



Review of the Statistical Methods Used in Original Articles Published in Iranian Journal of Public Health from 2015-2019: A Review Article

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Abstract

Background: Nowadays, statistical methods are used frequently in research articles. This review study aimed to determine the statistical methods used in original articles published in Iranian journal of public health (IJPH).

Methods: Original articles in the period 2015 to 2019 from volumes 44 to 48 and numbers 1 to 12 were reviewed by a 3-member committee consisting of a statistician and two health researchers. The statistical methods, sample size, study design and population, type of used software were investigated. Multiple response analysis (MRA), Kruskal–Wallis test and Spearman correlation coefficient were used to data analysis. All analyzes were performed in SPSS21 software. Significant level was set at 0.05.

Results: Statistical population in most of the articles were related to human samples at the field level (36% and 297 articles). 66.6% (549 articles) had the sample size less than 500 cases. Study design in most of them were analytical observational 56.2% (464 cases). Acceptance period was 115.5 ± 52.27 days. All the mentioned variables had no significant relationship with the acceptance period ($P > 0.05$). Both among the total tests and the articles, the highest rate of use of statistical methods was related to descriptive statistical method (34.4%, 75.8% and 532 articles), also, the highest use of tests was related to chi square test and t-test (29% (450 articles)).

Conclusion: Study design in most of the articles were analytical, to increase thematic diversity, accepting different articles seems necessary. The statistical tests, which used in most articles, were simple, so accepting articles with advanced statistical methods is recommended.

Keywords: Statistical methods; Original articles; Iranian journal of public health; Acceptance period

Introduction

Statistical methods, as a complement to biomedical research, include a significant part of research articles. In other words, these methods are the main part of studies from design to obtaining results and help in all aspects of the research pro-

cess from data collection and management to data analysis and interpretation (1).

Public health journals are very popular all over the world. In Iran, Iranian Journal of Public Health (IJPH) has been working as a valuable



journal since 1971 and since 2001; it has been published only in English language. So far, they have published more than 2000 papers on various subjects including bioethics, disaster health, entomology, epidemiology and biostatistics, health and environment, health economics, health services, immunology, medical genetics, mental health, microbiology, nutrition and food safety, occupational health and oral health (2). Publishing articles with good scientific quality is the main goal of all journals, especially journals in the field of medical sciences.

Statistical methods are like double-edged swords, so that their correct use will improve the quality and their misuse will lead to a loss of researchers' efforts (3). Improper study design and the use of inefficient statistical methods can lead to incorrect results, poor interpretation of study findings and incorrect conclusions (4). Authentic journals to increase the quality of articles and to ensure the validity of statistical tests used in manuscripts perform exact reviews by editors and judge with statistical expertise.

Some researchers believe that if they use more advanced statistical methods instead of just the usual methods; their chances of being accepted will be higher and their reviewing process will be even shorter. On the other hand, knowledge of the history of used statistical methods and the trend of the average of acceptance period, study design, statistical population and used software can be useful for self-evaluation and promotion of the journal, identify gaps in science, and increase the variety of articles. In this regard, recently review articles entitled "Review of statistical methods used in the original articles of scientific journals" have been published (5-8).

Therefore, we aimed to identify and review statistical methods, sample size, study design, statistical population, type of statistical software and sampling method used in the original articles published in the Iranian Journal of Public Health in the period 2015 to 2019.

Methods

All original articles in the period 2015 to 2019 from volumes 44 to 48 and issues 1 to 12 of the

Iranian Journal of Public Health were reviewed. Overall, 825 original articles were published during the study period. Review articles, case report, review, letter to the editor and editorial were not included in the study.

Each article was reviewed by a three-member committee consisting of a statistician and two skilled researchers in the field of health. The tools used in this study were researcher made check-lists including statistical methods, sample size, sampling method, study population, study design and used software. All statistical methods used in the articles were extracted and categorized. The list of all statistical methods used in the published articles of the journal in the period mentioned is summarized in Table 1. In addition to extracting the type of statistical method, other information including acceptance period (the period between receiving and accepting the manuscript), was also examined.

