Chapter 13
Meta-Analysis in Medical Research

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ABSTRACT

An effective statistical methodology that has become essential to medical research is meta-analysis. This chapter explores the fundamentals, approaches, uses, and difficulties of meta-analysis, illuminating its function in combining data and producing strong conclusions from a variety of studies. Results are presented through the combination and analysis of data from various studies on related research topics, as done in systematic reviews and meta-analyses. The topic explores some of how a comprehensive meta-analysis can be carried out and also explores how the findings can be presented and interpreted. As a quantitative and formal epidemiological study design, meta-analysis carefully assesses earlier research studies to make all-encompassing conclusions about the body of research as a whole. Thus, this chapter offers clinicians a simple introduction to conducting and comprehending meta-analyses.

INTRODUCTION

The science of gathering, analyzing, presenting, and interpreting data about the medical and health domains is known as medical statistics, a subfield of biostatistics. We can learn more about health phenomena in our populations by using it in medical research and investigations. You can acquire the statistical literacy required to stay competent and flexible in our rapidly evolving health industries by studying medical statistics (Indrayan, 2020, 2021; Glass, 1976; Egger et al., 2000; Sutton et al., 2000, Whitehead and Whitehead, 1991). The statistical foundations you will acquire can be applied to any industry, even though the examples and applications are within the context of health and medicine. A subfield of statistics known as "medical statistics" is concerned with gathering, analyzing, interpreting, and presenting data about healthcare and medical research. It is essential to the advancement of medical knowledge, the assessment of therapeutic results, and the development of evidence-based clinical

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practice decision-making (Nieminen, 2020; Sato et al., 2017). Statistical techniques are employed in medical research to plan investigations, gather and examine data, and derive reliable conclusions from the results. Several important domains in which medical statistics are utilized. Clinical trials are created by medical statisticians to assess the efficacy and safety of novel medications, therapies, or interventions. The present Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) pandemic and other new and re-emerging microbial illnesses serve as proof that clinical research can assist mitigate health-related problems. Clinical trials are essential to the creation of medications, equipment, and vaccinations (Kand and Vadakedath, 2023; Kandi et al, 2021; Kandi and Vadakedath, 2021; Guyatt et al., 1995). To guarantee that trial results are trustworthy and objective, they choose statistical tests, randomization techniques, and sample sizes (Nieminen, 2020; Sato et al., 2017). In epidemiological studies, which look into the distribution and causes of health-related events and outcomes in populations, medical statistics are crucial (Brar et al., 2020l; Daly and Paquette, 2019; Naylor, 1997). Regression analysis and survival analysis are two statistical methods used to evaluate disease risk factors, spot trends, and calculate disease burden. In medical screening and diagnosis, statistical techniques are employed to assess the precision and dependability of diagnostic tests (Chen, 2024; Chalmers et al., 2002). Test performance is often evaluated using metrics like receiver operating characteristic (ROC) curves, predictive values, sensitivity, and specificity (Sackett et al., 1996).

In a meta-analysis, data from several studies are combined to produce an extensive summary of the evidence regarding a specific research question or treatment effect. Medical statisticians combine data from various sources, evaluate heterogeneity, and more precisely estimate overall treatment effects by using meta-analytic techniques. When examining data, survival analysis—also referred to as time-to-event analysis—is employed to determine how long it will take for a particular event, like a disease recurrence or death, to occur (Pastopoulos et al., 2005; Hennekens et al., 2009; Bailar, 1997). Medical statisticians analyze survival data and evaluate factors influencing survival outcomes using survival models, such as Cox proportional hazards models and Kaplan-Meier curves (Dwivedi, 2022). Statistics findings must be communicated clearly in medical research and patient care. To interpret study results, convey risk estimates, and convert statistical findings into practical recommendations for clinical practice, medical statisticians work in tandem with healthcare professionals. In the fields of healthcare and medical research, medical statistics are crucial for producing trustworthy evidence, guiding medical decision-making, and enhancing patient outcomes (Durlak, 2003). Top of FormBottom of Form

Meta-analysis, a powerful statistical methodology, has become an integral tool in the realm of medical research. This chapter explores the principles, methodologies, applications, and challenges associated with meta-analysis, shedding light on its role in synthesizing evidence and drawing robust conclusions from diverse studies. This chapter's goals are to give a comprehensive overview of meta-analysis, go over the justification for this kind of study, and cover other related topics.

PRINCIPLES OF META-ANALYSIS

Meta-analysis is guided by several fundamental principles that govern its methodology and ensure the validity and reliability of its findings (Durlak, 2003). These principles include:

- Systematic Review: A meta-analysis starts with a thorough examination of the body of research that has already been done on a particular question or subject. To find all pertinent studies, a com-