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Misuses of Statistics in Research

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ABSTRACT
This paper reviewed the various misuses of statistics in research. It established the uses and misuses of statistics by application from different angles in research. As a branch of applied mathematics, statistics entails the collection, description, analysis and interpretation of data, and inference of conclusions from the analysed data. The uses of statistics include: making judgments about health, populations, education, and much more by the government; prediction of climatic change, weather upheavals, natural disasters, the amount of rainfall and areas prone to flood, and other conditions that may influence human life; and used to make decisions in sports management and learning environment. Statistical tests can be misused, either by accident or design, and this can result in potential misinterpretation and misrepresentation which arises when a researcher alters scales to change the distribution of data; focuses on certain variables and excludes others; ignores or removes high or low scores which are considered inconvenient, so that data can be presented more coherently; and presents correlation as causation. Misuse of statistics could be unintentional due to inexperience, lack of statistical skills and inappropriate knowledge, or it could be deliberate with an intent to deceive, mislead, or favour someone/something. Some common causes of misuse of statistics in research include the following: bias, inappropriate tests, ignoring important features, overgeneralisation, assuming causation from correlation, abuse of data collection and others. To ensure the appropriate use of statistics, the study amongst others recommended that the application of data should be timely, responsibly, ethically, and visually done for whatever purpose it is used for; the misuses of statistics should be revisited from time to time to remind one of the importance of using data in a proper way as to avoid misleading readers and others.
Keywords: Statistics, research, descriptive, inferential, use, misuse.

INTRODUCTION

Statistics is a branch of Applied Mathematics that is involved in the collection, description, analysis and interpretation of data, and inference of conclusions from the analysed data. Statistics uses mathematical theories which depend on linear algebra, differential and integral calculus, and probability theory. Its main focus is on determining how reliable conclusions are drawn about large populations from the characteristics of small samples. Statistics is applied in virtually all scientific fields. Two fundamental ideas in Statistics are uncertainty and variation. Life is full of uncertainties. The uncertainties, in some cases, may be because the expected outcome is yet to be determined, while in other cases the uncertainty is because although the outcome has been determined already, the result is yet to be made open or is yet

to be declared so we are not aware of it (for instance, the result of an examination that has been determined but not yet published or declared). These uncertainties are probability measures.

Probability is the branch of Mathematics concerning numerical descriptions of how likely an event is to occur, or how likely it is that a proposition is true (Stuart & Ord, 2009). The probability of an event is a number between 0 and 1, where 0 indicates that the event is not possible to occur and 1 indicates a certainty that the event will occur. The higher the probability of an event, the more likely it is that the event will occur. Probability plays a key role in Statistics. Measurements and data collections are subject to variations (uncertainties). These uncertainties are the primary concern of Statistics: the understanding and possible control of the variations.

Statistics has two branches called statistical methods which are used in analysing data. They are descriptive statistics and inferential statistics. Descriptive statistics mostly focus on central tendency, variability, and distribution of sample data. Central tendency means the estimate of the characteristics of a typical element of a sample or population. It is a single value that attempts to describe a set of data by identifying the central position within that set of data. It is a central value or a typical value for a probability distribution. Mean, median and mode are the most commonly used measures of central tendency. Measures of central tendency provide information about typical or average values of a set of data. They are values that describe how central a value is in a distribution, as against how much the values are spread or varied (measures of variability).

Variability or dispersion is the state of getting spread or dispersed. It means the extent to which numerical data is likely to vary about an average value. It shows how much difference there is among the elements of a sample or population along the characteristics measured, which include the range, variance and standard deviation in a distribution. Distribution is a mathematical function that describes the relationship between observations. It refers to the overall "shape" of the data, which can be depicted on a chart such as a histogram or dot plot, and includes properties such as the probability distribution function, skewness, and kurtosis. Data distribution is a function that determines the values of a variable and quantifies relative frequency. Distribution transforms raw data into graphical methods to give valuable information. It is important to understand the kind of distribution that a population has to be able to apply proper statistical techniques. Different types of distribution in statistics are the following: frequency, normal, binomial, Poisson, exponential, Bernoulli, gamma, chi-squared, beta, Weibull, and others. Generally, descriptive statistics depicts differences between observed characteristics of the elements of a set of data and help in the understanding of the collective properties of the elements of a data sample and forming of the basis for testing hypotheses and making predictions using inferential statistics.