In order to perform descriptive statistics, considering that it was possible to use more than one method in each article, the Multiple Response Analysis (MRA) technique was used and the frequency and percentage were reported. MRA is one of the valuable statistical methods for analyzing questions with the possibility of more than one answer (multiple response) (9). The output of this method, which we used in the present study, unlike simple descriptive statistics tables, presents a table containing two frequencies, one for each selected item (response) and one for the respondent (10). In this study the responses were the used statistical tests and the respondent were published articles.

The relationship between the type of used statistical methods, used software, study population and the study design with the acceptance period of the article was done by the Kruskal–Wallis test. After confirming the non-normality of errors in the quantitative variables through Kolmogorov-Smirnov test, Spearman correlation coefficient was used to investigate the relationship between sample size and acceptance period. All statistical analyzes were performed in SPSS (ver.21, Chicago, IL, USA) software with a significance level of 5%.

Table 1: Statistical methods extracted from the articles of 2015-2019

<i>ID</i>	<i>Method</i>	<i>Brief description</i>
1	Descriptive statistics	mean, standard deviation, percentage and frequency, minimum and maximum, median- Interquartile range- Gini coefficient- concentration Index- Kakwani index- DALY-QALY
2	T test	Independent/ paired T test
3	Linear Regression	Simple- hierarchical – stepwise –multiple- quantile
4	logistic Regression	Binary- Conditional- nominal
5	ANOVA- ANCOVA	One /Two Way
6	Qualitative	Thematic Analysis TOWS Matrix ¹ – content\Gap analysis
7	Data Mining methods	Decision tree- Neural Networks- Support vector machine- Relevance Vector machine- all type of cluster analysis- discriminant analysis
8	Multivariate Analysis	All type of factor analysis- multivariate regression- MANOVA ² - ICC ³ - SEM\GSEM ⁴ -Path- Time series model
9	Spatial Analysis	Hot Spot Analysis- Buffer analysis- PCO & ACO ⁵ algorithm- GIS analysis- Correspondence analysis
10	Post Hoc Tests	SNK -LSD- Duncan Multiple Range Test, Bonferroni 's, Tukey, Benjaamini Hocberg
11	Normality tests	Shapiro wilks- Kolmogrov Smirnov
12	Assumption checking test	Leven test, Homogeneity of variances- Bland altman analysis
13	Non parametric tests	Kruskal Wallis test- Mann Whitney U test - Friedman Test- Wilcoxon Test
14	Nominal variable tests	Cochran Q test/ Mcnemar test/ Mantel Haenszel Test
15	Concentration Curves Dominance Test/ Lorenz	-----
16	Chi square test	Fisher exact- Hardy Weinberg- Wald test- Trend analysis
17	Repeated measurement	Muchly test- Bartlet test
18	Evaluating techniques	Roc curve analysis- sensitivity- specificity
19	Correlation analysis	Pearson- Spearman- Partial-Kendall(or Man Kendall)-eta
20	Survival analysis	Kaplan Meier- Cox regression, Log Rank test- Parametric models- Cox Aalen model- illness death model- risk analysis- Joint modeling
21	Reliability & Validity	EFA- CFA- PCA ⁶ - Rating scale- Rash analysis- Partial credit model- Cronbach's alpha
22	Generalized linear model(GLM)	Poisson\ Quasi\ Tobit\ Probit\negative binomial Regression- GAM ⁷
23	Longitudinal models	GEE- random effect\mixed effect- multilevel model- Hierarchical model- growth curve
24	Simulation	Monte Carlo

1. (Threats, Opportunities, Weaknesses, and Strengths) matrix

2. Multivariate Analysis of Variance

3. Intraclass correlation coefficient

4. structural equation modeling (description GSEM fits generalized SEMs)

5. the ant colony optimization algorithm (ACO)

6. Exploratory Factor Analysis / confirmatory factor analysis / Principle Components Analysis

7. generalized additive model

Results

During the study period, of 825 article the statistical population of the most was related to human samples at the field level 36% (n= 297) and then patients with 33.5% (n= 276), respectively.

The lowest statistical population was related to statistical data with 1.9% (n=16 articles) (Table 2). Our results showed, most of the studies had the sample size less than 500 people 66.6% (549studies) (Table 3).

