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Statics in orthodontic

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***Abstract*---**The knowledge of statistical analysis is essential before planning any research study or undergoing any orthodontic treatment. Clinical studies often compare the efficacy of a new treatment in a study group with the efficacy of conventional treatment or with a control group. Aside from a pure description, we should know whether the observed differences between the treatment groups are just random or are really present. This article informs the reader about frequently used statistical tests and their application in orthodontics and also provides a brief overview of the type of statistical tests to analyze research data with its examples.

***Keywords*---**Statistics, Orthodontics, Biostatistics.

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Introduction

Statistics is the science and art of dealing with facts and figures with various scopes like methods of collection of data, classification, and analysis of data, summarizing the data, interpretation of data, and testing the significance of data. *Baumrind*[1] stated that Statistics can neither prove nor disprove anything, it is just a tool. Its field has two main areas: mathematical statistics and applied statistics. The former is concerned with the development of new methods of statistical inference and requires detailed knowledge of abstract mathematics for its implementation. The latter involves applying the methods of mathematical statistics to specific subject areas, such as economics, psychology, and public health.

Biostatistics is the branch of applied statistics that uses statistical methods for medical and biological problems which include orthodontics and are used in every study, especially in medical sciences. *Daniel*[2] quoted Biostatistics is also called **'Biometry'** meaning '**Life Metron'** meaning – Measured so, it is the measurement of life.

Biostatistics is important in clinical orthodontics because it improves the quality and efficiency with which clinicians meet the needs of their patients. Statistical knowledge is certainly a prerequisite for evaluating many research papers. *Rinchuse and Zullo*[3] stated "Statistics describe and demonstrate the validity of new information which can improve the practice of orthodontists". Statistical analysis is important for the clinician as well as the researcher to evaluate both clinical and to improve his and/or her understanding and skills in treating patients.

Rigorous research methods such as randomized controlled trials have been developed for clinical research, but are rarely used in orthodontics. Instead, less rigorous methods, such as uncontrolled trials, cross-sectional studies, case series, case reports, animal experiments, and even anecdotes are frequently used by practitioners for their clinical decisions. Although these methods can provide useful information, they are subjected to the influence of chance occurrence, bias, and confounding or effect modifiers.

Presently, there is a comeback in evidence-based decision making with evidence-based dentistry (EBD) the buzzword in dental periodicals. *William Proffit*[4] wrote, "The orthodontic practitioner is akin to the scientist who must continually evaluate new research findings." In the present age of EBD, orthodontists need to understand the basic tenets of science and research. This article summarizes the role of statistics in orthodontics and its implication.

History of statistics in orthodontics since the beginning till recent years: an update

Year	Contributor	Contribution
1662	John	Birth of statistics, developed early human statistical and census methods that provided a framework for modern demography, produced the first life table, giving probabilities of survival

	Graunt,[5]William Petty	to each age. His book *"Natural and Political Observations Made upon the Bills of Mortality"* used analysis of the mortality rolls to make the first statistically-based estimation of the population of London. John's pioneering work *Observations upon the Bills of Mortality* sounds notes that are very similar to biostatistical reports issued today.
1802	Laplace[5]	Estimated the population of France with a similar method. Although the origins of statistical theory lie in the 18th century, the modern field of statistics only emerged in the late 19th and early 20th centuries in three stages.
	Francis Galton and Karl Pearsoon[5]	The first wave, at the turn of the century, transformed statistics into a rigorous mathematical discipline used for analysis, not just in science, but in industry and politics as well.
1829	Bisset Hawkins[6]	Work *Elements of Medical Statistics,* which was concerned with "the application of numbers to illustrate the natural history of man in health and disease"[6].
1834		The Royal Statistical Society was founded.
19th century		The first statistical bodies were established.
1910	William Gosset[7] Ronald Fisher	The second wave involved the development of the better design of experiments models, hypothesis testing, and techniques for use with small data samples.
1923	Kanji [8]	An annual volume *of Statistical Abstract of British 1ndia* was published for the first time. This annual volume was finally transferred to India.
1926	Akdeniz and Dönmez[9]	The State Institute of Statistics was established.
1930	Egon Pearson and Jerzy Neyman	The final wave, mainly saw the refinement and expansion of earlier developments
The late 1940s and early 1950s	Ronald A. Fisher	Focus on randomization proved to have profound implications for research medicine – especially for the development of the modern clinical trial. Epidemiologic studies began to appear.
1954	E. Cuyler	A study was conducted in the US, with the support of the American Cancer Society. Both

