with neurological research on social media. They have also found different interests on different topics about neurology (Punia et al. 2019). In another study, a weak but significant correlation has been found in the articles published in the urology area (Nocera et al. 2019). A study that has been conducted among top ten dermatology journals has demonstrated a significant positive correlation between both AAS and 3-year citation count and PlumX and 3-year citation count (Jia et al. 2020). Another important study has been conducted by Luc et al. on this issue. They have carried on a randomized prospective study and follow-up publications about thoracic surgery in one year. They suggested that tweeting results in significantly more citations over time and social media interaction could increase the popularity of publications (Luc et al. 2021). In addition to cross-sectional data, this prospective study suggests important results about social media interaction and the possibility of citing a publication. Consistent with these results, we have found a significant positive correlation between the total citation count, the Total AAS, and PlumX metrics. Also, we have controlled the impact of journal quality and this association continues.

Twitter is an important social media platform for scientific publications. It is mentioned that more than 20% of published articles receive at least one announcement on Twitter (Haustein et al. 2015). In a recent editorial, it has been mentioned that using Twitter to share scientific publications could improve the impact of the articles and the journals (Clavier et al. 2020). In our study, we have found Twitter as a significant predictor of the total citation count, as well. Besides, the count of Mendeley reads has a great β value on regression analysis. This result could suggest that Mendeley has a great impact on the total citation count because it is free and open citation software.

This study has certain limitations. Firstly, we have reviewed only five child and adolescent psychiatry journals. We are not able to evaluate all of the journals that have publications in this area, but the top journals have been included in our study. There are numerous journals which publish articles about child and adolescent psychiatry area and excluding these journals is a limitation. Secondly, we have assessed the data in 2019, but we could not examine the longer-term effects of AAS and PlumX Metrics. Because of the cross-sectional design of the study, we could not establish a certain causality association.

## CONCLUSIONS

As a result, beside the classical methods measuring the quality of the articles such as the total citation count and impact factor, the importance of tools such as AAS and PlumX Metrics, which have gained importance with the spread of the Internet and social media, has been

increasing day by day. It is important to share scientific publications on these platforms to increase the impact of the articles and to spread reliable data over social media and the Internet. Although there are several limitations of these novel scientific metric methods, we think that these metrics would become more important in the future. Further prospective, follow-up studies with randomized design are needed to clarify this association.

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*Correspondence:*
*Sadettin Burak Açıkel MD*
*Department of Child and Adolescent Psychiatry, Ankara*
*University Faculty of Medicine, 060260 Mamak, Ankara, Turkey;*
*acikel42@gmail.com, +905448602316*