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A comparative analysis of quality of reporting statistics in two Indian journals

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Abstract

Purpose: The importance of statistical analysis in medical research papers is ever increasing, hence, evaluation of statistical validity is crucial when evidence based medicine is highly valued. Studies with poor methodological quality and poor statistics cannot prove or disprove study hypothesis with certainty. This study was designed to evaluate, analyze and compare the reporting of statistical methods and errors in articles published in Indian Journal of Pharmacology (IJP) and Journal of Association of Physicians of India (JAPI). **Materials and Methods:** All original articles published in IJP and JAPI from January 2009 to September 2014 were reviewed and evaluated by using a checklist which included type of statistical test, common errors, etc. The statistical software used for analysis of data in these articles were also reviewed. **Results:** Three hundred articles (IJP=154; JAPI=146) were reviewed. The most commonly used statistical test in IJP was one-way ANOVA (53.8%) as compared to Chi-square test (50.6%) in JAPI. The statistical software used for analysis was mentioned in 43.5% and 50.7% articles published in IJP and JAPI respectively. The most commonly used software was GraphPad Prism (66.4%) in IJP and SPSS (67%) in JAPI. Statistical errors as per the checklist were more common in JAPI (63.5%) as against 49% in IJP. Use of mean±SE instead of Mean±SD was the most common statistical error in IJP (51.9%) whereas failure to mention the type of 't' test was the most common error (38%) in JAPI. **Conclusion:** Statistical errors are common in IJP as well as JAPI. To elevate the quality of articles published in Indian journals, every article must be sent for statistical review.

Keywords: Statistical errors, ANOVA, Pharmacology, GraphPad, Research methodology.

INTRODUCTION

The importance of statistical analysis in medical research papers is ever increasing, hence, evaluation of statistical validity is crucial when evidence based medicine is highly valued [1]. Statistics can be very helpful in formulating experimental design and drawing appropriate inferences from the collected data. There is an extensive array of tests and techniques of statistical analysis which have become essential features of published medical studies. Studies with poor methodological quality and poor statistics cannot prove or disprove the study hypothesis with certainty [2]. The misuse or inaccurate use of statistical methods may point the research in the wrong direction and produce incorrect study results. Failure to describe research methods and to report results appropriately has potential scientific, ethical, and economic implications for the entire research process. The problem of poor statistical reporting is long-standing, widespread, potentially serious, concerns mostly basic statistics, and yet is largely unsuspected by most readers of the biomedical literature. A high level of statistical errors has been noted in various journal articles and has caused much concern [3]. The general standard of statistics in medical journals is poor. Quality of methodological and statistical parameters published in various Indian Medical Journals are usually debated in terms of appropriateness. Many surveys are done for statistical reporting in western journals, however data are lacking for studies published in Indian Medical journals. Thus, the present study was designed to evaluate, analyze and compare the reporting of statistical methods and errors in articles published in Indian Journal of Pharmacology (IJP) and Journal of Association of Physicians of India (JAPI).

MATERIALS AND METHODS

All original articles published in Indian Journal of Pharmacology (IJP) and Journal of Association of Physicians of India (JAPI) from January 2009 to September 2014 were downloaded from the journal website (www.ijp-online.com and www.japi.org). A total of 300 articles were downloaded (IJP=154;

JAPI=146) for analysis. Only original articles were considered for analysis. Short communications, research letters, and letter to editors were not taken into account. All articles were reviewed, evaluated and analyzed using a checklist (Table 1) for quality of reporting of descriptive statistics and inferential statistics. Descriptive statistics is evaluated on the basis of appropriate reporting of data as mean, median, or frequency with the central tendencies and appropriate reporting of variability as standard deviation (SD), Standard error (SE) or confidence interval (CI). Common types of figures used for representation of data were also noted. Inferential statistics was evaluated on the basis of reporting of assumptions of statistical tests and inappropriateness of statistical tests. Common methods of statistical analysis were noted. Common statistical errors of omission and errors of commission were also noted. Completeness of tables in each article was noted. The statistics checklist for individual articles was filled and analyzed. If more than one statistical method was used in one article, the number of times was added to the calculation individually. If there were different statistical errors in one article, each error was added up. The statistical software used for analysis of data in these articles were also reviewed.