	Hammond	implied conclusions consistent with retrospective studies: cigarette smoking increased one's risk of contracting cancer.
Since the 1960s		Several factors gave increasing prominence to Statistically based ways of studying biomedical phenomena. The clinical trial became a standard requirement before experimental drugs could be administered to the general public[8].

Discussion

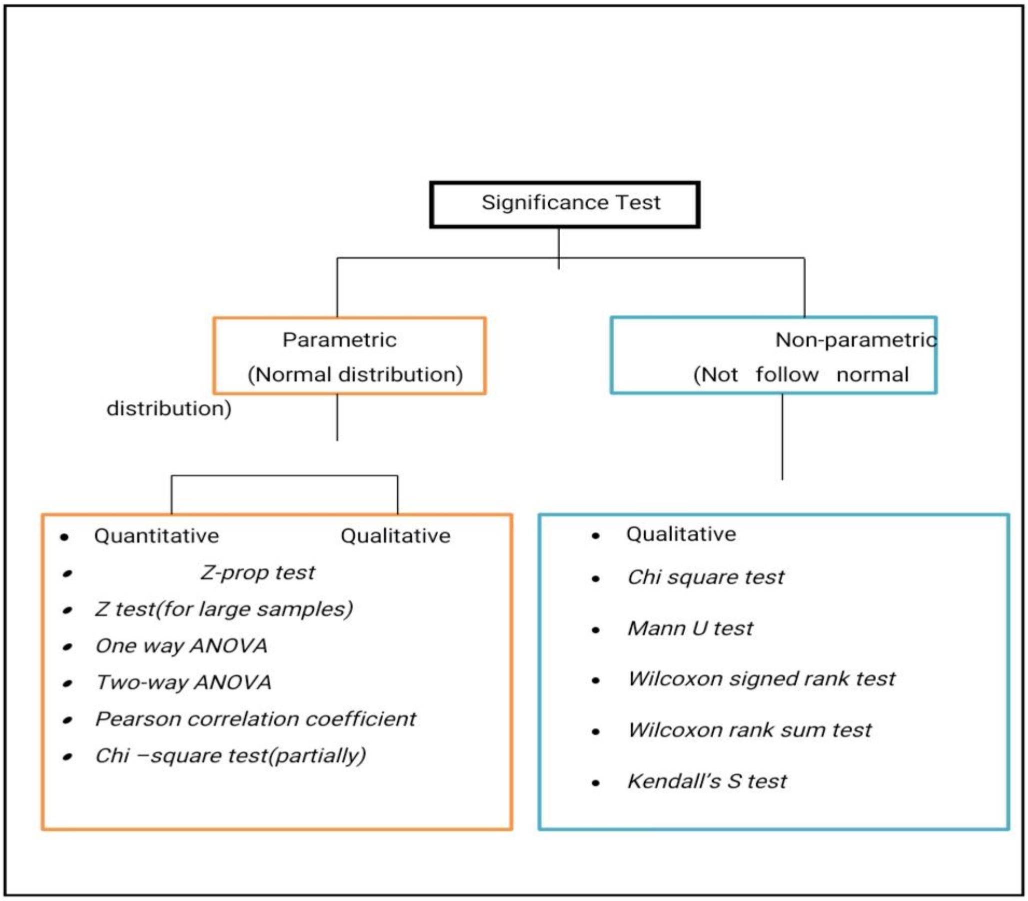
The term "statistics" encircles a number of different processes, some more familiar and others less. It is a measured or counted fact or piece of information stated as a figure. Statistics In simple words statistics is a science of figures. It is a field of study concerned with technique or methods of collection of data, classification, summarizing, interpretation, drawing inference, testing of hypotheses, making recommendations.

