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Nursing professionals' attitudes toward biostatistics: an international web-based survey

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ABSTRACT

Objectives: The present study, an international web-based survey, was focused on four aims: to obtain nursing professional's self-reported statistical knowledge levels and how this knowledge varies by research area, to investigate and specify when biostatistics courses should be taught in nursing education and to identify the key statistical methods relevant to nursing education.

Methods: A total of 448 nursing professionals from five continents and 52 countries participated in our study. For the data comparison, Kruskal-Wallis test and Mann-Whitney U test were applied.

Results: The results indicate that while nursing professionals place an emphasis on biostatistics education, the majority state that biostatistics education should be taken both at the undergraduate and postgraduate level and the participants also believe that taking a biostatistics course is useful for their occupation. A biostatistics education should also emphasize the necessity of consulting to a biostatistician when planning a study.

Conclusion: Our study provides information regarding self-reported levels of biostatistical knowledge of nursing professionals by research area and academic position, and provides guidance regarding the ideal semester for administering a biostatistics course.

Keywords: Biostatistics course, biostatistics knowledge, nursing education, nursing professionals, web-based survey

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Statistics have been an integral part of nursing practice and researchas well as other health science disciplines since the days of *Florence Nightingale* (1820-1910), the first known nurse statistician and founder of professional nursing. Statistics is an important tool in the conduct of clinical, basic, and outcomes research in nursing and allied health that are required at every stage of research, from planning to completion, to produce scientifically important and reliable results [1, 2]. Health professionals need at least a basic level of statistical knowledge and the support of a biostatistician to contribute to ongoing discussions in their research area and advance in their academic career. Furthermore, since the majority of journal articles are accompanied by statistics, readers who do not conduct research but follow the innovations in their own specialized area also need a working knowledge of biostatistics, which

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may help them to easily and clearly understand what they read [3, 4].

Being a health researcher is an extensive process that starts with undergraduate education. It is a common experience with health sciences students to generally accept statistics, as a difficult and non-popular subject, mostly because of inadequate mathematical background, which leads to a decrease in interest and ability towards the course [5-7]. Hence, in undergraduate education, the student's main objective is success in statistical courses, and students cannot gain a clear understanding of the importance of biostatistics [8]. At this point, another set of reasonable questions emerges: how to teach statistics, what statistics to teach, when to teach statistics and what statistics are common in the literature, to provide students with basic data comprehension that will enable them to interpret statistical results [9].

In undergraduate education, if the key concepts that would be most meaningful to students as they enter professional practice were identified and then coupled with the additional statistical knowledge gained during postgraduate education, health professionals would be better prepared about how to make intelligent choices based on their data, and how to evaluate it specifically for their research areas. As with other health field disciplines, nurse scientists also need to develop a statistical mindset for their own research, to be able to analyze clinical phenomena in a systematic manner, and to be able to use and generate research in the clinical setting for enhanced patient care [10, 11].

The present study, an international web-based survey, was focused on four aims:to obtain nursing professional's self-reported statistical knowledge levels and how this knowledge varies by research area, to investigate and specify when biostatistics courses should be taught in nursing education and to identify the key statistical methods relevant to nursing education.

METHODS

In the present study, nursing professional data were obtained by a web-based survey. Participants were selected randomly from the PubMed (www.ncbi.nlm.nih.gov) database for the years 2005-2016 using the keywords "*school of nursing, nursing school, faculty of nursing, nursing faculty*", by screening the nursing journals. Therefore, the participants were determined by searching the keywords in the corresponding or the first author's address information of the articles. After the participants were identified, they were also confirmed to be nursing professionals from their institutional web page or from their previous studies. The participants were invited to participate in the survey via e-mail, and the respondentswere directed to the survey at Survey Monkey (https://www.surveymonkey.com).