Inferential statistics, on the other hand, helps to suggest explanations for a situation or phenomenon. It allows one to draw conclusions based on extrapolations. It is used to derive estimates about a large group (or population) and draw conclusions on the data based on hypotheses testing methods. Inferential statistics enables researchers reach conclusions that go beyond the immediate data alone. For instance, inferential statistics infers from the sample what the population might be. Thus, inferential statistics is used to make inferences on a population from the sample. This use of result of a sample to infer on the population is more cost-effective and less tedious than collecting data from an entire population. It allows one to come to reasonable assumptions about the larger population based on a sample's characteristics. However, it must be emphasized that sampling methods should be unbiased and random for statistical conclusions and inferences to be valid.

Uses of Statistics

The uses of statistics are varied. While the focus of this paper is not on reviewing the various uses of statistics, attempts are made to highlight a few of them. Statistics is used in various areas of human endeavour ranging from government, sports, research, to education, and in fact in everyday life. It can be conveniently said that life will be meaningless without statistics. This is why the misuse of statistics is a colossal blow. Some uses of statistics are discussed below:

1. Government: Statistics is utilized in government by making judgments about health, populations, education, and much more. For instance, government needs to know the size and distribution of its

population, unemployment rate, and how healthy its population is. Are there prevailing diseases, epidemic or pandemic, the rate of their spread, intervention (if any). Government needs to know how many schools it has and at what levels: pre-primary, primary, secondary, and tertiary; the capacity of the schools; available and needed facilities, school enrolment, number of teachers and students/teacher ratio, funding, and many more. Statistics helps the government to make and modify policies and curricula for better teaching and learning.

2. Prediction: Statistics is used for prediction of climatic change, weather upheavals, natural disasters, the amount of rainfall and areas prone to flood, and other conditions that may influence human life. Armed with these predictions, preparations are made in advance to forestall or manage the events when they eventually occur. If interventions are needed: the nature, quantity and quality of such interventions are informed by statistics. Statistics also helps in disaster management: Rescue teams always use statistics in getting the population data, services, infrastructure present in the affected area, and what will be needed for effective rescue mission.

3. Sports: In sports management, statistics is used to aid decision making. Data from past experiences are analysed, and the right decisions made to avoid ugly experiences of the past. Managers of football and other teams chose tactics with the help of statistics by comparing tactics of other teams and attendant performances. Also, the hiring of staff in sports, and indeed all other endeavours use statistics. Training requirements are informed by statistics. Ranking of athletes, players, teams, individuals and fixtures are done using statistics. Sports data is recorded and analysed, put in tables, charts, and graphs for stakeholders to understand and appreciate. Sports commentators and analysts use statistics to predict the outcome of games.

4. Research: Data collection in research uses sample (a proportion of the population, which itself is a statistical measure), makes use of validation and reliability of the instruments of data collection. Collation, presentation and analysis of data are all statistical techniques. Research uses statistical measures of mean, standard deviation, and variance to answer research questions. Making comparisons in research on similarities and differences, drawing conclusions about populations based on sample results are techniques of statistics. Observations in research are recorded using statistics and decisions based on the recorded data provide better results than decisions based on intuition or gut feelings. Observations are analysed with descriptive statistics and generalized to the wider world using inferential statistics. Research covers areas of purchasing, production, capital investment, long-term development, quality control, human resource development, recruitment and selection, marketing, credit risk assessment or financial forecasts. These are made possible by the use of statistical data and analyses.

5. Education: Students' enrolment, carrying capacity of educational institutions, learners/teachers' ratio, and many other requirements of the learning environment are determined by the use of statistics. Statistics allows educators to understand student performance using descriptive statistics of mean, median, mode, standard deviation, percentiles, and inferential statistics of correlation and regression. These statistics are used at every level of education. For example, a principal can use descriptive statistics to monitor examination scores of students in an entire school. Or a Department of Education can use corelation to compare the performance of schools over time and regression to predict possible way to go. Also, statistics allows the comparison of different teaching methods using hypothesis tests. Over all, statistics is used to enhance effective teaching and learning with above applications.

6. Everyday Life: In modern times we cannot read books, newspapers and magazines, watch television, drive a car, or generally converse, without being confronted by statistics –opinion polls, death rates, unemployment rates, taxes, balance of payments, exchange rates, inflation rates, election figures, and so on. Thus, life is almost meaningless without the use of statistics (use of numbers to measure and analyse money, time, distance, rate, price, and so on). In fact, in today's world of information and communications technology, lack of appreciation of numbers and statistics is not only an aberration but also a malady, indeed a deep-seated disorder. Thus, basic statistical skills of collecting, storing, presenting, analysing and interpreting large quantities of information is greatly advised.