Daniel[2] states that it refers to tabulation or enumeration and often means documentation or proof, as against a general and numerically unsupported assertion. Garn[10]stated that instead of a single bogey or idol called statistics, there are numerous statistics', each having its own place as a research tool, as a precautionary measure, or as an adjunct to data collection and data presentation.

Fienberg[5], Akdeniz, and Donmez[9] reviewed historical aspects of statistical data and its use in the management of an empire. Kanji[8] made an attempt to study the statistical development in ancient India through the 19th century. It took more than a century to graduate to its present form but its history goes as far as 300 BC. During this period science, medicine and astronomy were far advanced indicating definite impetus towards the further development of statistical advancement. Matthews[7] illustrated dialect by highlighting selected historical episodes and methodological innovations. However, as this sketch illustrated, the ascendency of population-based thinking masks a larger ambivalence towards statistical methods within the medical profession.

Statistics has two main basic types: descriptive statistics (set of methods to describe the collected data) and inferential statistics (set of methods to generalize, predict and decide by using information from a sample and inferring something about the population).[11]

Tests of significance are mathematical methods by which the probability (P) or relative frequency of an observed difference, occurring by chance is found. Broadly statistical tests are divided into two groups: Parametric and Non parametric tests.



Classification of the types of variables according to the type of participation in the study:[12]

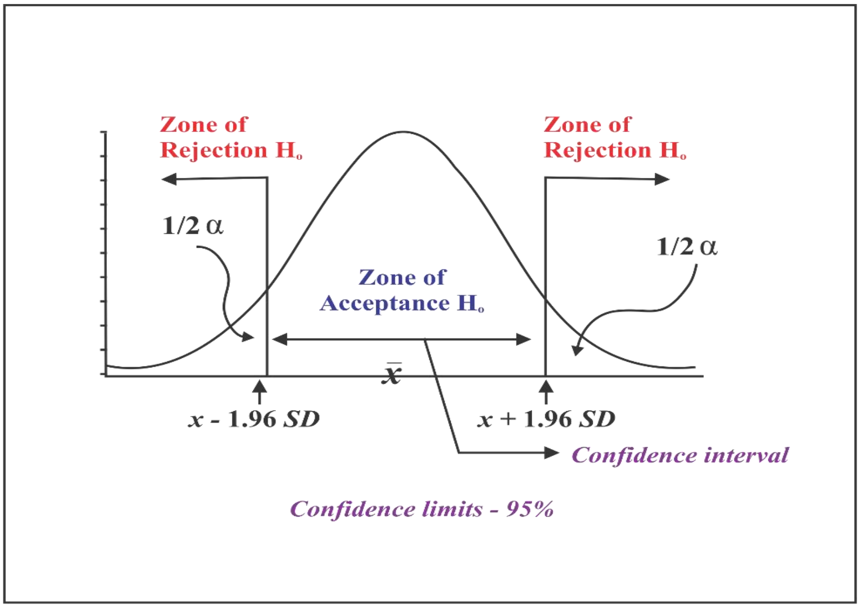
DEPENDENT VARIABLE (Response Variable)	INDEPENDENTVARIABLE (Explanatory or Predictor)
It is the event or characteristic that you want to discover or explain. It represents a quantity whose appearance, disappearance, increase, decrease, etc. depends on how the independent variable is handled by the researcher.	It is the determining factor, condition or cause that makes it possible to predict a response, effect, or consequence. It can vary during the study or be controlled but is not affected by any other variable within the experiment