The completed checklists were statistically analyzed with Microsoft Excel 2013 and values are described as frequencies and percentages.

Since, this study lacked human subjects, the study protocol did not require Institutional Ethics Committee (IEC) approval.

Results

Total 300 articles from various areas of research were downloaded from the journal websites. 154 articles from IJP and 146 articles from JAPI were reviewed in accordance with the checklist. Major areas of research were diabetes (59/300) and cardiology (48/300) in both the journals. Other areas were hepatoprotection, nephrology, inflammation, gastrointestinal, immunomodulation and toxicology.

The method of sample size calculation was mentioned only in 18 of 146 articles in JAPI and 4 of 154 articles in IJP. The most common method of graphical representation of data was bar diagram in both the journals (58% in IJP and 39% in JAPI).

Of these 300 articles, information related to descriptive statistics was missing in one article from JAPI. Out of these 299 articles, Confidence interval was mentioned in 15 articles in IJP(1%) and 60 articles in JAPI (41%). Inappropriate descriptive statistics was reported in 88 articles in IJP (57.1%) and 29 articles in JAPI (19.8%).

The most common reason for inappropriate reporting of descriptive statistics was the use of mean±SEM in place of mean or mean±SD (51.9%) in IJP.

Most common statistical method used in IJP was one way Analysis of Variance (ANOVA) (53.9%) and Chi-Square test (50.8%) in JAPI [Table 2].

Statistical errors were noted in 49% articles in IJP and 63.5% articles in JAPI. The most common error was failure to mention the type of ‘t’ test in 38% articles in JAPI followed by use of parametric test for non-parametric data (20.5%). [Table 3].

The actual p-value was mentioned in 24% articles in IJP as compared to 45% in JAPI.

Information of fulfillment of assumption of statistical method was mentioned in 40 articles in each journal. In one article, normal distribution was checked by Komolgorov-Smirnov test.

The statistical software used for analysis was mentioned in 43.5% and 50.7% articles in IJP and JAPI respectively. GraphPad Prism was the most common software used in IJP (66.4%) and SPSS in JAPI (67%).

Incomplete tables were noted in 31.8% articles in IJP as compared to 45.2% articles in JAPI. One table in IJP had discrepancy with the text.

DISCUSSION

Most of the articles in IJP were animal experiments and thus method of sample size calculation was not mentioned. A miscalculated sample size could lead to inappropriate results. In most animal experiments sample size of the group was restricted to 6 to 10. This sample size may not have enough statistical power to detect the true difference between the groups. However, it is noted that most studies do not mention the method of sample size calculation even in clinical articles published in JAPI. The importance of sample size calculation cannot be overemphasized. Any major mistake in the sample size calculation will affect the power and value of a study [4]. Equally important, readers of medical journals should understand sample size because such understanding is essential to interpret the relevance of a finding with regard to their own patients [5].

Animal experiments were most commonly published in IJP where multiple groups are compared; hence one-way ANOVA was the most commonly used statistical test. Clinical articles published in JAPI used Chi-Square test most frequently followed by ‘t’ test (paired & unpaired). However, failure to mention the type of ‘t’ test was the most common error of omission in articles published in JAPI. Inappropriate use of ‘’mean±SEM” was observed in most articles published in IJP. The ideal method of reporting data is mean±SD as it shows variability of observed within the sample [6]. In a study done by Nagele (2001), inappropriate use of Standard error of Mean (SEM) was observed in 23% articles in four anaesthesia journals [7]. Similar findings were also observed in a study done by Jayakaran *et al* (2011) in 90.6% articles in IJP & IJPP (Indian Journal of Physiology & Pharmacology) [2].

In this study, we found that one-way ANOVA, Chi-Square test, unpaired & paired ‘t’ test cover over 80% of all statistical methods and should be taught in detail to students & young researchers.

Graph Pad Prism seems to be the software of choice for pharmacologists whereas SPSS is preferred by most physicians. To the best of our knowledge, there are no studies mentioning the most common statistical software used for analysis.

Very few articles gave information about the fulfillment of assumption of statistical test. It could either be underreporting or ignorance of the researcher. Each statistical test has some assumptions which need to be fulfilled before its application. Information regarding fulfillment of these assumptions should be included in the manuscript [8].