7. Others: Statistics plays a critical role in agriculture in deciding the plant varieties, combination of fertilizers, pesticides, densities, soil qualities, and growth of output. Without the use of statistics,

business and economics cannot make proper planning and policy. Marketing strategies are based on some statistical data. Examination of climate change and environmental studies are made effective by statistical data and analysis of weather and environment. Estimation of the population of a country or community, per capita income, age distribution, health, and many more are made possible by the use of Statistics.

Misuses of Statistics

Statistics consists of tests used to analyse data and make decisions. Imagine that someone has decided what questions to ask, which group or groups to study, how the groups should be put together or divided, which variables to focus on, and what are the best ways to categorise and measure them, the next is what statistics to use. This gives one full control of the study, and which ways to manipulate the study. Statistical tests provide the framework within which one can pursue research questions. But such tests can be misused, either by accident or design, and this can result in potential misinterpretation and misrepresentation. Misuses of statistics which lead to misrepresentation and misinterpretation arise when a researcher alters scales to change the distribution of data; focuses on certain variables and exclude others; ignores or removes high or low scores which are considered inconvenient, so that data can be presented more coherently; and presents correlation as causation.

Misuse of statistics could be unintentional due to inexperience, lack of statistical skills and inappropriate knowledge, or it could be deliberate with an intent to deceive, mislead, favour someone/something. Deliberately misusing statistics is inexcusable and attracts global condemnation. Whether misuse of statistics is accidental or purposeful, the effects are the same. The misuse of statistics is a very challenging problem that has permeated researches by individuals, institutions, small and medium companies/industries, multinationals, and even nations. Some common causes of misuses of statistics in research include the following: bias, inappropriate tests, ignoring important features, overgeneralisation, assuming causation from correlation, abuse of data collection, data manipulation, truncating the axis, strategically picking the time period, and many more.

Bias

Bias refers to inclination or prejudice for or against something or someone in a way considered to be unfair. In research, bias is the systematic introduction of error into sampling or testing by selecting or encouraging one outcome over others. Research bias occurs when the researcher skews the entire or part of the research process towards a specific research outcome. It moves the investigation off the real direction of the study and produces results that are at variance with true outcomes. Bias in research is one of the dominant reasons for poor validity of research outcomes and it can occur at any time in the cause of research.

Biases in research can be in various forms: design, participants' selection/sampling, and analysis bias. Design bias has to do with the structure and methods of carrying out research. Design bias occurs when the research design, survey questions, and research method are largely influenced by the preferences of the researcher rather than what works best for the particular research. Participants' selection bias happens when the researcher deliberately excludes some part of the research population from the research process; or the researcher chooses participants that exhibit characteristics that appeal to him rather than the appropriate sample or members of the population that are sufficiently representative of the population (Moore & Notz, 2006). It must be noted that selection bias takes away the randomness that is expected of sampling or participants' selection.

Analysis bias happens during data processing whereby the researcher uses responses or scores that confirm his expectations, beliefs, personal experiences, or thoughts. In other words, analysis bias occurs when the researcher deliberately or unintentionally uses data that favours or confirms his hypotheses, or ignores data samples that are inconsistent with his expectations and thus, suggest research outcomes that differ from the hypotheses. Analysis bias can be far-reaching because it significantly alters the research (by overestimating or underestimating parameters) and provides false presentations and generalisations.

Inappropriate tests

Inappropriate tests yield measurement errors where provided responses are different from the real values. Inappropriate tests may result from ignoring the error of measurement in test scores, and using a single test score for decision making. According to Gardner (1989), every test score contains an error of measurement which when ignored becomes a misuse of statistics. Thus, it is a misuse of any test score or any observation to accept it as a fixed index containing no error. It is impossible to say with certainty that an individual's observed score gives his "true" performance on the general domain about which inferences are to be made. The best that can be done is to estimate experimentally the standard error of measurement and then use that value to set up a band within which a probability can be stated about the "true" scores being within that band.

The use of a single test score for decision making constitutes a misuse of statistics. When a single test score is used in decision making, and neglecting other parameters of the learner or respondent, there is a problem of misuse of statistics. To avoid this, tests scores must be considered and interpreted in the full context of the various elements that characterize pupils, teachers, and the general educational environment involved. This is so because a test score represents only a sample from a limited domain and does not include the variety of factors that might influence the said score (Gardner, 1989). Thus, for a test score to be used for decision making, it must be considered together with the testee's motivation, leadership ability, creativity, involvement in extracurricular activities, and others.