Statistical hypothesis

Hypothesis is an assumption about the status of a phenomenon or is a statement about the parameters or form of population. They are carefully constructed statements about a phenomenon in the population. They may have been generated by deductive reasoning or based on inductive reasoning from prior observations. One of the most useful tools of health research is the generation of

hypotheses that, when tested, will lead to the identification of the most likely causes of disease or changes in the condition being observed. Although we cannot draw definite conclusions, or claim proof using the inductive method, we can come ever closer to the truth by knocking down existing hypotheses and replacing them with ones of greater plausibility.
Hypotheses are two types:
Null hypothesis or hypothesis of no difference (H_0): There is no real difference in the sample & general population, or between two samples, and the difference found is accidental & arises out of sampling variations. It is denoted byH_0.
Alternative hypothesis of significant difference (H_1): Any hypothesis alternative to the null hypothesis, which is to be tested. It states that there is a difference between the two samples.

To minimize errors the sampling distribution or area under the normal curve is divided into two regions or zones.
Zone of acceptance: samples in the area of mean ±1.96 SE, null hypothesis – accepted.
Zone of rejection: sample in the shaded area i.e. beyond the mean ±1.96 SE, null hypothesis – rejected.



Rozeboom[13]

Quoted the traditional null-hypothesis significance-test method, more appropriately called the "null-hypothesis decision (NHD) procedure". This statistical analysis was excoriated for its inappropriateness as a method of inference. Traditional null-hypothesis procedure already superseded in modern statistical theory by a variety of more satisfactory inferential techniques. To obtain probability, statistics are calculated first and then compared with the distribution implied by the null hypothesis to obtain a probability using tables or statistical software.

P-value *- 'P' is the proportion of success.*
Probability or P-value:- The concept of probability is very important in statistics. Probability is the chance of occurrence of any event or permutation combination. It is denoted by P for the sample and P for the population.
P ranges from 0 to 1; 0 = there is no chance that the observed difference could not be due to sampling variation.
1 = it is absolutely certain that the observed difference between the 2 samples is due to sampling variation. However such extreme values are rare.
The essence of any test of significance is to find out the p-value and draw an inference.
*If the p-value is 0.05 or more:-*it is customary to accept that difference is due to chance (sampling variation). The observed difference is said to be statistically not significant.
If the p-value is less than 0.05:- the observed difference is not due to chance but due to the role of some external factors. The observed difference here is said to be statistically significant.

Pandis[14] stated that the 'P-value is the probability of having obtained a result like the one found with sample if the null hypothesis were true. Unlike the P-value, the use of evidential measures brought scientific judgment to data analysis. Most statistics-related texts devoted their attention to hypothesis testing, but even those that gave equal treatment to parameter estimation made the distinction more difficult to understand than was the case.

Yancey[15] proposed rules for reading clinical research and the simple facts were that the larger the sample size, the less the variability and the more powerful the statistical tool, the more likely one was to find trivial differences to bear the variability and the less powerful the statistical tool, the more likely one was to find profoundly important differences to be "not significant," and the more clearly confidence intervals and prediction limited would tell one that one does not yet know what one needs to know.

Goodman and Royall[16] reviewed the arguments for and against the use of p-values put forward in the Journal and other forums and showed that they were all missing both a measure and concept of "evidence."Polychronopoulou and Eliades[17]searched orthodontic literature and determined the frequency of reporting of confidence intervals (CIs) in orthodontic journals with an impact factor. Additionally, studies are classified according to the type/design as cross-sectional, case-control, cohort, and clinical trials, and according to the subject of the study as growth/genetics, behaviour/psychology, diagnosis/treatment, and biomaterials/ biomechanics.

