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Assessment of knowledge, perception regarding biostatistics and interpretation of research among Moroccan Dental professionals

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Abstract

Objective: The objective of the present study was to evaluate dental professionals' perception of biostatistics and interpretation of research results. **Methods & Materials:** A cross-sectional questionnaire survey was conducted among dental professionals of Casablanca Dental School, Morocco. 81 participants completed the questionnaire (rate of response 90%). The responses were assessed on 5-point Likert scale. With regards to biostatistics knowledge, one major result that stood out was the proportion of correct items in the questionnaire. **Results:** 60% of participants had a graduation duration ranging from 1 to 10 years. About two-thirds (62%) were professors and about 1 third (31%) were residents. 90% of the respondents wanted to learn more biostatistics. The overall mean percentage correct on statistical knowledge and interpretation of results was 19.4%. The most important response percentage was recorded for the knowledge of case-control studies (38.3%). The least important response percentage was 2.5% for Cox's regression identification. Length of time after graduation and the participants' grade were significantly associated with biostatistics knowledge. **Discussion:** The study concluded that dental professionals showed a low perceived knowledge of biostatistics concepts; thus, there is a need to implement biostatistics into dental programmes to meet dental professionals' use in research and clinical practice.

Keywords: Biostatistics, Biomedical Research, Education, Dental, Morocco.

INTRODUCTION

Biostatistics is the application of statistics to the biological and medical field. It allows clinical researchers to design, conduct and interpret health-related research. Therefore, it is important for dental professionals and researchers to understand the basics of biostatistics to be able to publish their research in international journals. Accordingly, the diagnosis and treatment of patients should be based on data from rigorously designed and conducted studies. This way, the reader is required to assess the design of the study and carefully analyse it before reaching conclusions. The concept of evidence-based medicine (EBM) has become the golden standard for decision making in medical practice and policy. EBM consists of "the process of systematically finding, appraising, and using contemporaneous research findings as the basis for clinical decisions" [1].

Today, in the era of evidence-based Dentistry (EBD), it is more important than ever to make scientific evidence-based decisions so as to provide patients with the best available treatment and enhance treatment efficiency. If endorsed by the dental professionals, EBD may well-influence the extent to which society values dental research. Thus, dental professionals should understand the precepts of EBD to be able to properly evaluate the literature and be able to identify high-quality evidence. Even though we can organize the level of evidence, based on the type of study, it is imperative that we look upon it with critical eyes and attentive mind, particularly when new or controversial evidence is being presented [2].

As new technologies evolve, dental schools are expected to provide students with the knowledge and skills needed to provide best care to their patients.

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It is through research and discovery that dental schools can prepare future practitioners to remain ahead of this emerging health care curve, stay relevant and up-to-date, and be better prepared to recognize the challenges EBD presents to the research community to strengthen the available evidence and improve the processes of summarizing the evidence and translating it into practice. Despite an increased emphasis on evidence-based practice to improve patient outcomes, there are several research gaps in the dental profession. In addition to efforts aimed at promoting evidence-based practice, there is a strong impetus for university programs to design curricula that will back up the development of students' knowledge, attitudes, skills and behaviours associated with evidence-based practice. Although curricula in North America and Europe are becoming increasingly focused on evidence-based practice, research on students' attitudes towards evidence-based practice, their perceptions regarding the integration and impact of this content within the curricula, and the impact of the curriculum on their readiness for evidence-based practice in Morocco is scarce. In this respect, Moroccan dental students express concern that they are ill-prepared to evaluate evidence using disciplines such as biostatistics and research methodology. That preparation should include a range of research and scholarly experiences that will equip students with the tools required to evaluate and assess the most current literature and scientific discoveries that will shape the future of dental practice [3].

This "exercise was designed as a limited, but feasible intervention which would build on earlier learning from the preclinical, clinical epidemiology and biostatistics courses, and demonstrate an approach that students could practice during clinical years" [4, 5]. For this reason, it is essential that errors in scientific articles be minimized. "Over the past decades, a great increase in the use of statistical methods has been documented for a wide range of medical journals" [6]. Nevertheless, "a high proportion of published medical research contains statistical errors" [6].