In the first part of the survey, subjects were asked whether a biostatistics course would be useful for their future careers (from "completely disagree: 0"; to "completely agree: 4"), at which semester or semesters should biostatistics be administered, and how much importance they placed on biostatistics (from "not important: 0"; to "very important: 10"). In the second section of the survey, the subjects were asked which statistical methods, tests and techniques they knew, out of 54 methods and techniques which referenced based on our previous studies [4, 12, 13]. Only self-reported general knowledge about the procedures was assessed. In the questionnaire, methods, tests and techniques were grouped as "general statistics knowledge." Subgroup statistical methods, tests and techniques were classified as follows: "parametric tests", "non-parametric tests", "multivariate methods", "sampling methods" and "survival analysis methods". The self-reported statistics knowledge of each participant was converted to a ratio by dividing the number of methods, tests and techniques that the participant knew by the total number of methods, tests and techniques in that subject group.

Statistical Analysis

In this study, the Shapiro-Wilk normality test was applied to determine whether the variables were normally distributed. For comparison, Kruskal-Wallis test and Mann-Whitney U test were applied using a significance level of $\alpha = 0.05$. For post hoc comparisons, Dunn-Bonferroni tests were considered. Dueto the use of nonparametric tests for comparison, data were represented with median and interquartile range(IQR), which is equal to the difference between the 25th and 75th percentile value. Statistical analyses were performed by using SPSS(IBM Corp. Released

Table 1. Distribution of the participants according to continents and countries

Continent	Country
Africa n = 19 (4.20%)	Nigeria (5), Ethiopia (4), South Africa (4), Botswana (2), Egypt (1), Malawi (1), Uganda (1), Zambia (1)
America n = 206 (46%)	United States (162), Canada (22), Chile (3), Brazil (19)
Asia n = 112 (25%)	Turkey (30), China (14), Iran (14), Jordan (12), Israel (8), Japan (7), Saudi Arabia (6), India (5), Republic of Korea (4), Indonesia (2), Malaysia (2), Oman (2), Lebanon (1), Qatar (1), Thailand (1), United Arab Emirates (1), Vietnam (1), Yemen (1)
Europe n = 81 (18.10%)	Spain (15), United Kingdom (14), Italy (9), Ireland (6), Norway (6), Greece (5), Sweden (4), Switzerland (4), Cyprus (3), Belgium (2), Finland (2), Lithuania (2), Netherlands (2), Poland (2), Austria (1), Germany (1), Malta (1), Serbia (1), Slovakia (1)
Oceania n = 30 (6.70%)	Australia (27), New Zealand (3)

2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.).

RESULTS

Of the 10.000 e-mail invitations sent, 866 were rejected by the server due to e-mail addresses being either incorrectly spelled or no longer valid, leaving an estimated 9,134 email recipients. Those who responded with the intention of participating numbered 463, reflecting a responserate of 5.07%. Additionally, of 463 respondents, 15 were excluded from the study due to their failure to complete the survey.

Participant median age was 49 (IQR = 18) years (range: 20 to 77 years). The majority of participants were female (n = 359, 80.10%). A total of 448 nursing professionals from five continents and 52 countries participated in our study (Table 1).

Of the total, 141 were academic staff, including 44 (9.80%) Assistant Professors, 54 (12.10%) Associate Professors and 43 (9.60%) Full Professors. The rest of the participants, who also had academic careers but were not academic staff, were distributed as follows: Doctor of Philosophy (Ph.D.) (n = 260,