Table 2: Description of the statistical population of the reviewed articles

<i>Statistical population</i>	<i>No.</i>	<i>Percent</i>
Patients	276	33.5
Occupations	54	6.5
Laboratory samples	81	9.8
Non-laboratory samples	19	2.3
Community-level examples	297	36.0
Statistical data	16	1.9
Others	82	9.9
Total	825	100

Occupations included teachers, nurses, doctors, dentists, farmers, workers, employees, bodybuilders, soldiers, writers, specialists, and other similar jobs. Laboratory samples included genes, chromosomes, cells, microorganisms, blood samples, and toxins. Non-laboratory samples included water and milk samples, websites and sites, money, journals, fruits and plants. Community-level examples included women, men, children, mothers, the elderly, middle-aged, spouses, infants, adolescents, students, addicts and drug users, families, married people, and drivers. Statistical data included patient records, reports, documents and information. Others included drugs, indicators, hospital resources, provinces, universities, surgical centers, mortality, and like that

Table 3: Describe the sample size used in the reviewed articles

<i>Sample size</i>	<i>No.</i>	<i>Percent</i>
Less than 100	306	37.1
100-500	243	29.5
500-1000	82	9.9
More than 1000	186	22.5
Unknown	8	1.0
Total	825	100

Moreover, the design of study in most of the articles was analytical observational type 56.2% (464 articles) and in 11.2% (92 articles) the type of study was not mentioned (Table 4). The acceptance time of articles had mean of 115.5 d with a standard deviation of 52.27 and a median of 113 and an inter quartile range of 59 days. As shown in Table 5, most of the published articles had chosen SPSS software for data analysis (728 articles and 88.2%). Findings of MRA showed that in total, among all the used statistical methods, the highest rate of use was related to de-

scriptive statistics (34.4% and 532 articles), Chi square test (15.2% and 236, articles), T-test (13.8% and 214 articles), logistic regression (8.3% and 128 articles), and one-way analysis of variance (6.7% and 103 articles), respectively. Results of MRA also showed among all articles, 75.8% used descriptive statistics, 33.6% used chi-square test, 30.5% used t-test, 18.2% used logistic regression and 14.7% used one-way analysis of variance (Table 6).

Table 4: Type of the study in the reviewed articles

<i>Type of study</i>	<i>No.</i>	<i>Percent</i>
Descriptive	138	16.7
Analytical- observational	464	56.2
Analytical -Interventional	87	10.5
Methodology	4	0.5
Qualitative	40	4.8
Unknown	92	11.2
Total	825	100.0

Table 5: Statistical software used in the reviewed articles

<i>Name of software</i>	<i>No.</i>	<i>Percent</i>
SPSS	723	87.6
R	5	0.6
STATA	27	3.3
Minitab	1	0.1
SAS	12	1.5
Excel	13	1.6
Arc GIS	2	0.2
MATLAB	4	0.5
Others	38	4.6

Others: Graphpad prism, the pHstata2 software, MAXDDA software, REST2009 software, Rotor gene software, SHE sis software, the PASW, Ergo Fellow, Logger Pro V3.6 software, MEGA software, WEKA software, Statistica 10.0 PL software (Stat Soft, Poland), Deap software

Table 6: Results of multiple response analysis

<i>ID</i>	<i>Statistical methods</i>	<i>All tests</i>		<i>Percent of articles</i>
		<i>No.</i>	<i>Percent</i>	
1	Descriptive statistics	532	34.4	75.8
2	Linear Regression	44	2.8	6.3
3	T-test	214	13.8	30.5
4	Logistic Regression	128	8.3	18.2
5	ANOVA	103	6.7	14.7
6	Qualitative	6	0.4	0.9
7	Data mining	17	1.1	2.4
8	Multivariate Analysis	12	0.8	1.7
9	Spatial Analysis	5	0.3	0.7
10	Post Hoc Tests	17	1.1	2.4
11	Normality	33	2.1	4.7
12	Assumption checking	5	0.3	0.7
13	Non parametric	57	3.7	8.1
14	Nominal variable tests	7	0.5	1.0
15	Chi square test	236	15.2	33.6
16	Repeated measurement	3	0.2	0.4
17	Evaluating techniques	4	0.3	0.6
18	Correlation analysis	75	4.8	10.7
19	Survival analysis	20	1.3	2.8
20	GLM	11	0.7	1.6
21	Reliability & Validity	11	0.7	1.6
22	Longitudinal models	7	0.5	1.0
23	Simulation model	1	0.1	0.1
	Total	1548	100	220.5