A growing number of studies are emerging in the medical literature that describe biostatistical flaws of research studies. Many examples of these flaws are related to the dental literature. These deficiencies can irreparably bias the final results [4, 5]. Studies of published medical literature estimate the error rate in statistical analyses and interpretation of results between 27% and 90% [6, 7]. The analysis of articles submitted to one medical journal showed that among the most frequent and serious errors were determination of the type of the study, sample size considerations, population sampling, the use of parametric tests, analysis of frequent measures, determination of confidence intervals (CI), selection bias (denial of participation), data quality, choice of confusion factors and lack of «p» values [7, 8]. A systematic review of the medical literature published in 34 journals having the highest impact factor showed that 10% of the articles did not carry out an adjustment for the confusion factors. The scientific quality of the articles published by researchers in epidemiology and biostatistics departments in public health was rated higher [9].

Therefore, to critically appraise published articles, dental professionals should have a basic understanding of biostatistics. This includes helping with description, organization, data analysis and interpretation of the results, and their applicability to better care for patients [10]. However, only a handful of articles have been published in the dental literature concluding that dental professionals' knowledge of biostatistics is so limited that they cannot draw the right conclusions from statistical analyses presented in dentistry journals. There is evidence that researchers often inappropriately apply statistical methods due to poor understanding of statistical concepts [11] and Glantz [12] suggested that approximately half of the published articles in medical journals that use statistical methods, use them incorrectly. Specifically, they have pointed out that doctors who had no prior training in biostatistics, had a limited knowledge of statistical tests and their ability to interpret study results was poor [13, 14]. Many of them have increased difficulty today because the statistical methods used in medical articles today are getting more complicated [15, 16]. Corroborating this lack of knowledge, Horton *et al*, doctors maintained that physicians' ability to understand statistics and interpret the results represented only 21% [15]. Therefore, we can deduce that dental professionals' lack of the *basic* statistical tools and *techniques is common among them.*

Even worse, there is dearth of research on the understanding of statistical methods and results of scientific articles among interns, residents and faculty working at Casablanca School of Dentistry, Morocco. The present study fills this gap by evaluating the perception of Moroccan dental professionals' towards biostatistics and interpretation of research results.

METHODS &MATERIALS

A cross-sectional study was conducted between January 2011 and April 2011 at University Casablanca School of Dentistry, Morocco. The study population consisted of interns, residents, specialists and professors.

We used a self-administered questionnaire, which was developed by D.M. Windish *et al* 2007 [1]. However, the questionnaire was divided into four sections, unlike the original questionnaire which had three sections. It was based on a literature review of 239 articles published in six journals, namely, *The American Journal of Medicine*, *Annals of Internal Medicine*, *BMJ, JAMA, Lancet, and New England Journal of Medicine*. In these articles, the authors summed up the statistical methods used, brought into focus the questions and interpreted the common statistical methods (eg, 2, « *t* » test, analysis of variance) and developed multivariate analyses (eg, Cox regression). The original questionnaire was translated into French, which is used as a means of instruction in Moroccan Dentistry schools.

The version obtained after the process of translation was tested on a focus group of 10 professors and residents who belonged to the Department of orthodontics. The adapted questionnaire underwent a number of modifications, one of which was related to the number of sections.The first part consisted of nine questions addressing the socio-demographic characteristics of participants. These included age, sex, rank, number of years since graduation and background knowledge in epidemiology, biostatistics, critical reading of scientific articles and EBM. The second part consisted of five questions related to the dental professionals' perception of biostatistics. Perception questions were evaluated using a 5-point Likert scale where 1 referred to, do not agree at all and 5 expressed strongly agree. The third part, comprised of four questions, investigated how much confident dental professionals were about interpreting and evaluating statistical methods. Confidence questions were evaluated using a 5-point scale where 1 referred to no confidence and 5 expressed complete confidence. Part four consisted of 14 multiple-choice questions (MCQs), and assessed the participants' understanding of statistics, study design, and the interpretation of study results. The questions focused on the different types of research variables, statistical methods, confidence intervals, the interpretation of the p value, the sensitivity and specificity, power and sample size. The MCQ statistic test in the original survey comprised 20 questions. This change was sought to reduce the questionnaire-time filling.

All the participants who took part in this work were informed in advance about the objectives of the study. 90 survey instruments were distributed to all the participants during staff meetings without limiting the response time. Data were collected from respondents as soon as they answered the questions to minimize data loss and check the non-response bias. Only 81 participants completed the questionnaire. 9 participants did not complete the questionnaire because of their inadequate kowledge of bisostatistics.

Data analysis

Data analysis consisted, first of all, of a statistical description of the population under study. The measurements of central tendencies and dispersion were calculated for each question of the first part. The percentages of both participants who agreed or completely agreed with each question of the second part related to biostatistics and those participants who had full confidence in the third part questions were calculated. The percentage of correct answers concerning biostatistics knowledge test was also calculated. The missing values were considered incorrect.