Data Collection

Misuse of statistics also arises from data collection when the researcher's personal preferences or beliefs affect how data samples are gathered instead of using recommended methods of sample selection. In other words, the researcher adopts data-collection methods that are unsuitable for the study. It must be noted that poor sampling results in poor data giving rise to results that are inaccurate and misleading. Poor data could also arise when survey questions are leading and loaded to elicit responses that are inclined towards the beliefs of the researcher. Another common technique to influence data collection is when the responses to surveys are manipulated by wording the question in such a way as to induce a prevalence towards a certain answer from the respondents (Kahneman, 2013). The way to do this is to precede questions by information that supports the "desired" responses, thereby obtaining data that is skewed towards the researcher's beliefs and preferences. At other times, this is done by discarding unfavourable data. For instance, tobacco companies do not publish every study they carry out, thus denying consumers the link between smoking and cancer, and that smokers are liable to die young. Also, poor data collection occurs when data-collection is done through the internet which favours only those who have access to the internet, excluding those who cannot access the internet. In any or all of these, the emerging data is faulty, and therefore, whatever analysis that is done with such data must yield wrong and misleading results.

Data manipulation

Another source of misuse of statistics is data manipulation, also called "fudging the data," where selective reporting is done and false data used to carry out analysis leading to inaccurate report. Often this is done by choosing sets of data that follow a pattern consistent with the preferred hypotheses of the researcher, while ignoring other sets of data that otherwise should have been used to generate appropriate results (that contradict the hypotheses). Data manipulation also includes ignoring important features (Neylon, 2009). For instance, multivariable datasets have two or more features/dimensions. If too few of these features are chosen for analysis (for example, if just one feature is chosen and simple linear regression is performed instead of multiple regression), the results can be misleading. This leaves the analyst vulnerable to any of various statistical paradoxes. Data manipulation is a serious case of misuse of statistics which is frequently perpetrated by both experienced and inexperienced researchers.

Overgeneralisation

Overgeneralisation is a misconception occurring when a statistic about a particular population is asserted to hold among members of a group for which the original population is not a representative sample. It is making a claim based on very small evidence. It often occurs when information is passed through nontechnical sources. Overgeneralisations are claims by researchers or authors that are so broad that they

can hardly be proved or disproved. Sometimes, overgeneralisation is made not by the original researcher, but by others using the result, often interpreting the original result to suit their present purpose. Real-life examples of overgeneralisation include (a) All birds can fly; (b) Red roses cannot survive long winters because in my garden, two red roses died over a long winter; (c) All Nigerian politicians are thieves because some Nigerian politicians have looted the national treasury.

Researchers use overgeneralisation for two basic reasons: To create an allusion of authority, and to sway the opinion of readers. However, irrespective of the motive of overgeneralisation, its effect as a misuse of statistics is far reaching. While researchers are advised to avoid overgeneralisation, readers are encouraged to identify issues of overgeneralisation and report them.

Concluding causation from correlations

It is a great temptation to conclude that because two factors are correlated, then one of these factors caused the variations in the other. The researcher must be careful not to fall into this trap and not to try to draw cause-and-effect conclusions from statistical data concerning correlated factors. Causation is significantly different from correlation: while a causation always implies correlation, a correlation does not always imply causation. Causation means that a change in one variable, brings about the change in the other variable being compared. For instance, in Demand and Supply analysis, a change in the price of a common commodity brings about a change in the quantity supplied and demanded. This is causation. But just because sales of yams are higher in the festive periods in Nigeria (the months of December and January) does not mean that these sales are caused by the festive period. The real reason is that yams are harvested in the months of December and January leading to reduced price of yams, resulting in more yams being purchased ("lower price, higher demand", is one of the laws of Demand and Supply in Economics). It must be cautioned that researchers should avoid the temptation of concluding causation from correlation.

Truncating an axis

A misleading graph, also known as a distorted graph, is a graph that misrepresents data, constituting a misuse of statistics and with the result that an incorrect conclusion may be derived from it. Graphs may be misleading due to poor construction. Misleading graphs may be created intentionally to hinder the proper interpretation of data or accidentally due to inexperience, poor knowledge, inadequate skill with graphing, or because data cannot be accurately conveyed. Misleading graphs are often used in advertising to conceal facts or sway the opinion of consumers, or in politics to exaggerate a result that would otherwise be much less interesting. One way to construct misleading graphs is by truncating an axis to create an impression of large differences or exaggerate profits/benefits of a product. When creating a graph to portray a statistic it is natural to assume that the X and Y axes start at zero. Truncating an axis means doing the opposite. A truncated graph (also known as a torn graph) has a Y-axis that does not start at zero (0). Truncated graphs can create the impression of important change where there is relatively little change. While truncated graphs can be used to exaggerate differences or to save space, their use is often discouraged. Truncated diagrams will always distort the underlying numbers visually. Several studies found that even if people were correctly informed that the Y-axis was truncated, they still overestimated the actual differences, often substantially (Hanel, Maio, & Manstead, 2019).

