



Basic, Intermediate, or Advanced? Levels and Accessibility of Statistical Techniques in Nursing Research Articles

Khalil Tazik¹, Esmail Mousavi Asl²  and Mahmood Maniati^{1,*}

¹Department of General Courses, School of Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

²Department of Psychiatry, Golestan Hospital, School of Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

*Corresponding author: Department of General Courses, School of Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran. Email: maniatim@yahoo.com

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Abstract

Context: This study investigated the uses of statistical techniques in nursing research articles (RAs) published within 2016 - 2020.

Evidence Acquisition: Through stratified random sampling, 374 quantitative and mixed-method RAs were selected from five nursing journals (i.e., International Journal of Nursing Studies, Journal of Nursing Scholarship, Nurse Education Today, Nursing Outlook, and Journal of Cardiovascular Nursing) published within 2016 - 2020. The statistical techniques used in these articles were derived, aggregated, and listed.

Results: Descriptive statistics (20.59%) and multiple regression (15.74%) were the most frequent statistics used in the nursing RAs. Regarding the level of statistics, 49.83%, 17.00%, and 4.31% of the techniques were basic, intermediate, and advanced, respectively, indicating that basic statistical techniques are by far the most frequently used techniques in nursing RAs. The findings also revealed that students with basic and intermediate knowledge of statistics could understand 66.83% of the techniques used in nursing RAs.

Conclusions: The classification of statistical techniques derived from RAs presented in this study can meet the needs of nurses who wish to understand the benefits of statistics in nursing practice and hopefully can encourage them to take this part of research and practice more seriously.

Keywords: Nursing, Research Articles, Statistics, Accessibility

1. Context

Research articles (RAs), as the most accessible sources of knowledge among researchers, practitioners, and students, have been used to extract valuable information about different fields of study (1, 2). Some researchers emphasize the comprehension and critical appraisal of these sources (3). Accordingly, as the main component for analyzing and understanding RAs, statistical methods have been the focus of some studies (4). According to the literature, nursing students are not well-educated in statistics, and educators should find ways for fruitful teaching of statistics to these students. Some studies have suggested simultaneous teaching of research and statistics as an optimal strategy, followed and applied by different researchers (5, 6). These researchers administered a web-based test to the nursing students and reported that this method was helpful in understanding statistics.

It is recurrently emphasized that both nurses and student nurses need to be aware of evidence-based practices in the nursing and healthcare profession. One of the important areas essentially helpful in this regard is attain-

ing acceptable knowledge of statistics, which is a source of problems for most nurses. It is noted that nurses might not be involved directly in different clinical research processes; however, they need to be aware of the statistical techniques used for data collection and analysis (7).

Understanding and utilizing research by nurses have been an underpinning concept in different studies (8). This is based on the argument that being knowledgeable about research methods helps nurses critically appraise research reports and improve their practice by gaining positive attitudes. However, what is missing in such an argument is ignoring statistical techniques as the main components of research reports.

Nurses' insufficient knowledge about research has been reported to be among the main barriers to research utilization (8), which has been stated to improve through the enhancement of nurses' understanding of research methods and skills for critiquing research (8). A practical way to achieve research utilization has been to offer research training, which is traditionally practiced through taking university courses. However, the level of familiar-

ity and the association between the content and the actual practice of the content have not been clear.

Acknowledging the scant research on nursing statistics courses, Hagen et al. (9) evaluated undergraduate nurses' attitudes toward statistics courses, their preferred styles for teaching and learning, and the perceived utility of statistics in the syllabus. Through a pre-experimental study carried out on 104 nursing students, they reported students' positive attitudes toward statistics courses, team-based learning preferences, and moderate agreement with the usefulness of statistics in their career. Hagen et al. concluded that further research is required to enhance students' perceptions of the usefulness of statistics courses in nursing careers (9).

Gaudet et al. (10) investigated nurses' perspectives on statistics education and its application in practice. Based on a survey study followed by some interviews, the researchers reported that the nurses valued learning statistics. However, since the nurses were not asked to use statistics in their practice, they felt denied of using statistics in practice. Most of the nurses in this study stated that teachers should find ways to teach statistics in connection with their application in practice rather than merely teaching statistical formulas.

In nursing education and research, availability of data is an important concern (11). The duty of material development and teaching research falls on the tutors' shoulders. Perkins (11) believes that nurse tutors rely on research findings to be well-informed and apply integrated teaching approaches in their classes. One of the main components of research is using statistics in presenting and interpreting data, which makes tutors convinced to put much time into learning and teaching statistics to nurses. Different statistics books have been published for nursing; however, managing them for a limited number of sessions is somehow impossible. Therefore, one solution could be focusing on the most frequently used statistics in nursing research and teaching the actual use of statistics in practice.