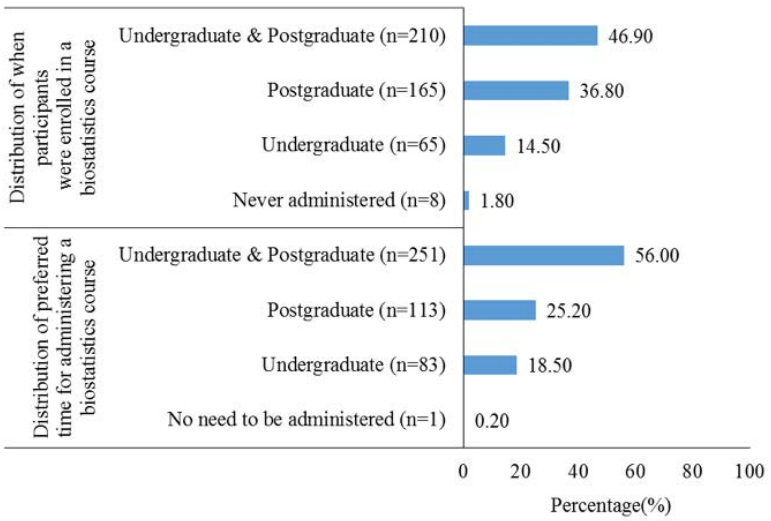

Figure 1. Percentage of when the participants enrolled a biostatistics course and preferred time line.

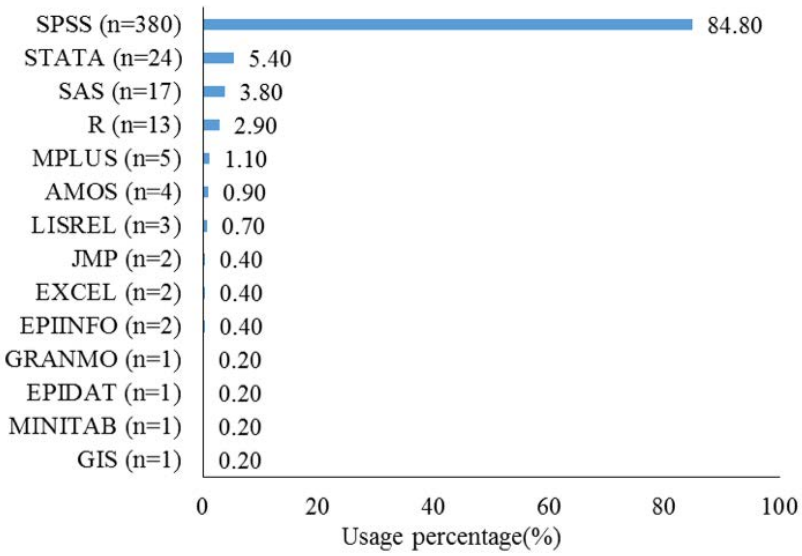

Figure 2. Usage percentage of preferred statistical software by nursing professionals.

58.00%) and Master of Science (M.Sc.) (n = 47, 10.50%).

Nearly half of the participants (n = 210, 46.90%) stated that they have administered a statistics course in both undergraduate and postgraduate education. This is followed by the percentage of those (n = 165, 36.80%) who only administered such courses at the postgraduate level. The distribution of the responses of the remaining participants, by the time periods in which they were administered a biostatistics course,

Table 2. Descriptive values and comparisons of whether enrolling in a biostatistics course is useful for one's occupation and the importance placed on biostatistics in nursing science according to academic staff and research area

Academic Statue	Do you agree with the idea that taking a biostatistics course is beneficial for a nurse's profession? (min-max: 0-4)	What is the importance of biostatistics in nursing science? (min-max: 0-10)
Academic Staff (n = 141)	4 (0)	10 (1)
Non-academic Staff (n = 307)	4 (0)	10 (2)
***p* value**	0.978[a]	0.351[a]
Research Area		
Fundemantel Nursing & Basic Science (n = 28)	4 (1)	10 (2)
Surgical Nursing (n = 31)	4 (0)	10 (2)
Medical Nursing (n = 119)	4 (0)	10 (1)
Obstetrics and Gynecological Nursing (n = 40)	4 (0)	10 (2)
Family and Community Health Nursing (n = 87)	4 (0)	10 (1)
Pediatric Nursing (n = 35)	4(0)	10 (2)
Psychiatric and Mental Health Nursing (n = 44)	4(0)	10 (0)
Nursing Management (n = 46)	4 (0.25)	10(2)
Nursing education (n = 18)	4 (2)	8(3)
***p* value**	0.532[b]	0.200[b]

Data are presented as median(Interquartile range). [a]: Mann Whitney U test, [b]: Kruskal Wallis test

was as follows: 14.50% (n = 65) took a biostatistics course only during undergraduate education, and the remaining 1.80 % (n = 8) stated that they never took a statistics or biostatistics course (Figure 1).

