Preface

During the past four decades, we have observed a steady increase in the use of repeated measures data. As the type of data in repeated measures can be discrete or continuous, quantitative or qualitative, there has been an increasing demand for models for not only normally distributed variables observed repeatedly over time but also for non-normal variables where classical regression models are clearly inadequate or fail to address the objectives of studies conducted in various fields. There are well-documented developments in the analysis of repeated measures data using normality assumption; however, the literature and textbooks are grossly inadequate for analyzing repeated measures data for non-normal variables. Since the introduction of the generalized linear model, the scope for generalizing the regression models for non-normal data in addition to data approximately based on normality assumption has been widened to a great extent. This book presents a broad range of statistical techniques to address the emerging needs in the field of repeated measures. The demand for statistical models for correlated outcomes grew rapidly during the recent past mainly attributable to two types of underlying associations: (i) association between outcomes and (ii) association between explanatory variables and outcomes. In real-life situations, repeated measures data are currently available from various sources. This book provides a systematic treatment of the problems in modeling repeated measures data for estimating the underlying relationships between covariates and outcome variables for correlated data. In other words, this book is prepared to fulfill a long-standing demand for addressing repeated measures data analysis in real-life situations with models applicable to a wide range of correlated outcome variables.

This book starts with background chapters on linear model, exponential family of distributions, and generalized linear models. Throughout the book, except for Chap. 15, the concepts of generalized linear models have been used with extensions wherever necessary. The developments in repeated measures data analysis can be categorized under three different broad types: marginal models, conditional models, and joint models. In this book, we have included models belonging to all these types and examples are given to illustrate the estimation and test procedures. In Chap. 5, covariate-dependent Markov models are introduced for first or higher

orders. This book provides developments on modeling bivariate binary data in Chap. 6. In many occasions, researchers need conditional or joint models for analyzing correlated binary outcomes. Tests for dependence are also necessary to develop a modeling strategy for analyzing these data. These problems are discussed with applications in Chap. 6. In modeling repeated measures data, the use of geometric models is very scanty. The problems associated with characterization are available in the literature but bivariate geometric models with covariate dependence are scarce. However, it is noteworthy that applications of bivariate geometric models in various fields where incidence or first time occurrence of two events, such as incidence of two diseases can be very useful. For understanding the risk factors associated with the incidence of two diseases or two complications, bivariate geometric models can provide deeper insight to explain the underlying mechanism. The bivariate count models are useful in various disciplines such as economics, public health, epidemiology, environmental studies, reliability, and actuarial science. The count models are introduced in Chaps. 8 and 9 that include bivariate Poisson, bivariate double Poisson, bivariate negative binomial, and bivariate multinomial models. The bivariate Poisson models are introduced for truncated data too. The under- or overdispersion problems are discussed and test procedures are shown with examples. In reliability and other lifetime data analysis, the bivariate exponential models are very useful. In Chap. 9, an extended GLM is employed and test for dependence is illustrated. In repeated measures, the extended GLM approaches such as generalized estimating equations and generalized linear mixed models play very important roles. It is noteworthy that the use of quasi-likelihood methods created opportunities for exploring models when distributional assumptions are difficult to attain but variance can be expressed as a function of mean. In Chaps. 11–13, quasi-likelihood, generalized estimating equations, and generalized linear mixed models are discussed. Generalized multivariate models by extending the concepts of GLM are shown in Chap. 14. This chapter includes simple ways to generalize the models for repeated measures data for two or more correlated outcome variables with covariate dependence. In this book, the semi-parametric hazards models are also highlighted which are being used extensively for analyzing failure time data arising from longitudinal studies that produce repeated measures. Multistate and multistage models, effective for analyzing repeated measures data, are illustrated for both the graduate level students and researchers. The problem of analyzing repeated measures data for failure time in the competing risk framework is included which appears to have an increasingly important role in the field of survival analysis, reliability, and actuarial science. For analyzing lifetime data, extended proportional hazards models such as multistate and multistage models with transitions, reverse transitions, and repeated transitions over time are introduced with applications in Chap. 15. In many instances, use of the techniques for repeated measures data cannot be explored conveniently due to lack of appropriate software support. In Chap. 16, newly developed R packages and functions along with the use of existing R packages, SAS codes, and macro/IML are shown.

This book aims to provide important guidelines for both researchers and graduate students in the fields of statistics and applied statistics, biomedical sciences,

epidemiology, reliability, survival analysis, econometrics, environment, social science, actuarial science, etc. Both theory and applications are presented with details to make the book user-friendly. This book includes necessary illustrations and software usage outlines. In addition to the researchers, graduate students and other users of statistical techniques for analyzing repeated measures data will be benefitted from this book. The potential users will find it as a comprehensive reference book essential for addressing challenges in analyzing repeated measures data with a deeper understanding about nature of underlying relationships among outcome and explanatory variables in the presence of dependence among outcome variables.

We are grateful to our colleagues and students at the University of Dhaka, University Sains Malaysia, King Saud University, and East West University. The idea of writing this book has stemmed from teaching and supervising research students on repeated measures data analysis for many years. We want to thank Shahariar Huda for his continued support to our work. We extend our deepest gratitude to Amiya Atahar for her unconditional help during the final stage of writing this book. Further we acknowledge gratefully the continued support from Tahmina Khatun, Farida Yeasmeen, and Jayati Atahar. We extend our deep gratitude to the University Grants Commission, Bangladesh and the World Bank for supporting the Higher Education Quality Enhancement Sub-project 3293 on repeated measures. We are grateful to Rosihan M. Ali, Adam Baharum, V. Ravichandran, A.A. Kamil, Jahida Gulshan, O.I. Idais, and A.E. Tabl for their support. We are also indebted to Farzana Jahan, M. Aminul Islam and Mahfuza Begum for their support at different stages of writing this book.

Dhaka, Bangladesh

M. Ataharul Islam
Rafiqul I. Chowdhury

http://www.springer.com/978-981-10-3793-1

Analysis of Repeated Measures Data

Islam, M.A.; CHOWDHURY, R.

2017, XIX, 250 p. 6 illus., Hardcover
ISBN: 978-981-10-3793-1