One of the key issues in teaching statistics to nurses has been students' stress and anxiety over learning statistics. To deal with this problem, Pollard (12) suggested article assessment and group discussions for the nurses, especially those who have not experienced enjoining research projects. The same solution could entail providing these nurses with valuable information on the levels of statistical use in nursing studies and making a list of the most frequent techniques over the past years. In this way, they could find the most usable statistics in a pool of terms, formulas, and concepts introduced in research and statistics books.

Regarding the use of statistics in nursing education, there are different perspectives. Some define the statistics

course as a separate unit; nevertheless, others tend to integrate statistics across different courses. Regardless of their separation or integration essence, these perspectives have one basis in common: The actual use of statistics in nursing research and practice. To provide authentic data, the analysis of RAs aiming at foregrounding the actual use of statistics in nursing research and practice can be a much-needed line of inquiry. Therefore, this study tends to analyze the published RAs derived from different prestigious nursing journals to classify the statistics used for presenting the findings.

2. Evidence Acquisition

To start with and to find the quantitative RAs, five prominent nursing journals, including International Journal of Nursing Studies, Journal of Nursing Scholarship, Nurse Education Today, Nursing Outlook, and Journal of Cardiovascular Nursing, were selected. Over the 2016 - 2020 period, one volume from each of the aforementioned journals was randomly selected for further analysis through stratified random sampling. The researchers read the articles and picked up quantitative RAs for coding (the quantitative phase of mixed methods was also included). Qualitative studies and those with unclear research designs were excluded. The number of articles in line with the purposes of this study was 74 (2016), 91 (2017), 61 (2018), 81 (2019), and 67 (2020), 374 in total (note the chronological order). These studies included systematic reviews, surveys, controlled trials, cohort studies, cross-sectional studies, and validation studies. The coding procedure involved meticulous reading of the articles and listing used statistical techniques, deciding if the techniques were cited in the literature or used by the authors themselves, omitting those statistical techniques reported in the literature and listing those techniques used by the authors, assuring that the techniques were counted once in each paper regardless of how many times they were used in the same paper, and categorizing the techniques as basic, intermediate, or advanced according to the framework suggested by Goodwin and Goodwin (13).

To enhance the quality of this review and make subjective analysis less likely, 10% of the articles in each year were randomly selected and analyzed by two authors independently. Among all the reviewed papers, only six cases were observed to be incompatible (the first researcher was not sure about the complete report of the techniques by the authors). The disagreements were resolved after a group discussion. The accessibility of RAs was another analytical procedure examined in this study. Accessibility is an average reader's understanding of all the statistical techniques used in an article (14). Accordingly, assuming that

an average reader does not possess any knowledge of statistical techniques, the percentage of statistical techniques that this reader can comprehend by knowing the most frequently used ones was computed.

3. Results

According to Table 1, for the nursing RAs analyzed in this study, descriptive statistics were the most frequently used technique (20.59% of all coded statistical techniques), followed by multiple regression (15.74%), other techniques not mentioned in Goodwin and Goodwin's framework (13.15%), chi-square test (11.16%), other nonparametric tests (9.43%), and *t*-test (8.70%) (13). The least frequently used statistical techniques, those observed to be used under 1%, were factorial analysis of variance (ANOVA), trend analysis, one-way analysis of covariance (ANCOVA), factorial ANCOVA, part and partial correlations, discriminant analysis, path analysis, canonical correlation, one-way multivariate analysis of variance (MANOVA)/multivariate analysis of covariance (MANCOVA), and factorial MANOVA/MANCOVA. Interestingly, the categories "other correlational techniques", "other nonparametric techniques", and "other techniques", among the least frequent techniques in Goodwin and Goodwin's study, were observed to be highly frequent in nursing RAs (13).

As shown in Table 1, Goodwin and Goodwin (13) classified statistical techniques into three classes, namely basic, intermediate, and advanced. Summing the occurrences in each level showed that basic techniques occurred 750 times (49.83%); nevertheless, this frequency was 256 (17.00%) and 65 (4.31%) for intermediate and advanced techniques, respectively. Basic statistical techniques were the most frequently used techniques in nursing RAs.

It is also suggested by Goodwin and Goodwin (13) to re-group the techniques as follows:

(1) ANOVA-related techniques: *t*-test, ANOVA, ANCOVA, MANOVA, MANCOVA, and posthoc multiple comparison technique

(2) Parametric correlational-based techniques: Pearson correlation, trend analysis, part and partial correlations, multiple regression, discriminant analysis, path analysis, canonical correlation, and factor analysis

(3) Nonparametric techniques: Chi-square test and other nonparametric techniques

Aggregating the occurrences showed that ANOVA-related techniques included 23.25% of all techniques, followed by parametric correlational-based (22.85%) and nonparametric (20.59%) techniques. Therefore, ANOVA-based techniques were used slightly higher than the other two groups.

