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# Role of Biostatistics in Analysing Public Health

MD.Shahadat Hossain
*[Sena Kalyan Sangstha, Bangladesh]*

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## I. Introduction

According to Velasco (2018), Biostatistics is the application of statistical information in various fields of biology such as public health. The increase in the emerging diseases or infection rates emphasises the bio-statistical analysis of the disease or infection patterns. Public health issues or challenges are found increasing day by day in which the use of bio-statistical tool or techniques significantly support digitalise epidemiological study for evaluating the treatment responses and distribution or monitoring of diseases thus promoting effective decision making within the public health field (Ahlbom, 2017). It helped to determine the occurrence of disease or infection in any geographical location with help of statistical data.

The significance of biostatics within public health helps in analysing the rate of diseases or infections within the targeted set of populations. The biostatistical analysis was found helpful in determining various medical and biological aspects with respect to population age, gender, or ethnic group. The application of biostatics found applicable in various areas including health service research. It also helps to examine different factors such as financial, social, ethical, and other health-related aspects that help to analyse their influence on population health. The aspect of biostatics in public health help increase understanding along with preventive measures analysis towards the disease within the population (Cataldo et al., 2019). The role of biostatistics within the health services helps in making an appropriate decision towards improve patient care and enhancing health or medical research while supporting the data available.

The analysis of health determinants along with their distribution within the population help to predict the behaviour of illness along with the estimation of mortality or morbidity rate. It also helps to analyse the need for public health programs along with the evaluation of different methods or techniques for public health research data. It is found through evidence that increases in biostatistical analysis help to increase the quality of life through specifying the treatment measures thus safeguarding public health problems on both large and small scales. The different biostatics techniques or methods found contributing to epidemiology study in public health include standardisation, probability estimation, electronic datasets or algorithm prediction, and others (Ahlbom, 2017). Therefore, the main aim of the study is to analyse the role of biostatics within the public health sector. This aim is divided into the following objectives as indicated below;

1. To analyse the importance of biostatics in public health
2. To explore techniques of biostatics contributing toward public health
3. To analyse the impact of biostatics on public health.

## II. Overview of Biostatics

Over the past century, the relatively new field of statistics has become a crucial component of all disciplines. Nowadays, descriptive, logical, and analytical domains are typically included when using the term statistics. Biostatistics refers to those analytical techniques that have been discovered to be especially beneficial analyses of clinical and public health research investigations. Biostatistics linked two different disciplines, biology, and statistics, by applying statistical techniques to public health and medicines (Baek, 2019).

Biostatistics has a primary focus on the development and utilisation of statistical methods to solve queries and provide an answer to those questions that arise from human biology and health. The roots of biostatistics have been expanded to statistical theory and their adaptations and implementations in terms of particular underlying methods to identify the essential questions related to the community of researchers, practitioners, and policymakers interested in health and its related aspects. The roots and development of biostatistics can be best described with the help of a few examples (Islam and Al-Shiha, 2018).

The prediction of the human life span and its translation in quantitative form has always been of great concern and has gained much popularity in research. Many types of research have been done to identify the average life span of human beings related to different age groups. A work reported by John Grant on the rate of mortality, lists of burial dates, births, and marriages have been declared as a landmark at the beginning of these researches along with other pioneer researchers like Halley and Huygens. Their effort resulted in the creation of

life tables, estimations of birth and mortality rates for different ages, and estimating the average lifespans of populations in clearly defined geographic regions and subgroups of these populations that are based on more reliable data, including complete birth and death statistics (Rosner, 2015). However, Pagano (2022) stated that the statistical methods that these researchers applied were of great importance and enhanced the use of these data in social sciences, such as forecasting population size and estimating economic conditions.