Hoenig and Heisey[18] highlighted a misconception about the relationship between observed power and P-value in the applied literature which confuses statisticians. So by usual standards of using the P-value as statistical evidence, their experiment gave stronger support against the null, contradicting the power interpretation. They referred to this inappropriate interpretation as the *"power approach paradox" (PAP).* The higher the computing power for detecting meaningful departures from the null, the stronger the evidence was taken to be for nature to be near the null when the null was not rejected.

Pandis[19] focused on P values that resulted in either a yes/no, significant/non-significant, or important/unimportant interpretation of the trial results without regard to the size and the importance of the clinical effect. A 'P' value on its own can only tell us the strength of the evidence against the null hypothesis of no difference. It cannot tell us in which treatment group the benefit is seen, the estimated size of any benefit, or the certainty of the estimated effect. A small 'P-value did not necessarily indicate a large intervention effect and vice versa. Interpretation based solely on 'P' values might be misleading and is not recommended.

O'Brien[20] stated procedures that were considered for the comparison of two or more multivariate samples. These included a newly proposed nonparametric rank-sum test and a generalized least squares test. He considered the following tests: ordinary least squares, Hotelling's P, and a Bonferroni per-experiment error-rate approach. The null hypothesis of no treatment difference was tested with power directed towards alternatives in which at least one treatment was uniformly better than the others. In all simulations, the nonparametric procedure provided relatively good power and accurate control over the size of the test and was recommended. A convenient expression for this was obtained and its *Asymptotic relative efficiency* with respect to the ordinary least squares test was evaluated.

Bartlett and Govindarajulu[21] demonstrated the small-sample property of the randomized rank-sum procedure. Definition and properties of the statistics were developed, which generalized some of their results. Both the randomized rank-sum and the non-randomized rank-sum statistics were employed earlier in the k population selection problem. It was further shown that an 'indifference zone' procedure based on the randomized rank-sum statistics and the 'indifference zone' 'scores' procedure was asymptotically equally efficient. Gupta and Sobel[22] took a multiple decision approach of selecting a subset from *k* given normal populations which include the 'best' population, i.e., the one with the smallest population variance. Formulae were obtained for the expected number of populations retained in the selected subset, and it was shown that the function attained maximum when the population variances were all equal.

Harrison and Lennon[23] identified all published randomized controlled trials (RCTs) studies in the British Journal of Orthodontics (BJO) and European Journal of Orthodontics (EJO). Despite RCT being regarded as the 'Gold Standard' for the evaluation of therapeutic interventions and materials only six such studies were used in their method.

Moher et al[24] described the pattern over time in the level of statistical power and the reporting of sample size calculations in published RCTs with negative results. Power calculations were based on results from the primary outcomes reported in the trials. Most trials with negative results did not have large enough sample sizes to detect a 25% or a 50% relative difference. Chalmers and Lee[25] stated that randomization of drugs tested or dosage regimens at the earliest stages of clinical use were needed to evaluate relative therapeutic efficacy and toxicity. Potent ethical arguments also required that when a new drug is tried, patients should be given a 50-50 chance of receiving the conceivably better standard therapy.

Pandis[26] studied design on the pyramid of evidence that did not necessarily indicate the validity of the results, but rather, the priority was given in decision making for treatment recommendations. The first theme of this series dealt with clinical trials: specifically, RCTs. Observational studies were used extensively to describe the distribution and exposure in populations and to generate hypotheses; hypotheses could be further assessed, when feasible, with RCTs. Observational studies, although more prone to bias and confounding, were suitable for hypothesis generation and also for developing predictive and diagnostic models.

Pandis[27] discussed the purpose and use of controls in RCTs. Statistical adjustments for known factors were possible, but not for unknown factors and this could only be remedied by using the methods of randomization with concurrent controls in an RCT (biased analysis). The use of concurrent controls was important for valid results because they allowed for fair comparisons between treatment groups.