The normality of error in quantitative variables such as acceptance period and sample size was assessed by Kolmogorov-Smirnov test and the results indicated that these variables were not normal ($P < 0.05$). The relationship between acceptance period and type of community as well as the type of used software and test through Kruskal-Wallis test was examined and the results were not significant ($P = 0.761$). Results of Spearman

correlation test showed there were no significant relationship between the used sample size in the articles and the acceptance period ($r = 0.014$, $P = 0.068$). The results of Kruskal-Wallis test showed that the median acceptance period of articles during different years is not the same ($P < 0.001$). Fig. 1 showed trend of mean of acceptance period in five different years, it is a downward trend.

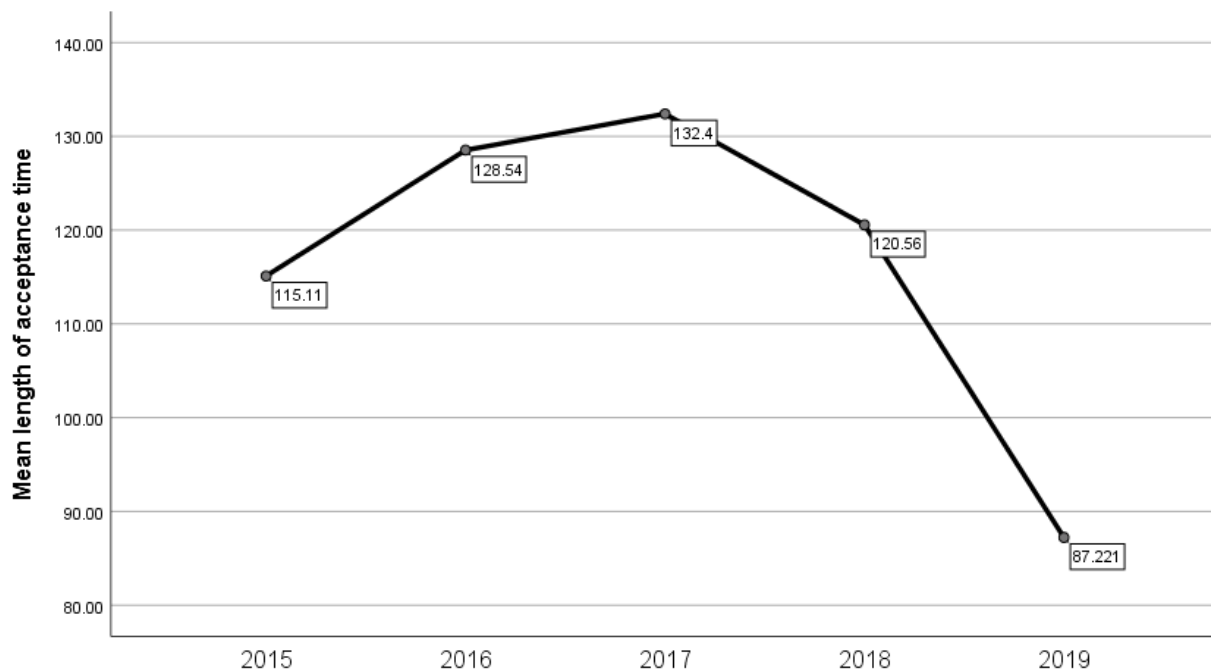


Fig. 1: Trend of acceptance time during 5 years

Discussion

The use of statistical methods is expanding today, and some researchers have a wrong belief that if they use sophisticated statistical methods for analysis, their paper will definitely be accepted. Editors of medical journals seek the help of statistical experts in judging statistical methods. Scientific journals need a general self-assessment in the field of published articles in order to improve the quality level and receive valid scientific indexes and increase citations and impact factor. In this way, they can identify strengths and weak-

nesses, as well as necessary policies for accepting various future articles and determine the journal policy.