More than half of the participants (n = 251, 56.00%) preferred that biostatistics courses be taken at both the undergraduate and postgraduate levels. The choice of the biostatistical course, only in postgraduate education, was the second most-preferred option (n = 113, 25.20%). The rest of the preferred opinions were as follows: 18.50% (n = 83) of the participants preferred that the course be administered only at the undergraduate level, and 0.20% (n = 1) stated that there was no need to administer the course (Figure 1).

It was determined that SPSS is the most preferred statistical software for statistical analysis (Figure 2). The three most-preferred statistical software are as follows: SPSS (84.80%), STATA (5.40%) and SAS (3.80%).

Academic and non-academic participants think that the biostatistics course is very important for them and that administering the course will definitely benefit the profession in the future (Table 2). There was no difference in responses between academic and non-academic staff. Furthermore, all participants also agreed on the importance of biostatistics in nursing science with the median point 10 (IQR: 2). Regardless of whether they were academic staff or not, there was also no difference between participant's responses to the importance of biostatistics and its usefulness, even when examined only in the research fields of nursing science (Table 2).

The comparison of self-reported statistical knowledge level according to academic status is given in Table 3. Although there is no difference between the academic and the non-academic staff, according to the level of information, interestingly, there is a difference between statuses (Table 3).

There was a difference between the status groups according to the information levels in all of the sub-

Table 3. The comparisons of the level of self-reported statistics knowledge possessed by academic statues and research area

Academic Statue	Sampling methods (%)	Parametric tests (%)	Non-parametric tests (%)	Multivariate Methods (%)	Survival Analysis Methods (%)	General Statistics (%)
Academic Staff (n = 141)	33.33 (75)	85.71 (28.57)	50 (35.72)	33.33 (41.66)	0 (66.67)	46.30 (38.89)
Non-academic Staff (n = 307)	41.67 (66.67)	100 (28.57)	50 (28.58)	41.67 (41.66)	33.33 (66.67)	51.85 (35.19)
***p* value**	0.125[a]	0.264[a]	0.656[a]	0.513[a]	0.181[a]	0.357[a]
(1) M.Sc. degree (n = 47)	25 (58.33)	85.71 (42.86)	42.86 (35.71)	16.67 (25)	0 (33.33)	35.19 (83.34)
(2) Ph.D. degree (n = 260)	50 (66.67)	100 (100)	50 (28.58)	41.67 (41.67)	33.33 (66.67)	53.70 (35.19)
(3)Assistant Professor (n = 44)	20.84 (50)	85.71 (71.43)	42.86(42.86)	29.17 (50)	0 (33.33)	40.74 (37.50)
(4) Associate Professor (n = 54)	33.33 (58.33)	85.71 (28.57)	50 (28.57)	33.33 (20.83)	0 (66.67)	43.52 (28.24)
(5) Professor (n = 43)	75 (66.66)	85.71 (28.57)	64.29 (35.71)	41.67 (33.34)	33.33 (100)	61.11 (38.89)
***p* value**	**< 0.001[b]**	**0.011[b]**	**0.001[b]**	**< 0.001[b]**	**0.002[b]**	**< 0.001[b]**
	Pairwise Comparisons Among Academic Statues					
Sampling methods (%)	$\boldsymbol{p_{2\&3}=0.041}$, $\boldsymbol{p_{3\&5}=0.003}$, $\boldsymbol{p_{4\&5}=0.007}$, $\boldsymbol{p_{1\&5}=0.050}$, $p_{1\&4}=1.00$, $p_{1\&3}=1.00$, $p_{2\&4}=0.101$, $p_{1\&2}=0.689$, $p_{2\&5}=0.644$,					
Parametric tests (%)	$\boldsymbol{p_{1\&2}=0.014}$, $p_{1\&4}=0.943$, $p_{1\&5}=0.358$, $p_{3\&4}=1.00$, $p_{3\&5}=1.00$, $p_{2\&3}=0.386$, $p_{4\&5}=1.00$, $p_{2\&4}=1.00$, $p_{2\&5}=1.00$,					
Non-parametric tests (%)	$\boldsymbol{p_{1\&2}=0.014}$, $\boldsymbol{p_{1\&5}=0.001}$, $\boldsymbol{p_{3\&5}=0.043}$, $p_{1\&3}=1.00$, $p_{1\&4}=0.712$, $p_{3\&4}=1.00$, $p_{3\&5}=1.00$, $p_{2\&4}=1.00$, $p_{4\&5}=0.157$, $p_{2\&5}=0.344$,					
Multivariate Methods (%)	$\boldsymbol{p_{1\&2}<0.001}$, $\boldsymbol{p_{1\&5}<0.001}$, $p_{1\&3}=0.135$, $p_{1\&4}=0.110$, $p_{3\&4}=1.00$, $p_{2\&4}=0.182$, $p_{4\&5}=0.153$, $p_{3\&5}=0.239$, $p_{2\&5}=1.00$					
Survival Analysis Methods (%)	$\boldsymbol{p_{3\&5}=0.027}$, $\boldsymbol{p_{4\&5}=0.043}$, $p_{3\&4}=1.00$, $p_{1\&3}=1.00$, $p_{2\&3}=0.129$, $p_{1\&4}=1.00$, $p_{2\&4}=0.209$, $p_{1\&2}=0.388$, $p_{1\&5}=0.074$, $p_{2\&5}=1.00$					
General Statistics (%)	$\boldsymbol{p_{1\&2}=0.001}$, $\boldsymbol{p_{1\&5}<0.001}$, $\boldsymbol{p_{3\&5}=0.009}$, $\boldsymbol{p_{4\&5}=0.023}$, $p_{1\&3}=1.00$, $p_{3\&4}=1.00$, $p_{2\&3}=0.064$, $p_{2\&4}=0.179$, $p_{2\&5}=1.00$					