The correlation analyses used were the t-test of students; they were utilised check if two sets of data differed significantly. When the assumptions of ANOVA were not met, Kruskal-Wallis test was used to test the correlation between the average percentage of correct answers and the demographic characteristics of the population.

Data entry and statistical analysis were carried out using the Epi-Info software version 3.5.1.

RESULTS

81 respondents took part in this study. The response rate was 90%. The mean age ± SD of the respondents was 33.5 (SD = 5.6 years). A large percentage of the respondents were female (79%). About two-third (62%) were professors and about 1 third (31%) were residents. More than 70% of the respondents received some biostatistics training. 77% of the participants reported attending epidemiology courses. 61% were familiar with EBM concepts. The three main sources of information were medical conferences 36%, courses 25% and critical reading of scientific articles 18%. Approximately 60% of the respondents had a graduation duration ranging from 1 to 10 years. Table 1 displayed the respondents' demographic characteristics.

Concerning the participants' reading habits, 86% stated that they did not read journal on regular basis. The percentage of respondents who read journal in English was 34%, and with just the same percentage having read specialised scientific journals (Table 1).

Table 1: Demographic characteristics of participants

Characteristics		**N° (%)**
Sex	Men	63 (79,7)
	Women	16 (20,3)
Age (year) mean (SD)		33,5 (5,6)
Participants position	Professor	49 (62,0)
	Resident	4 (30,4)
	Intern	6 (7,6)
Years after graduation	<1	10 (12,2)
	1-3	23 (29,3)
	4-10	23 (29,3)
	11-20	19 (24.3)
	>21	4 (4,9)
Previous training/coursework in biostatistics		53 (69,7)
Previous training/coursework in epidemiology		60 (76,9)
Previous training/coursework in critical reading		47 (58,0)
Previous training/coursework in evidence-based		49 (61,3)
Congress		18 (36,0)
Courses		12 (25,1)
Reading Articles		9 (17,9)
Other proposition		10 (21,0)
Regularly reads medical journals	Yes	11 (14,0)
	No	68 (86,0)
Language of the journal	French	61 (75,3)
	English	28 (34,5)
	Odontology journals	28 (34,6)

Almost all participants (94%) agreed that it was important to have some knowledge of statistics to be an intelligent reader of the literature. 90% of the participants expressed their desire to learn more biostatistics, and 5% did not trust statistics (Table 2).

Table 2: Participants' confidence in statistical interpretation

Need statistics knowledge for an intelligent reading	93.82%
Learn more Biostatistics	90.12%
Use statistics in medical practice	66.25 %
Ability to understand statistics terms found in articles	22.22%
No confidence in statistics	04.93%

Concerning the degree of confidence to interpret statistical methods, 25% of the participants reported that they were able to interpret the p value, 12% could determine whether the statistical method used was correct or not, and 10% had complete confidence in their ability to interpret and evaluate statistical results (figure 1).

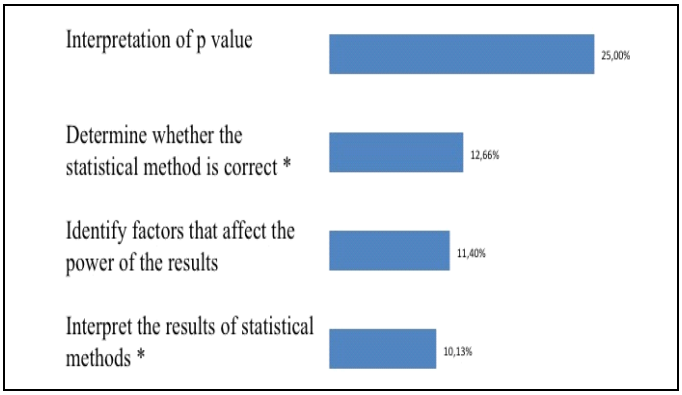

Figure 1: Participant's confidence in their statistical abilities

An examination of the results of biostatistical methods showed that the overall mean resident knowledge score was 19.4%. The highest percentage of correct answers was recorded for the recognition of case-control studies (38.3%) [95% CI, 27.7-49.7] followed by the identification of quantitative variables (34.6%), ordinals (29.6%) and nominals (29.6%). 25.9% of the participants were able to recognize the objectives of a double-blind study. The other percentages were below 20% and the average of the lowest percentage was recorded for Cox's regression identification. (Table 3).