Biostatisticians are referred to as specials that develop multiple mathematical frameworks to draw inferences through data analysis and thus provide the scientific justification to generalise the findings for making rational decisions. These specials have the potential to shrink the gap between theory and practice with the help of biostatistical models to signify scientific information and knowledge (Cataldo et al., 2019). Biostatisticians in the government, universities, insurance companies, pharmaceutical companies, medical centres, and independent research centres continue to focus their research on the mathematical and statistical methods of gathering data, explanation, and forecasting, with the attendant concern towards statistical precision. The important biostatistics topics are the invention, use, and claim of statistical techniques in medical research. Therefore, biostatisticians must comprehend the medical setting and the clinical background of the study subject they are currently working on. In the bottom line, joint coordination with biostatisticians will be proven helpful in translating meaningless data into meaningful knowledge and making accurate and suitable decisions (Schumacher et al., 2020). Baek, J., 2019. Introduction to Biostatistics-Lecture 1: Introduction and Descriptive Statistics.

**Importance of Biostatics in Public Health**

It is found through literature evidence that biostatics within the science field found effective as it helps in providing scientific, historical data that help to direct future outcomes. The increase in public health issues with raise in the number of diseases and infections due to different factors causes the importance of biostatistics in health sciences (Lepš, and Šmilauer, 2020). The overview of the study has indicated the importance of biostatistics as one of the major foundation disciplines within the public health field. It helps to conduct research-based studies within the field of public health domain to determine the health trends along with related risk factors affecting the health of individuals (Daniel, and Cross, 2018).

With help of different research including qualitative and quantitate the utilisation of biostatistical tools can be integrated thus benefiting public health research. The biostatistical analysis can be based on clinical trials or either focused group. The significance of biostatics is found in assessing the process of development, progress, and spread of disease or infection. It is found by biostatisticians that the incorporation of biostatics tools and techniques within public health helps in the prediction of mortality rate along with the indication of symptoms that can be encountered during the spread of disease. In addition, the role of different biostatistics theories influences the examination of health determinants leading to disease within the population.

Also, the beneficial aspects of biostatics are found to contribute to the evaluation and development of public health programs that can help to minimise the spread of disease or infection (Rossi, 2022). The importance of monitoring disease patterns or trends within communities or society increases the indication of health emergencies along with guidance to public health policy and strategies. The increase in public health prevention strategies or prevention programs contributes to the control of the disease. On another hand, the contribution of biostatics within the public health sector was also found beneficial in the field of epidemiology (Shortreed et al., 2019). The clarity in determining the health-related problems or challenges influences the safety and improvement approaches within healthcare (Wang, 2018).

The spread of disease among different age groups or populations irrespective of the size can be evaluated through bio-statistical analysis. The bio-statistical analysis allows assessing the insights into emerging health-associated risk factors along with a comparison to the existing trends or patterns. The major cause of an increase in infection or disease rate is found due to be rapid changes in the pattern of disease occurrence and distribution. The importance of public health thus helps in preventing the rapid spread of health-associated risk factors causing a negative impact on an individual's health. Public health aims to encourage continuously improving the healthy lifestyle approaches within the population to achieve the global goal of decreasing mortality or morbidity rate. Biostatistics have great importance in both develop and underdeveloped countries although the scope of biostatistics varies from country to country (Cataldo et al., 2019).

In the US, the significance of biostatistics is indicated within the educational sector as different biostatistics courses such as preventive medicine and epidemiology have been integrated. In some Asian countries education in biostatistics is reinforced to increase the importance of research. It is found that in certain regions the application of biostatistics analysis or technique use was found mandatory to reach for significant conclusive outcome in research. Bio-statistical methods were also found beneficial in analysing the drug efficacy and development research. Different functions of statistics are indicated as the providence of significance test, the providence of experimental design, and the reduction of data (Singh, and Dixit, 2021).

According to the study by Luque-Fernández, and Negro Calduch, (2020), it is found that an immense amount of investment was done within the public health research sector for the accurate analysis and interpretation of data. It is reported that negligence towards the discipline of biostatistics affects the beneficial outcomes of investments done within the research for improving population health and safety. Different health and medical councils around the globe are found working toward medical and public health research. It is reported that biostatistics methods and techniques allow small data interpretation and analysis thus facilitating improved research outcomes with increased reliability and credibility. The use of large data sets as indicated in the previous era hinders the expansion of quality research. The major problem raised from statistical reasoning includes the extraction of information from data sets in the existence of uncertainty and variability. Furthermore, it is evaluated that bioinformatics and computational technology use within medical care lead to data-intensive biomedical research (Grobbee and Hoes, 2014).