Dersimonian et al[28] reported information about statistical analyses, statistical methods, random allocation of subjects, and reported the method of randomization. Pierce[29] observed that for finite parameter space, non-Bayesian procedures allowed a winning strategy for a statistician's adversary. Goodman[30] emphasized the Bayes factor, which in its simplest form was also called a *likelihood ratio.* This reflected the widespread misperception that the only utility of the Bayesian approach was as a belief calculus. Bayes theorem has two components, one that summarized the data and one that represented belief.

Baumrind[31] used a pre-existing database to test the hypothesis on the appropriateness of some common orthodontic beliefs concerning in growing subjects. In an initial pass, data from a stratified random sample was drawn retrospectively from the practice of a single, experienced orthodontist. The generalize ability of the findings from the initial pass to other treated growing subjects was then assessed by retesting the modified hypothesis against a second database stored sample. Rinchuse[32], Rinchuse, and Zullo[3] assessed the statistical procedures and found that inferential methods were more likely to be nonparametric than parametric. There was a twofold increase in articles using statistics over the past ten years. Mostly in the use of inferential statistics; revealing the importance of orthodontists being knowledgeable about statistical research design and analytical methods

Shears, Pankratz[33], and Wallman[34] familiarized the orthodontic clinician with those statistical procedures commonly encountered. Emphasized the appropriate use of techniques like the Students-test, analysis of variance, the chi-square test, and the nonparametric alternatives to these methods, which comprise more than 50% of the statistical tests used in the journals. Schafer, Rutemiller[35], and Mantel[36]reviewed the characteristics of an x^2 statistic, as a function of an estimator for the population parameter, and used these statistics to order the populations.

Ziegler and Chang[37] gave the diversity of disciplines, methodology, and orientation of the studies that might be classified as "statistics education research".

Summarizing and critiquing this work was a challenging and important endeavour. Bond et al[38] did a mixed-methods study, in which undergraduate students provided their perceptions of statistics and completed the Survey of *Students' Attitudes Toward Statistics*-36 (SATS-36). Robert and Bilderback[39] reported on the development and validation of an effective measure that was more relevant in statistics. Statistics Attitude Survey (SAS) was developed and administered by taking a beginning statistics course. All samples provided similar data with the exception of the correlations. Analysis showed that the scale was highly homogeneous and that total scale scores had moderate correlations with statistics grades.

The topics in orthodontics that currently provide the best evidence, as documented by meta-analyses, included issues concerning maxillary protraction treatment, prevention of posterior crossbites, reliability of lateral cephalometric measurements, the correlation between anterior tooth injuries and magnitude of overjet, correlation of external apical root resorption with treatment-related factors and type of tooth movement, and prevalence of tooth agenesis. Papadopoulos, Gkiaouris[40] documented, meta-analyses provide the best evidence to investigate the topics in orthodontics, by critically evaluating and discussing the methodologies used in studies. However, it has weaknesses, limitations, or deficiencies. Papadopoulos[41] said that at the beginning of the 21st century there was evidence for only a few orthodontic-related issues as documented by meta-analyses and more well-conducted high-quality research studies needed to produce strong evidence in order to support evidence-based clinical practice in orthodontics.

The *Cochrane Database of Systematic Reviews* (CDSR) focused on orthodontic literature and assessed the quality of the existing evidence. Koletsi and Fleming[42]analyzedmeta-analyses included in *systematic reviews* (SRs) published in leading orthodontic journals. The overall quality of evidence from the selected orthodontic SRs was predominantly low to very low indicating the relative lack of high-quality evidence from SRs to inform clinical practice guidelines. Turpin[43] discussed *Consolidated Standards of Reporting Trials* (CONSORT) guidelines developed by a team of dedicated journal editors, epidemiologists, and statisticians which comprises a checklist and a flow diagram to help improve the quality of reports of randomized controlled trials.