Not many articles mentioned the exact p value. Null hypothesis significance tests are commonly used to provide a link between empirical evidence and theoretical interpretation. However, this strategy is prone to the "p-value fallacy" in which effects and interactions are classified as either "significant" or "not significant" based on whether the associated p value is greater or less than 0.05. This dichotomous classification can lead to dramatic misconstruals of the evidence provided by an experiment. For example, it is quite possible to have similar patterns of means that lead to entirely different patterns of significance, and one can easily find the same patterns of significance

that are associated with completely different patterns of means. Describing data in terms of an inventory of significant and non-significant effects can thus completely misrepresent the results [9].

At least 31.8% tables published in IJP and 45.2% tables in JAPI were incomplete. Most of them used abbreviations and did not have proper headings or footnotes. This could lead to incomplete understanding of the reader.

A high number of statistical errors in published articles in experimental as well as clinical journals could be attributed to insufficient knowledge of statistics in the researcher, insufficient ethical and peer review or inadequate statistical review by the editors [10-14].

Thus, it is important to have a precise understanding of statistical methods frequently used in each professional field [15-16].

Table 1: Checklist for assessing the reporting of statistics

1. Area of research		
2. Type of study		
3. Sample size & its method of calculation		
4. Descriptive statistics (Mean+SD/%/Confidence Interval/Others)		
5. Figures used for representation of data (Bar diagram/Pie chart/Other)		
6. Type of statistical test used:	a. Paired‘t’ test	b. Unpaired‘t’ test
	c. One-way ANOVA	d. Repeated measures ANOVA
	e. Post-hoc test	f. Karl-Pearson correlation analysis
	g. Chi-Square test	h. Fischer’s exact test
	i. Kruskal-Wallis test	j. Freidman’s test
	k. Mann-Whitney U	l. Wilcoxon rank sum test
	m. Spearman’s	n. Regression analysis
	o. Survival Analysis	p. Others
7. Use of exact p-value		
8. Information of fulfillment of assumption of statistical test		
9. Type of statistical software used (with version)		
10. Errors of omission:	a. No statistics were used even though statistical methods were required	
	b. Statistical method used but not mentioned in methodology.	
	c. Incomplete description of basic data or applied statistical methods	
	d. Others	
11. Errors of commission:	a. Inadequate description of measures of central tendency or dispersion	
	b. Incorrect analysis:	
	i. t test without considering variable independency: paired or unpaired	
	ii. Repeated t-test for more than 2 groups	
	iii. Parametric test used for Non-parametric data	
	c. Others	
12. Completeness of tables		

Table 2: Commonly used Statistical Tests

Type of statistical test	IJP (n= 154)	JAPI (n=146)
Chi-Square test	26 (16.9%)	74 (50.8%)
Paired ‘t’-test	08 (5.0%)	11 (8.0%)
Unpaired ‘t’ test	16 (10.4%)	25 (17.1%)
One-way ANOVA	83 (53.9%)	08 (5.0%)
Regression Analysis	01 (0.6%)	20 (13.7%)
Fischer’s exact test	17 (11.0%)	17 (11.6%)
Survival Analysis	01 (0.6%)	07 (5.0%)

Table 3: Common Statistical Errors

Type of statistical error	IJP (n=154)	JAPI (n=146)
Statistical method not mentioned	04 (3.0%)	20 (13.7%)
Incomplete description of basic data	08 (5.0%)	21 (14.4%)
No statistical method used	02 (1.3%)	09 (6.2%)
Type of ‘t’-test not mentioned	16 (10.4%)	40 (27.4%)
Use of Mean+ SE instead of Mean+SD	80 (52.0%)	06 (4.1%)
Use of parametric test for non-parametric	0 (0%)	30 (20.5%)

SE: Standard Error of Mean; SD: Standard Deviation

CONCLUSION

The findings of this study suggest that statistical errors are common in both IJP as well as JAPI. To elevate the quality of articles published in Indian journals, all articles should go through statistical review. It is advisable to have a statistical expert on the editorial board which would minimize the errors. Guidelines for reporting of statistics in articles should be laid down by the editors in order to improve the accuracy and quality of medical research.

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