The findings of this study, obtained by reviewing IJPH from 2015-2019 according to 825 original articles, showed that community-level samples were the most statistical population used in the articles, which indicates that IJPH paid special attention to accepting articles with the subject is social health and the problems it faces. The lowest statistical population mentioned was related to secondary data as well as statistical data extracted from patient records, reports, documents

and information, because file information and secondary data are often lost or unrecorded and may be incomplete, despite much effort by researchers, they are usually exactly reviewed by the editors of the journal, and in some cases by questioning the accuracy of the results, the article in question is not accepted.

The calculation of cumulative frequency in Table 3 shows that most of the articles published in the journal had a sample size less than 500 people, which is consistent with the statistical population of most articles that were community-level samples. Although this issue was not studied in similar studies, but as a rule of thumb in community-based studies, according to the subject under study, if possible, the larger the sample size, the greater the power of statistical tests to identify significant relationships (11).

Our finding showed that study design was not mentioned in 11.2% of the articles, and if this defect is repeated in future issues, can be a negative points and a possible obstacle to the progress of the journal. Cumulative frequency of different used study design showed that most of the articles had the type of analytical and interventional study and this confirms the special attention of the journal to analytical and interventional studies. Methodological studies with a detailed explanation of a statistical method or a non-statistical applied method are a great contribution to attracting citations for the journal. In the journal under study, the portion of methodological articles was very small (about 5%), which shows the need to the editor's attention to this issue as much as possible.

SPSS software is one of the most popular statistical analysis software among researchers. Although it has a very good coverage of common statistical methods, it is not a complete software and researchers must use programming or semi-programming software to use more advanced statistical methods. Among the articles published in this journal, the majority of articles have used SPSS software and cumulatively up to 1.4% have used programming or semi-programming software.

According to Table 6, the results of the analysis of multiple responses showed that both among the total tests and among the articles, the highest use of statistical methods was related to descriptive statistical methods. Descriptive statistics is the most common method of statistical analysis, which was consistent with the results of the present study (4). Moreover, the findings of the present study regarding the high use of descriptive statistics methods were consistent with other similar studies (12, 13), easy calculation and lack of complexity of descriptive statistics may have led to the common use of these methods.

According to the results, the highest use of tests was related to Chi square and T-tests. In the present study, paired and Independent t-test were considered as t-test. Moreover, Fisher's exact test and Wald tests were considered as Chi square test. Investigation of the frequency of using statistical tests in similar studies showed that the most commonly used tests were Chi square and T-tests (14-16). The T-test is a parametric test that compares the average of the two groups when the error distribution in the quantitative variable is normal. Chi-square test is also used to evaluate the relationship between two qualitative variables (17). Both of these tests are among the available statistical methods and are user-friendly, easily used in most statistical software, so they have many fans. Advanced statistical methods such as longitudinal data analysis, generalized linear model and simulation study were less used in articles, which requires the attention of editors to accept articles with more advanced statistical methods.

The results showed that articles acceptance period in terms of type of test, sample size, type of population, study design and type of used software on the time of acceptance was not significantly different, but the acceptance period during the years 2109-2015 showed a decreasing trend so that the duration 115 d was reduced to 87 d, considered as the strength point of IJPH.

In expressing the strengths, this study is the first study in Iran that examines the statistical methods used in articles in journals, especially IJPH

journal. Our study considered more variables than other similar studies.

One of the main limitations of this study was the lack of access to articles rejected by the journal that only accepted articles were reviewed. Another limitation of the article was the lack of access to the submission period until the first decision of the journal, the time of revision and the time of acceptance until the publication of the article separately. In this study, only the time from receipt to acceptance (acceptance period) written on the front page of the articles was used.

Conclusion

Acceptance period of IJPH had reducing trend during the time, this is an important item for researchers to select a journal, if this time is reduced, and it can pave the way for increasing the impact factor and success of the journal. Contrary to what the researchers thought, the type of test, sample size, type of statistical population, study design and type of used software were not effective factors on acceptance period. Study design in most of the articles were analytical (observational-interventional) with mostly human samples. To increase thematic diversity, accepting different articles seems necessary. The statistical tests, which used in most published articles were simple tests including *t*-test and chi-square test, so accepting articles with advanced statistical methods is recommended.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Conflict of interest

The authors declare that there is no conflict of interests.

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