The area of biostatistics requires the provision of technical skills for the understanding of mathematical calculations and the utilisation of statistical tools and techniques. The role of educational sessions and training contribute to addressing the need for knowledge towards the use of complex techniques. It is found that for a better understanding of biostatistics it is necessary to have insights into mathematics, probability, sources of bias, and knowledge of technical skills. It is also indicated that a superficial understanding of statistics can lead to the practice of unscientific experiences. In addition, it is found that big data increases the demand for biostatistical expertise that can contribute in process of effective decision-making practice along with the extraction of valuable knowledge through computational data (Milic et al., 2018). The enhancement in the capacity of the computational tool in form of reduced dimensionality, distributed processing, language processing, and machine learning can be observed. The main aspects within biostatistical analysis remained as quality and reproducibility of research findings which are found dependent on the design of the data collection process, bias, selection of analytical method, and prediction of associated limitations.

Therefore, it is analysed that recognising the statistical trends and determinants in public health areas helps service providers or health care providers, or researchers to assess and monitor national conditions along with its comparison to the international trends in public health (Wang, 2018). Moreover, it also helps to relocate and generate greater funds for strategies for the prevention programs and research for control of public health problems. Also, an increase in efforts towards the generation of empirical data influences improvement in the quality of practices in public health. Through the evaluation of biostatics within public health, it is reported that the significance of preventive programs for disease control can be enhanced (Singh, and Dixit, 2021).

**Contributions of Biostatics in Public Health**

Biostatics is used to determine and explain health outcomes, and the advent of epidemics and pandemics influences decision-makers for public health. Those individuals engage with analysing and advising the mitigation strategies towards pandemic utilize biostatics data to guide public health practitioners regarding precautions of the current situation. Extensive literature has been reported regarding the contribution of biostatics to public health. Numerous historical scientists applied biostatics techniques to discover several landmarks that are a foundation for many types of research nowadays (Leider et al., 2018).

Among other contributions, one of the pioneer contributions is the work of Mendel, which he did use pea plants. Mendel aimed to identify the concept behind resemblance between parents and offspring, and on his journey, he proposed Mendel's law, which now serves as a landmark for all researchers. Mendel, for his research, collected data and applied multiple statistical methods to identify the regularities in heritability among mature variations. However, the main focus of Mendel's work was on plants. Still, his discovery grabbed the attention of biologists and statisticians to understand variations that occur in human heritability (Grant and Burgess, 2022). In this context, Francis Galton and Karl Pearson contributed significant work. These two scientists were foremost and pioneer scientists in developing unique concepts and statistical methods to infer data regarding resemblance between parents and offspring. Francis and Karl were interested in the physical and behavioural resemblance between parents and offspring. The statistical theories and concepts they developed are still used as basics for understanding these forms of data. These contributions provided the basic concepts of correlation and regression methods to estimate the features transformed into offspring from parents (Ahlbom, 2017).

As it has been clear from the above example, biostatistics is problem oriented. It is mainly focused on the queries that arise in biomedical science. Biostatics contributions have spanned a wide range of scientific discoveries and inquiries that lie from the basic structure and function of human beings to the interaction of human beings with an environment that further includes the problem of environmental pollution, sanitation, toxicities and disease prevention as well as therapy (Sullivan, 2017).

Luque-Fernández et al. (2017) suggested that there are many areas where biostatics contribution solved multiple queries related to public health. One place of another great importance is the design of randomised control trials. Recently, most of its interest floated towards medical therapies where many patients were randomly assigned to two or more treatments. The specific cohort was then observed for an extended period to

identify survival rates or some other trends such as disease reoccurrence. After the observation period, the data was gathered and analysed and presented the statistical problem associated with summarisation and survival rate comparison of each cohort with the help of obtained results. Such statistical methods and techniques provide the basis for statistical planning in clinical therapeutic and public health aspects (Wang et al., 2018).