Strategically picking the time period

Another common misuse of statistics is strategically picking the time period to show a result. Unlike other misuse of statistics that can occur intentionally or accidentally, strategically picking the time period is a case of misuse of statistics that can be done only intentionally. It involves picking only good-performing months, for instance, to report the sales performance of a company. This portrays a misleading picture that the company is doing very well, when in actual sense the company has average performance when all the performances for all the months under review are reported. Definitely, the time periods chosen as the reporting period must affect the performance that viewers perceive as the company's performance. For instance, reporting the performance for three months can show radically different trends than reporting it for six months, twelve months, and indeed over the entire period of the company's performance.

However, it is obvious that when you look at a longer time period, say three years, four years, or even longer, the true performance shows.

CONCLUSION

This work has reviewed some common cases of misuses of statistics: bias, inappropriate test, data collection, data manipulation, overgeneralisation, concluding causation from correlation, truncating an axis, and strategically picking time period. Others abound, though. But with what has been done here, any honest researcher or reader can easily identify misuses of statistics in everyday life. However, as Calzon (2021) put it, a few questions should guide one's decision on the classification of the misuses of statistics. Such questions include the following: who carried out the primary research - independent university study group, lab-affiliated research team, or consulting company? Who paid them? What are the motives behind the research? What did the researcher try to figure out? How big was the sample set, and who was part of it? Answers to these questions would guide the researcher's or reader's inclination.

However, if one is performing the analysis for self, for instance generating reports for one's job, one can ask oneself the following relevant questions to avoid using misleading statistics: Are data visualizations representing the data accurately - labels are clear, axes begin at 0, right chart type are used, etc? Is the research represented honestly, and in an impartial manner? What information is missing from the data? To enhance one's good judgment, one can ask others external to the research to look at the data to confirm that the results are not misleading.

From the foregoing, identifying misleading statistics is very easy. Therefore, in order to ensure to keep a safe distance from the misuse of statistics, remember to always ask the questions above and answer them honestly, whether as an individual or group.

RECOMMENDATIONS

Although misuse of statistics has caused damages to programmes of independent university study groups, lab-affiliated research teams, consulting companies, and individuals, it has at the same time benefited others: manufacturers, advertising agencies, politicians and political groups, researchers, and many more. The use of statistics in medical diagnoses and biomedical research may affect whether individuals live or die, whether their health is protected or jeopardized, and whether medical science advances or gets side-tracked. Life, death, and health, as well as efficiency, may be at stake in statistical analyses of occupational, environmental, or transportation safety. Effective functioning of the economy depends on the availability of reliable, timely, and properly interpreted economic data (The major woe of Nigeria is the use of unreliable, untimely, and improperly interpreted population, economic, educational, and other data). This study advocates for proper, efficient, and transparent use of statistics which benefits everyone and every group on the long run. To ensure the appropriate use of statistics, the following recommendations are proffered:

1. Take care to apply data timely, responsibly, ethically, and visually whether for research reporting, learners' performance, institutional appraisal, market intelligence, customer experience, business reporting, weather forecast, advertising, political campaigns, and many more.
2. Revisit the insightful list of misuses of statistics from time to time to remind you of the importance of using data in a proper way to avoid misleading readers, users of your product or information.
3. The randomness of sample from large population is very important and should be used always, except when practically impossible, or when other sampling techniques make for better inclusion and representativeness.
4. Causation is significantly different from correlation: while causation always implies correlation, correlation does not always imply causation. Therefore, the temptation to conclude causation from correlation must be avoided always. Not every researcher is strong mathematically: when not sure of the direction to go, consult a mathematician for guidance.
5. Tests scores must be considered and interpreted in the full context of the various elements that characterize pupils, teachers, and the general educational environment involved. The use of a single test score for decision making constitutes a damaging misuse of statistics. When a single test score is used in

decision making, and neglecting other parameters of the learner or respondent, the negative effects could be very colossal: despondency, death, withdrawal, collapse of businesses/nations, war, and a lot more.

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