Another important analysis was the statistical accessibility of nursing RAs. As Table 2 shows, nursing students with a basic knowledge of statistics can comprehend respectively 47.29%, 51.71%, 55.87%, 45.48%, and 50.2% of the statistical techniques used in nursing articles published within 2016 - 2020. With intermediate statistical knowledge, this comprehension rose to 61.82%, 67.42%, 75.7%, 65.15%, and 66.39%. On average, students with basic and intermediate knowledge of statistics can understand 66.83% of the techniques used in the published articles in nursing journals over the past 5 years. Other portions of statistics are accessible through understanding advanced and other noted techniques.

4. Conclusions

As the findings of the present study showed, most of the techniques used in nursing RAs are basic and intermediate. Therefore, statistics and research instructors should prioritize these techniques in designing the syllabus for graduate nursing students. The findings revealed that teaching appropriate techniques is vital for understanding nursing RAs. Accordingly, instructors should not be satisfied with the few instances given in statistics books. They should focus deeply and teach the points in detail.

Undoubtedly, nurses' knowledge of statistics increases their professional image and mirrors their abilities in both research and practice. Accordingly, they can practice within an evidence-based framework in which every hypothesis is supported with statistical evidence. Concomitantly, the nurses will be recognized as active staff in both their profession and research agendas. To this end, the findings of the present review can be used to educate nurses during and after their university periods. Most nurses are eager to participate in research projects carried out in their work settings. Equipping these nurses with the most frequent and applicable statistical techniques can help them feel confident to participate fully in research projects.

As reported by Gaudet et al. (10), those nurses who do not feel confident in using statistics acknowledged the lack of connection between statistics education and its application in practice. They reported that teaching some formulas in one semester without visualizing them in actual practice, does not encourage the nurses to value the statistics or even to take them seriously. The classification of statistical techniques derived from RAs presented in this study can be of essential assistance to the nurses who seek to understand the benefits of statistics in nursing practice and hopefully can encourage them to take this part of research and practice more seriously.

Table 1. Statistical Techniques Used in Nursing Research Articles within 2016 - 2020 ^a

Statistical Level	Publication Years					Total
	2016	2017	2018	2019	2020	
Basic						
Descriptive ^b	64	85	56	42	63	310 (20.59)
Pearson correlation	11	20	9	13	5	58 (3.85)
Chi-square test	44	31	27	35	31	168 (11.16)
<i>t</i> -test ^c	27	23	33	29	19	131 (8.70)
One-way ANOVA	20	22	13	22	6	83 (5.51)
Intermediate						
Factorial ANOVA	3	2	1	1	0	7 (0.46)
Trend analysis	0	0	0	0	0	0
One-way ANCOVA	2	2	2	2	1	9 (0.59)
Factorial ANCOVA	0	0	0	1	1	2 (0.13)
Part and partial correlations	1	0	0	0	0	1 (0.06)
Multiple regression	45	51	46	57	38	237 (15.74)
Advanced						
Discriminant analysis	2	1	0	2	0	5 (0.33)
Path analysis	1	0	0	0	0	1 (0.06)
Canonical correlation	0	1	2	0	2	5 (0.33)
Factor analysis	14	12	3	11	6	46 (2.45)
One-way MANOVA/MANCOVA	2	2	1	0	0	5 (0.33)
Factorial MANOVA/MANCOVA	0	0	1	1	1	3 (0.19)
Other correlational techniques ^d	25	28	9	22	10	94 (6.24)
Other nonparametric techniques ^e	29	32	20	31	30	142 (9.43)
Other techniques ^f	61	38	24	41	34	198 (13.15)
Number of techniques	351	350	247	310	247	1505 (100)
Number of coded articles	74	91	61	81	67	
Mean techniques/articles	4.74	3.84	4.04	3.82	3.68	

Abbreviations: ANOVA, analysis of variance; ANCOVA, analysis of covariance; MANOVA, multivariate analysis of variance; MANCOVA, multivariate analysis of covariance
^a Values are expressed as No. or No. (%).

^b Descriptive statistics include frequency, percentage, and measures of central tendency and variance. The occurrence of each of these techniques marked the use of descriptive techniques in the article.

^c *t*-test includes both dependent and independent *t*-tests.

^d Other correlational techniques included Spearman's rho, intraclass correlation, lambda, Kendall's tau, biserial and point-biserial correlations, gamma, phi, and the correlation ratios of eta squared (η^2) and omega squared (ω^2), (p 16) (13).

^e Other nonparametric tests included McNemar test for significance of changes, Kendall's coefficient of concordance W, Wilcoxon matched-pairs signed-rank test, Kruskal-Wallis one-way analysis of variance, Mann-Whitney U test, Friedman's two-way analysis of variance, and Kolmogorov-Smirnov one-sample test (p 16) (13).