Statistics contribute a major role in public health that is usually helpful in analysing disease trends and in the evaluation of the relationship of various variables and predictors of public health. Biostatistics rules and models can be applied to the health care data. The models can variate from the simple straight plot to a scatter plot in the x-y plane. In addition to that, a variety of non-linear predictors can be used to analyse the influence of the change with respect to time. Other than that, biostatistics is also significant in analysing health problems by identifying the set of information, collecting the data, and summarising and explaining the assessed information for describing the targeted population. Biostatistics also assist in the development of the essential tools that determine the problem and related risk factors in public health. These tools are not only helpful in determining the disease risk but also play an effective part in the estimation of the cost of interventions and the influence on the monetary system due to the prevalence of the disease and its side effects. Furthermore, it also assists in the allocation of the resources to treat the targeted population and control the spread of the infection by calculating the probability of transmission in the population (Mooney, and Pejaver, 2018.).

The vast contribution of biostatistics was also found beneficial in cancer research. With the use of different statistical tools and methods evaluation of cancer-causing indicators or their significance can be determined (Wang, 2018). The role of the biostatistician is found unique in safeguarding and protecting public health concerns. The correlation between different causative factors or variables can be determined with help of biostatistics. Moreover, it also helps to contribute toward indicating gaps in hypothetical causes of disease. This helps in diverting researchers for the elimination of risk factors. Within quantitative studies, the utilisation of biostatics increases the reliability of the research outcome (Luque-Fernández, and Negro Calduch, 2020). Biostatics also facilitates the examination of the large data set that helps to generate generalised results. There are different methods and techniques of biostatics that are utilised within the public health sector. In addition, the prediction of possible disease indicators can be determined through statistical analysis.

The frequency distribution analysis within statistical analysis helped researchers in estimating the prevalence of the disease among particular demographic groups based on age, gender, ethnicity, or other aspects. The contribution of biostatistics also includes the generation of knowledge towards genetic data for disease analysis and the determination of causative agents or factors (Milic et al., 2018). The use of different biostatistics methods for the collection of data and its processing helps in gathering information through participants. The existence of biostatistician data can be supported or utilised in combination with medical records, particularly within cancer research (Shortreed et al., 2019). Therefore, it is found that wide contributions of biostatics in the field of public health are focused and beneficial in emphasising better treatment approaches for the control of disease or infection. The skills of biostatisticians are found complex and can be enhanced by the incusing of extensive and advanced training. Also, the differences within the research in public health can be assessed efficiently through biostatistics (Martínez et al., 2019).

Methods and techniques in Biostatics for Public Health study

Biostatistics can be used in determining public health issues, it can also assist in calculating the inaccuracy in the information, it can also play an influential role in correcting the missing response and it is also beneficial in evaluating the effectiveness of the medical treatment or intervention that identifies the need to change the policy or its modification. Probability can also be used to estimate the health issues in people those using medication and those who are not taking any prescription, probability measures the chances of occurring the event and situation by taking the ratio of favourable consequences with overall consequences of the event (Collinson et al., 2015). By considering the hypothetical data given in the below table, the application of biostatistics in public health can be explained.

| **Consequences** | **Adult Smokers** | **Adult Non-Smokers** |
|---|---|---|
| Severe Lung Cancer | 2 | 1 |
| Not Severe lung Cancer | 8 | 19 |

***Table 1:*** *Relation between Smoking and Lung Cancer based on hypothetical data (Self-made)*

Table 1 represents the hypothetical data, this illustrates how probability can be used in assessing public health problems. For instance, those adult populations who were habitual to smoking experienced severe lung cancer of 20 per cent whereas for non-smokers the probability of severe lung cancer was only 5 per cent. People who die from lung cancer each year can be explained as an event and probability in statistics describe the occurrence of this situation in present and future, this can help the policymakers to propose some alternative solution in order to minimize this consequence. By using data from hospitals and medical care departments of very large sizes the occurrence of the disease and harmful consequences can be calculated accurately. Similarly,