Data are presented as median(Interquartile range). [a]: Mann Whitney U test, [b]: Kruskal Wallis test

Table 4. The comparisons of the level of self-reported statistics knowledge possessed by academic status and research area

Research Area	Sampling methods (%)	Parametric tests (%)	Non-parametric tests (%)	Multivariate Methods (%)	Survival Analysis Methods (%)	General Statistics (%)
Fundamental Nursing & Basic Science (n = 28)	33.34 (83.33)	92.86 (39.29)	57.14 (37.50)	25 (47.92)	50 (100)	52.78 (39.81)
Surgical Nursing (n = 31)	33.33 (75)	85.71 (28.57)	50 (42.86)	25 (33.33)	0 (66.67)	44.44 (40.74)
Medical Nursing (n = 119)	33.33 (66.67)	85.71 (28.57)	50 (28.58)	33.33 (41.66)	0 (66.67)	50 (37.04))
Obstetrics and Gynaecological Nursing (n = 40)	25 (72.92)	85.71 (28.57)	50 (35.72)	33.33 (33.33)	16.67 (66.67)	45.37 (37.97)
Family and Community Health Nursing (n = 87)	50 (66.67)	100 (28.57)	50 (35.72)	41.67 (41.67)	0 (66.67)	53.70 (31.48)
Paediatric Nursing (n = 35)	58.33 (83.34)	100 (28.57)	50 (21.43)	50 (41.66)	33.33 (66.67)	59.26 (38.89)
Psychiatric and Mental Health Nursing (n = 44)	41.67 (58.34)	92.86 (28.57)	50 (28.58)	33.33 (41.66)	0 (33.33)	49.08 (35.19)
Nursing Management (n = 46)	41.67 (75)	85.71 (28.57)	50 (35.72)	50 (35.42)	0 (66.67)	53.70 (32.87)
Nursing education (n = 18)	25 (100)	92.86 (32.14)	42.86 (51.79)	37.50 (75)	0 (66.67)	49.08 (59.73)
***p* value**	0.370[b]	0.799[b]	0.908[b]	0.246[b]	0.411[b]	0.650[b]