^f Other tests not mentioned in the Goodwin and Goodwin's framework or the ones not occurred more than once were standardized metric d, mixed-effects logit model, R^2 , Cohen's Kappa test, Cochran-Mantel-Haenszel test, Anderson-Darling test, Omnibus test, Rasch unidimensional measurement model, cross-tabulation analysis, Kaplan-Meier analysis, Agglomerative hierarchical cluster analysis, Helmer contrast coding test, Markov correlation structure, McFadden's pseudo R-squared measure, Kuder Richardson, Single-level regression modeling, log-rank test, Sobel test, bootstrapping methodology, standardized coefficient and unstandardized coefficient, *t*-statistics, Hosmer-Lemeshow test, random effects, Kaiser-Meyer-Olkin test, Bartlett's test of sphericity, Shapiro-Wilk test, signal detection measures, Cohen's d, optimal information size, minimal important difference, I^2 test, exponential coefficient, Welch or Brown-Forsythe test, Games-Howell test, Mackinnon and White's procedure, Wald's test, Kaiser-Guttman rule, Lo-Mendell-Rubin test, Glasgow Coma Score, generalized estimation equations, incidence rate ratios, odds ratio, hazard ratios, likelihood ratios, ordinal alpha, Bonferroni's tests, Scheffe test, the funnel plot, Egger's intercept test, least squares means, Prais-Winsten regression, ordinary least squares regression, Akaike's information criterion, Bayesian information criterion, listwise deletion, Tukey-Kramer test, Cramer's V, Levene's test, Welch's F test, Mauchly's test, adjusted Huynh-Feldt F statistic, and Steiger's Z test.

Table 2. Statistical Accessibility of Nursing Research Articles within 2016 - 2020 ^a

Statistical Level	Publication Years					Total
	2016	2017	2018	2019	2020	
Basic	166 (47.29)	181 (51.71)	138 (55.87)	141 (45.48)	124 (50.2)	750 (49.83)
Intermediate	51 (14.53)	55 (15.71)	49 (19.83)	61 (19.67)	40 (16.19)	256 (17.00)
Advanced	19 (5.41)	16 (4.57)	7 (2.83)	14 (4.51)	9 (3.64)	65 (4.31)
Other correlational techniques	25 (7.12)	28 (8)	9 (3.64)	22 (7.09)	10 (4.04)	94 (6.24)
Other nonparametric techniques	29 (8.26)	32 (9.14)	20 (8.09)	31 (10)	30 (12.14)	142 (9.43)
Other techniques	61 (17.37)	38 (10.85)	24 (9.71)	41 (13.22)	34 (13.76)	198 (13.15)
Total	351 (100)	350 (100)	247 (100)	310 (100)	247 (100)	1505 (100)

^a Values are expressed as No. (%).

The findings of this study can be used by both educators and nurses during and after university education. University educators can use these findings as a part of the statistics education syllabus to demonstrate the real use of statistics in nursing studies. The findings can also be used in follow-up programs wherein nurses are required to have knowledge of the most frequent statistical techniques for confident participation in joint studies, recognize the healthcare systems better, be aware of the institutional research agenda, and participate in making related decisions with statistical evidence.

Another critical issue is the research support expected from management and senior doctors. In addition to involving nurses in research projects, they should be encouraged and supported to conduct research and apply their statistical knowledge by themselves. Hospital management teams should hold statistics courses to upgrade the nurses' statistical knowledge. The findings of this study provided authentic materials that management teams can use to reach the nurses' expectations. The findings can be taught in crash courses with the least cost and time.

According to Gaudet et al. (10), most nurses suggested ways to improve statistics courses in their educational programs and connect the statistics content to their everyday practice. They believed that the quality of teaching statistics should be improved and that the content should adapt to the nursing practice. The results of the current study corroborated these suggestions and reflected the actual use of statistics in nursing practice. The classification suggested in this study can be taught in statistics classes as authentic materials.

The classification presented in this study emphasizes the nurses' involvement in research processes and evidence-based practice; however, as Purssell and While (7) noted, the assumptions and meanings of statistics and research concepts should be understood to reduce the risk of misinterpretation. Therefore, it is recommended to teach

statistics concepts, along with their uses in research. Another suggestion is given by Henshaw (15), noting that defining the existing statistical level of nurses can be a good departure to provide valuable materials for proceeding to learn. The findings of this study can be a suitable complement to the aforementioned purposes.

Footnotes

Authors' Contribution: Study concept and design: All authors; Acquisition of the data: All authors; Analysis and interpretation of the data: All authors; Drafting of the manuscript: All authors; Critical revision of the manuscript for important intellectual content: All authors; Statistical analysis: All authors; Administrative, technical, and material support: All authors; Study supervision: All authors

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