Table 3: Percentage of correct answers in biostatistics test

Question N°	Objective	Correct % (95% CI),
1a	Identify continuous variable	34,57 (24,34-45,96)
1b	Identify ordinal variable	29,63 (19,99-40,81)
1c	Identify nominal variable	29,63 (19,99-40,81)
2	Recognize a case-control study	38,27 (27,69-49,74)
3	Recognize purpose of double-blind studies	25,93 (16,82-36,86)
4a	Identify ANOVA	12,35 (6,08 - 21,53)
4b	Identify 2 analysis	19,75 (11,73-30,09)
4c	Identify *t* test	14,81(7,90 - 24,45)
5	Interpret the meaning of *P* value >.05	14,81 (7,90-24,45)
6	Identify Cox regression	2,47 (0,30-8,64)
7	Interpret standard deviation	13,58 (6,98-23,00)
8	Recognize power, sample size, and significance-level relationship	11,11(5,21-20,05)
9	Determine which test has more specificity	13,58 (6,98-23,00)
10	Interpret an unadjusted odds ratio	11,11 (5,21-20,05)

The number of years after graduation and the title of the participants were significantly associated with biostatistics knowledge. In fact, participants with a postdoctoral duration between 1-3 years had the highest average percentage of correct answers, 31% ($p < 0.05$) followed by the range between 4 and 10 years who recorded a percentage of 20 %. Residents recorded the largest level of knowledge in biostatistics among all participants with a percentage of 29% correct answers ($p < 10^{-3}$) (Table 4).

Table 4: Knowledge Scores by participant' Characteristics

Characteristics	**Mean Correct %**	***p***
Sex		0,206
Men Women	20,75 14,29	
Grade of participants		**0,0003***
Professor Resident Interne	15,89 28,57 10,71	
Years since medical school graduation		**0,04**
<1 1-3 4-10 ≥11	17,15 30,95 20,07 14,63	
Previous training/coursework in biostatistics		0,248
Yes No	20,48 15,22	
Previous training/coursework in epidemiology		0,449
Yes No	19,17 20,63	
Previous training/coursework in evidence-based		0,472
Yes No	20,55 17,51	
Regularly reads medical journals		0,384
Yes No	14,93 20,10	
Reading of English journal		0,588
Yes No	20,92 18,60	

**Test de Kruskal-Wallis*

Table 5 : Association between degree of confidence and biostatistics knowledge

	Mean of correct answers (%)	**P**
Degree of confidence in the interpretation of p value		0,278[a]
total confidence No confidence	25,0 11,7	
Identify factors influencing the power of the results		1[b]
total confidence No confidence	11,1 11,4	
Interpret the results of statistical methods *		0,408
total confidence No confidence	2,55 1,95	
Determine whether the statistical method is correct *		0,860
total confidence No confidence	1,27 1,90	

a comparison of the correct% to item 5 on the interpretation of the p value
b comparison of the correct% to item 8 on recognazing the power
* Comparison of the mean correct% for all items

Table 5 shows a lack of association between the level of confidence to interpret statistical methods and the current level of knowledge in biostatistics.

DISCUSSION

The purpose of this study was to investigate the assessment of knowledge, perception regarding biostatistics and interpretation of research among Moroccan Dental professionals. Based on the results obtained, 94% of the respondents believed that it was necessary to have some knowledge of biostatistics to be able to evaluate the quality of research reported in medical and dental research journals. However, a very small proportion of respondents were confident enough in determining whether the statistical method used was correct, identifying the factors that influence the power of a study, and interpreting statistical results (respectively 12%, 11% and 10%). This very low level of knowledge, in which the overall mean score was 19.4%, confirmed this lack of confidence. Post-graduation years were associated with a marginal drop in knowledge scores, with 11 years or more post-graduation associated with a 14, 63% a dramatic fall in score compared with less than 3-year post-graduation.

The title (Professor, resident, etc.) of the participants was associated with higher score; in fact, knowledge scores were found to be higher among the residents as compared to the professors and junior doctors. This level of knowledge was unrelated to gender, a university program, or previous biostatistics training.

9 participants did not complete the questionnaire because they felt embarrassed about their inadequacies when filling out the questionnaire. Boynton [17], claimed that despite the high percentage of participants with training in epidemiology and biostatistics, their level of knowledge was very low.