Data are presented as median(Interquartile range). [b]: Kruskal Wallis test

subjects identified. It was determined that the level of professor knowledge about sampling was higher than participants with M.Sc. degrees, assistant professors and associate professors. It was also determined that the level of knowledge about sampling is higher for participants with Ph.D. degrees than assistant professors. For the sub-subject, group-titled parametric tests, the only difference was found between participants who had MSc. degrees and those who had Ph.D. degrees. Again, professor knowledge levels about non-parametric tests were found to be higher than participants with M.Sc. degrees and assistant professors, while participants with Ph.D. degrees also had higher self-reported knowledge levels than participants with M.Sc. degrees. In terms of multivariate methods, it was determined that participants with M.Sc. degrees had lower levels of knowledge than participants with Ph.D. degrees and professors. As for survival analysis methods, it was determined that the self-reported knowledge levels of professors were higher than assistant professors and associate professors.

When assessed in terms of general knowledge level, it was determined that except for participants with PhD. degrees, professor knowledge levels were higher than all other statuses. It was also observed that participants with Ph.D. degrees had higher self-reported knowledge levels than participants with M.Sc. degrees. It can be seen that the differences achieved in the sub-group subjects, according to academic status, also could not be observed among the research areas in nursing science (Table 4).

DISCUSSION

In the nursing profession, the use of statistics directly affects patient care and advocacy efforts to advance the profession. However, for evidence-based practice to become well established, nursing professionals must have a basic understanding of statistics to be able to read, understand, and interpret the relevant literature. Although there are a multitude of studies [4, 6, 8, 12-17] assessing statistics and biostatistics education in the field of medicine and other health science fields, there are fewer studies [7, 10, 18] particularly in nursing science.

Nearly half of the participants stated that they completed statistics or biostatistics courses at both the undergraduate and postgraduate levels. In fact, this finding is consistent with our previous studies in literature [12, 13]. In these studies, nearly half of the

participants in medicine (n = 128, 46%) and veterinary medicine (n = 66, 42.60%) also stated that they had taken such courses during similar periods. In another similar study focused on academic dentists, Ocakoglu *et al*. [4] also reported that the majority of participants (n = 111, 44%) stated that they took the statistics or biostatistics course during the undergraduate period. These studies reflect that in the subfields of health science, statistics is considered part of postgraduate education as well as undergraduate education. Participants were also asked their opinions about when the course should be provided. Furthermore, over half of the participants (n = 251, 56%) were united in the idea that a nursing practitioner who wanted to have an academic career should take statistics at both the undergraduate and postgraduate levels. In similar studies [4, 12, 13], on the direction of their experience in academic life, participants from various health science fields also suggested that the course should be administered during both the undergraduate and postgraduate periods.

Nurses should be trained in basic statistics during their career. Nurses who pursue masters or Ph.D. degrees in nursing science especially need to know advanced statistical techniques, as they are required to do a research thesis or to publish their study. Utilization and the use of statistics in nursing practice helps nursing professionals to determine the effectiveness of their work.

Statistical software is a useful tool that transfers the statistical skills of nurses to research reports. With a solid understanding of statistical fundamentals, combined with appropriate statistical software, evidence-based nursing research has much to offer the healthcare community [19]. In the present study, it was found that SPSS is the most preferred statistical software for statistical analysis. The same preference has been obtained in similar studies applied to other disciplines in the field of health sciences [4, 12, 13, 20].

It is an unfortunate truth that statistics and biostatistics courses are the courses in which most health professionals are unwilling and do not give adequate attention to during their undergraduate education [21, 22]. After graduation, when these former students participate in research, even if only temporarily, there is considerable motivation to obtain a sufficient understanding of basic statistical methodology [8, 13]. In this study, academic and non-academic nursing professionals stated the importance of biostatistics in nursing science and its acceptance as a useful tool for the profession. Beyond the difference between academic and non-academic, regarding the importance of statistics courses and their role in career advancement, there was also no difference among research areas of nursing professionals.