Wallach et al[44] evaluated how often the Cochran Q test was used to re-evaluate heterogeneity with the data from all available trials. In addition, all effect sizes from meta-analyses were attenuated toward the null. Pandis[45,46] discussed the clustering effects in orthodontics when data in clusters such as several teeth nested within patient clusters correlated. The design effect formula was introduced that incorporates the ICC and indicates how much we must increase the required sample size of a trial with clustering effects and in comparison, with a trial without clustering effects. The formulas used for sample calculations or proportions and mean differences were adapted by incorporating the coefficient of variation when calculating sample sizes for cluster randomized trials. Clustering effects are common in orthodontics.

Spanou[47] studied the prevalence of adjustment for confounding within the statistical analysis and matching at the designed stage in leading orthodontic journals and explored potential associations between accounting for confounding and publication characteristics. Tu, Chiu, and Pandis[48] showed how longitudinal orthodontic data can be analyzed using multilevel modeling (also known as hierarchical linear modeling or random-effects modeling) and illustrated how they outperform the aforementioned methods. Tu and Pandis[49,50,51] showed how an alternative approach to the curvilinear model i.e., the nonlinear growth model might be useful for orthodontic growth data analysis. Choosing appropriate nonlinear curves is more of an art than a science and inspection of the observed growth curve can provide clues for which model to begin with and how to choose starting values. They also showed how to fit nonlinear growth curves to a group of subjects within the framework of multilevel modeling and compare its results with multilevel curvilinear modeling with higher polynomial terms. The use of multi level nonlinear models to analyze complex growth curves helps in understanding the facial growth process. They explained how to use latent growth curve models for data with repeated measurements. It can be a useful tool for the analysis of data from clinical trials when a limited number of repeated observations of the same outcomes were undertaken after the intervention.

Feinstein and Koss[52] demonstrated that the proportion of "clinical" topics in the research manifested by papers was either patient centered, disease-oriented, or concerned with human material concomitant with a progressive increase in the proportion of "basic" investigations whose material was neither human nor diseased. Armitage and Gehan[53] presented an expository paper that reviewed the rationale for determining prognostic factors and the statistical methods for finding and allowing in the design and analysis of clinical studies. These include a grouping of patients according to prognostic variables and comparing treatments separately within each group; covariance analysis and maximum likelihood.

Gore et al[54] compared report on subsequently unpublished and published papers which showed adverse statistical assessments suggesting major problems were common in the papers that were not accepted. Murray[55] presented the results of an audit of the statistical standard of papers published in The British Journal of Surgery. A number of deficiencies were highlighted, many of which stem from an over-emphasis on statistical significance at the expense of any assessment of the clinical relevance of research findings.

Cicchetti and Conn[56] studied abstracts for the Study of disease. Specific tests of systematic differences in scoring revealed statistically significant levels of observer bias on most of the abstract components.

Errors In Statistical Tests:-
Type I error/ a error/ false positive error:

The null hypothesis is rejected, even though it is true. The null hypothesis is rejected even though it falls in the zone of acceptance. It is also called false-positive error. It is a serious error in clinical trials since it says that the intervention is effective in bringing in certain change though it is not. The probability of committing a type I error is denoted by α. The maximum allowable α is 5%.

***Type II error/ false-negative error**:*

The null hypothesis is wrongly accepted even though it falls in the zone of rejection. It says the intervention does not bring in any change in the variable under study. It is also called false-negative error. Not so a serious error. It necessitates confirmation of the result by changing the level of significance. The probability of committing a type II error is denoted by β. The maximum allowable β is 20%.

Pandis[57] described the random error & sources of bias in clinical trials, but some studies suggested that bias was a systematic error that leads to distortion of the true treatment effects and could arise at various stages of the trial: during design, conduct, analysis, and reporting. The most common types of bias were shown in clinical trials, must always guard against selection, performance, detection, attrition, and reporting biases.

Walter[58] compared the traditional method of statistical inference on the data from biomedical studies with a proposed index of fragility in the results. In summary, the proposed index of unit fragility was based on the notion of moving one data point from one sample to another, so that the effect measured changes by the smallest possible amount.