The lack of biostatistics knowledge among the participants reflects inadequate and inefficient training. In fact, most biostatistics instruction takes place in undergraduate studies and is never reinforced in postgraduate programmes (residency, etc.).

The last medical school biostatistics evaluation study was carried in the late 1990s; the study found out that approximatively 90% of medical schools put emphasis on biostatistics teaching in the preclinical years and that the content of the curriculum varied from one medical school to another [18].

The study also stated that basic statistical concepts such as p values, t tests, and 2 analyses were heavily used (95%, 92%, and 88%, respectively); nevertheless, advanced statistical concepts (such as Cox regression, multiple logistic regression, and Kaplan-Meier analyses) were ignored [18]. The low level of knowledge in biostatistics and the need to develop residency programmes in biostatistics to meet the needs of dental professionals in clinicalresearch were the main conclusions of the medical literature that focused on these parameters [1, 7, 14, 19, 20].

Like Windish *et al.*, 2007 [1] our study illustrated that 94% of the respondents believed that it was mandatory to understand biostatistics to be able to evaluate the research design, how it is put into use, and finally how the results of each study are interpreted.

Windish *et al*. 2007 [1] also reported that 75% of the participants did not trust their current ability to interpret the statistics they encounter in medical journals. Our study, however, reported a percentage of 90%.

The overall mean resident knowledge score was 19.4%. This result was very low compared to the American students in Windish *et al*'s study 41.1% [1]. A similar percentage (49%) was found among Pakistani students [19] and among resident in oral and maxillo-facial surgery (38%) in Best *et al*'s study [21].

The highest percentage of correct answers was recorded for the recognition of case-control studies 38. 3%. This proportion was similar to that reported in the Windish *et al*. study 39.4% [1]. The highest percentage, in this survey, was 87.4% for recognizing the objective of a double-blind study. Our results were below average, as the majority of the percentages of correct responses did not exceed 20%. This difference with the international standards was very significant even when it comes to basic statistical tests: only 19.8% could identify a 2 analyses, 14.8% could identify the ***t*** test and even fewer participants could identify an ANOVA test (12.4%). Americans, however, found 25.6%, 58.1% and 47.3%, respectively [1].

Our study pointed out a statistically significant association between the years after graduation and the title of the participants, with residents recording the most significant percentages of correct answers. In fact, research methodology and biostatistics courses are scheduled during the first year of residency programmes at Casablanca School of Dentistry. Similar results were reported by Windish *et al*., 2007 [1]. They showed, in addition to these two factors, that the male gender and previous courses in biostatistics and research methodology were associated with significant scores of correct answers. Other studies showed that the reading of scientific articles, biostatistics knowledge, medical research experiments and the number of published scientific articles were the most associated factors [7, 14].

While the present study has yielded some important findings, it presents some limitations. The first limitation involves the sample population. While 81 participants may be considered an adequate number, it may limit the extent to which one can generalize the results. The second limitation relates the reduction of the total number of questions compared to the original questionnaire [1]. The questions excluded are related to determining the statistical significance from a confidence interval, the interpretation of the odds ratio, the interpretation of relative risk, the determination of power relationship, and the interpretation of Kaplan-Meier analysis results. This has limited our ability to assess the understanding of all biostatistical concepts and research results. In a similar vein, the questionnaire is made up of MCQs related to medicine rather than to odontological knowledge.

The results obtained in this paper indicate that if we want to implement the concept of EBM in daily practice, the following measures need to be taken:

- First, dental professors develop their clutch of statistical principles to be able to judge the quality of research reported in dental journals to stay up to date in their knowledge of biostatistics and EBM practices; this objective can be achieved through professional and career development.

- Second, the study showed a low level of perception of knowledge, and attitude towards biostatistics in research and indicated an excessive motivation for further training is required. Therefore, there is a need to integrate biostatistics as a subject in the dental curriculum. Incorporating biostatistics into EBM practice and curriculum would pave new ways into research field and help teaching this subject.

In sum, a fundamental knowledge of biostatistics is essential for dental professionals for understanding the concepts, applications and importance of biostatistics. It serves as methodological tool in evaluating medical literature. It is very hard to adequately interpret dental research findings without working knowledge of biostatistics. Therefore, all interns, residents, dental practitioners should be trained to have not only the theoretical foundations of biostatistics, but also the verbal and written skills to be effective in a team research environment. An effective biostatistics and research methodology training program should be an integral part of dental residency training in Morocco; it

should enable practitioners understand the results of scientific articles published in the current literature.

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