effective models to explain the probability and accuracy of the statement for people who die from lung cancer can also be determined effectively by focusing on two assumptions as common distribution of the situation by targeting people affected by the event and is same for all members within the group, and independence events in which targeted population may or may not experience the event but it does not affect others. This type of simple model can be applied to various public health issues. This also explains the hypothesis testing. This can be calculated between the comparison groups of people such as those who take medicine and those who do not take medicine for treating cancer, and simple health issues, by calculating the probability it can be determined whether both groups have any difference or not. Hence, if there is a difference between comparison groups then the hypothesis can be accepted and if there is no difference then it can be rejected as well. To completely analyse the risk of lung cancer due to smoking, a large sample size need to be considered that can depict the consequences between both smoking and non-smoking population (Lee and Lee, 2018.).

Another method for the estimation of the public health intervention is to calculate the linear relationship between the two variables such as the measurement of health solution effectiveness and health issue (Heath et al., 2016). A simple graph can also be used to explain the relationship between two variables by plotting the interest variable on the y-axis and plotting the explanatory or predictor variable on the x-axis. The x and y variable all range values can be represented in the form of a graph also referred to as quantitative measurement or continuous measurement. For instance, a serious health problem issue found in children is a high level of lead in the blood that has the potential to develop severe health complications such as a neurological disorder at 10g/dl or below this level (Rodgers, 2018). This cause higher damage in the development of the brain, and a higher lead level can cause harm to the kidneys and leads to seizures, unconsciousness and death as well. Soil is the main source of blood lead levels as compared to paint lead level, and environmental pollution can cause higher lead levels in the blood of both children and adults. Therefore, measuring soil lead levels and blood lead levels in children and comparing these levels can assist in identifying the relationship between the soil lead level and blood lead level. The measurement of the blood lead level of each child and the measurement of the soil lead level near the residing place children was taken. The below graph shows curvature in the plot, therefore, a measurement transformation has been done to make a more linear relationship. Data can be transformed by taking reciprocals, logarithms, and square roots (Pek et al., 2017). In this case, the logarithm of the data was taken to make the relationship more linear.

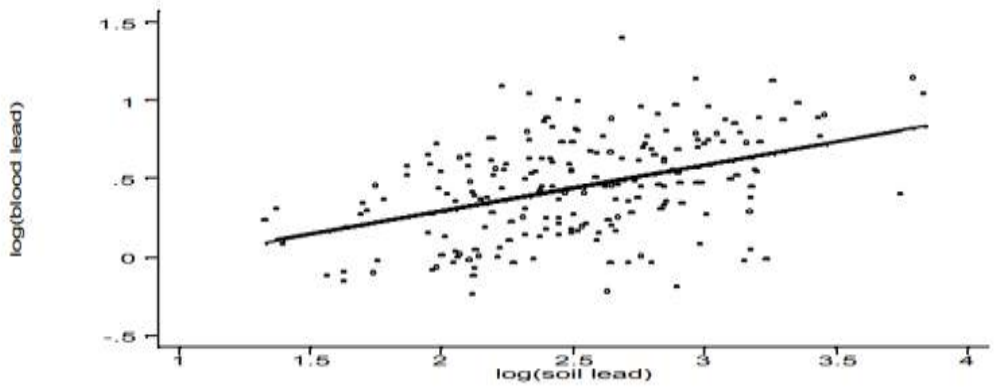


*Figure 2: Relation between soil Lead level and Children's blood lead level (Source: William, 2015)*

The above plot was used from the different studies on the same topic the plot was developed through Stata software. The regression equation for this plot was also determined which explains the slope is .29 and intercept of -0.3. Other than Stata, various software tools and packages can be used to determine the regression, and correlation from the various data sets. However, the most feasible software that can be used commercially is SAS, SPSS, and Stata as well which could be used from both IBM and Macintosh versions (Darlington and Hayes, 2016). The above graph shows that an increase in soil lead by 1 unit can lead to an increase in the blood lead level by 0.29 which represents the linear relationship between the variables. Furthermore, the graph also shows that there is a linear relationship between the soil lead level and blood lead level (William, 2015).

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