Inappropriate use of statistics could be found in every stage of medical research because of the lack of statistical knowledge and since they don't take statistical consulting. Strasak et al[59] presented a comprehensive review of common statistical pitfalls which can occur at different stages in the scientific research process ranging from planning a study to conducting statistical data analysis and documenting statistical methods applied to the presentation of study data and interpretation of study results. Consideration of issues discussed in the paper, when planning, conducting, and preparing medical research manuscripts, should help further enhanced statistical quality in medical journals.

Ercan[60] pointed out that inappropriate use of the statistical method and technique cause time consuming, costly and can be misleading to other scientific researchers. She discussed the main statistical error sources in medical research and aimed to be informative for researchers. Baumrind[31] stated statistics are important so that they can improve the quality and efficiency with which clinicians meet the needs of their patients. A basic understanding of the logic of statistical inference is much more important to the reader of the orthodontic literature than is the ability to manipulate or remember the numbers.

Johnston[61] highlighted a relatively non-technical, jargon-free overview of the basic methods of statistical analysis and the reasoning behind their application to the process of clinical decision-making. Cioffi[62] developed a website to support a large scale-orthodontic RCT that aimed to evaluate the efficacy of a functional appliance (www.ortodonzia.unina.it). Websites that increase the quality of data collection, simplify the randomization process, speed up data collection, and improve trial monitoring. Chudasama[63] ascertained the number, type, and overall usage of statistics in *Am J Orthod Dentofacial* Orthop. (AJODO) articles. The frequency and distribution of statistics used in the original articles were dichotomized into those using statistics and those not using statistics.

Scotch[64] examined the use of statistics in informatics research. For each journal, the results by statistical methods were analyzed as descriptive, elementary, multivariable, regression, machine learning, and other statistics. Proffit[4] made rational decisions as to what was valid and what was not. The questions put the practitioner in exactly the same position as a scientist critically evaluating new research findings; the recently launched journal clearly was aimed at the market. Professional excellence required a commitment to critical evaluation and cannot be maintained in a climate of uncritical clinical experimentation.

Rinchuse[65] highlighted the importance of understanding the principles of scientific inquiry so that the orthodontist has a greater appreciation for well-conceived clinical orthodontic research and evidence-based care. The purpose was merely to report the incidence, prevalence, or level of a disease or disorder. In the present age of EBD (evidence-based Dentistry), orthodontists need to understand the basic tenets of science and research.

Mulimani[66] evaluated how EBD had played itself out so far so that it could continue to grow strong and stand up to the challenges of 21st-century orthodontics.

This article reviews thoroughly all the statistical tools that help the orthodontist judge the clinical importance of patient centred studies. An honourable outcome will require both the generation of valid data and the ability to interpret it properly. Without a minimal knowledge of statistics and a respect for its importance in clinical research, the former is unlikely and the latter is impossible.

Conclusion

- Human subjects bring many characteristics and experiences to a research study. The complexities of the human psyche can influence and impact research findings making the controlling of experiments challenging. By understanding sound experiment design strategies and principles and issues related to specific patient characteristics, orthodontists will be better able to critically evaluate the periodic literature.
- Evidenced-based data (EBD) is the most trusted information for making decisions relative to patient diagnosis and treatment. However, one must be cautious in using and interpreting this data; it is merely a tool.
- As the specialty of Orthodontics strives to embrace the practice of EBD to guide clinical decisions, expectations are often raised regarding the use of appropriate statistical analysis.
- Thus, orthodontists are urged to become familiar with common statistical concepts and analytical procedures. They must examine the threats that encompass research and strive to account for them by developing a critical understanding of experimental design and research. If orthodontists desire to be part of the profession, the science part of orthodontics must not be

ignored in favor of the art. Patients deserve the highest level of care that is possible only through the judicious use of the best available statistics.

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