In the present study, participants were also asked to indicate whether they have awareness or knowledge about subjects that are harmonized within biostatistics or statistics lessons that are commonly taught in other health science disciplines. In similar studies [4, 12, 13], the low level of participant's self-reported knowledge, especially about sampling methods, was remarkable; surprisingly, this finding does not exist in the present study of nursing professionals. It can be concluded that nursing professionals realize that data collected from given samples, and its interpretation, will accurately reflect conditions found in the general population.

There was no difference between academic and non-academic nursing staff professionals in terms of self-reported knowledge of biostatistics subjects. Moreover, there was no difference in the level of knowledge by nursing professional's research areas. The remarkable finding is that the level of knowledge varies according to academic status. This finding can be interpreted as the product of more publications with an increase of vocational skills and experience, and in this regard, the increase of biostatistics knowledge level.

The biostatistics curriculum should be adaptable and include specialized statistical methods appropriate to the data characterization and analysis,and for the research areas of the target group enrolled in the course. In other words, it may be unnecessary to teach the same set of statistical methods to every field within the health sciences [4]. For this reason, it can be accepted that the level of knowledge differs according to the statistical methods used by different disciplines in health sciences. In the present study, while the topic with the lowest level of self-reported knowledge was declared as survival analysis methods, the topic with the highest level of knowledge was reported as parametric tests. In contrast, with parametric tests, nursing professionals were less informed about the

non-parametric statistical methods, yet nonparametric tests must be used when the assumptions for parametric tests are not satisfied. Imperatively, this situation leads us to the following questions: Are parametric tests used, by nurses within the habit of analyzing the data? Are the parametric procedures being tested to ensure that they meet the necessary assumptions, such as normality, for their application? Therefore, research related to this topic should be conducted according to the result of these studies, if it is indeed needed, more importance should be given to parametric and nonparametric distinction in the courses [12]. Even if health professionals take biostatistics courses, they should not implicitly trust themselves in the field of statistics. It is important to remember that the design of each study and the characteristics of the data obtained may be different and specific to a particular study, so each study may require different statistical methods, with which the researchers may be unfamiliar [4].

It is clear that medical study that involves any aspect of the collection, summarization, analysis and/or interpretation of clinical quantitative information requires statistical support and guidance. This input may be provided by the health professionals themselves if properly trained but is most appropriately and commonly achieved by a collaboration with a biostatistician. The biostatistician can be an assistant, consultant, or colleague co-investigator [23]. In 1938, R.A. Fisher said "*To consult the statistician after an experiment is finished is often merely to ask him to conduct a post mortem examination. He can perhaps say what the experiment died of*". Therefore, obtaining the services of a biostatistician in the planning stage of a study is strongly encouraged, to assist in the stages of "proper study design" and "conducting the study" in the research process, before finally setting up the database and statistical analysis [24].

Limitations

One of the main limitations of this study is the low response rate (< 10%). The low response rate is not surprising, given that response rates to surveys have dramatically declined over time, due to the proliferation of junk mail, the rapid growth and ease of large-scale surveys, and resulting complaints that people feel "bombarded" with internet-based surveys in the face of increasing demands on their time [25]. However, our response rate of 5.07% is similar to that of web-based studies in previous research aimed at medical providers (4%) [26], academic veterinarians (4.38%) [13], primary care physicians (5.7%) [27], dental physicians(9.1%) [4], and a group of urologists (9.3%) [28]. When similar studies are considered, our response rate is acceptable.

CONCLUSION

The present study is significant in terms of its international scope, intent and originality due to the uniqueness of this scope. Our study provides information regarding self-reported levels of biostatistical knowledge of nursing professionals by research area and academic position, and provides guidance regarding the ideal semester for administering a biostatistics course. This study can also make a contribution interms of revising higher education nursing curricula by including frequently used statistical methods as a part of nursing research to enable nursing professionals to understand current research and contribute to its ongoing discussion.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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