The Mean Heart Rate Associations of The DSE Data

Rabindra Nath Das[*]

Department of Statistics, The University of Burdwan, Burdwan, West Bengal, India

[*]**Corresponding author:** Rabindra Nath Das, Department of Statistics, The University of Burdwan, Burdwan, West Bengal, India, Tel: 03422634975, E-mail: rabin.bwn@gmail.com

Editorial

It is very hard to define the individual changes in the heart rate even by an experienced cardiologist. There are numerous reasons for a heart rate to speed up, or slow, or vary inexplicably. These reasons are not well-known in the cardiology literature. The basal, peak and maximum heart rates are commonly used values in physiology and clinical medicine [1-3]. For example, the percentage of maximum or peak heart rate, or a fixed percentage of heart rate is used to prescribe the medicine or the intensity of exercise in both the disease prevention and the rehabilitation programs [4]. Recently, it has been reported that a delayed heart rate recovery during the first and second minute after acute exercise is an independent predictor of overall mortality [5,6].

The present note considers the basal, peak, and maximum heart rates of the cardiac patients who underwent dobutamine stress echocardiography (DSE) [7]. It examines the following queries: What are the determinants of the mean basal, peak, and maximum heart rates? How are the determinants associated with these mean heart rates? What are the effects of these determinants on these mean heart rates? These are very little known in the cardiology literature.

The responses basal, peak, and maximum heart rates are positive, heteroscedastic, and non-normally distributed. These responses have been examined based on the joint generalized linear gamma and log-normal models [8,9]. Based on the joint gamma model analysis of the DSE data set (better than the log-normal analysis), the present results have been noted in the report. The DSE data set [7] has been recorded on 558 subjects with 31 variables/factors, which are as follows: age (Age), gender (Gender) (male=0, female=1), basal blood pressure (Bbp), basal heart rate (Bhr), systolic blood pressure (Sbp), double product of Bbp and Bhr (Bdp), peak heart rate (Phr), double product of Phr and Sbp (DPhrSbp), maximum heart rate (Mhr), dobutamine dose applied (Dose), maximum blood pressure (Mbp), percent maximum predicted heart rate (PMhr), double product of maximum dobutamine dose and Mbp (DPMdoMbp), dobutamine dose at maximum double product (DobDose), baseline cardiac ejection fraction (Bef), ejection fraction on dobutamine (DobEf), positive stress on echocardiogram (yes (y)=0, no (n)=1) (Pse), chest pain (y=0, n=1) (CtPain), resting wall motion abnormality on echocardiogram (y=0, n=1) (Rtwma), history of smoking (no=0, medium=1, high=2) (HCig), history of coronary artery bypass

surgery (y=0, n=1) (HCABG), history of hypertension (y=0, n=1) (HHT), history of myocardial infraction (MI) (y=0, n=1) (HMI), history of diabetes mellitus (y=0, n=1) (HDM), history of angioplasty (y=0, n=1) (HPTCA), recent angioplasty (y=0, n=1) (NePTCA), new MI (y=0, n=1) (NeMI), recent bypass surgery (y=0, n=1) (NeCABG), death (y=0, n=1) (Death), baseline electrocardiogram diagnosis (normal=0, equivocal=1, MI=2) (Ecg), death or NeMI or NePTCA or NeCABG (death=0, no=1) (Event).

The DSE data set contains three heart rates such as basal heart rate (Bhr), peak heart rate (Phr), and maximum heart rate (Mhr). The association of each heart rate with the remaining explanatory factors/variables has been examined based on the joint gamma generalized linear models [9,10]. The joint gamma model analysis of the basal heart rate (Bhr) on the remaining other variables/factors reveals the following associations:

- The mean basal heart rate (Bhr) is negatively associated with the basal blood pressure (Bbp) (P<0.001), indicating that the Bhr increases as the Bbp decreases.
- The mean Bhr is positively associated with the double product of Bbp and Bhr (Bdp) (P<0.001), indicating that the Bhr increases as the Bdp increases. This is due to the fact that the Bdp is a direct function of Bhr.
- The mean Bhr is positively associated with the percent maximum predicted heart rate (PMhr) (P<0.001), indicating that the Bhr increases as the PMhr increases. Note that the PMhr is a function of Bhr.
- The mean Bhr is positively associated with the maximum blood pressure (Mbp) (P<0.001), indicating that the Bhr increases as the Mbp increases.
- The mean Bhr is negatively associated with the double product of maximum dobutamine dose and Mbp (DPMdoMbp) (P<0.001), indicating that the Bhr increases as the DPMdoMbp decreases.
- The mean Bhr is negatively associated with the dobutamine dose at maximum double product (DobDose) (P =0.074), indicating that the Bhr increases as the DobDose decreases.
- The mean Bhr is negatively associated with the age (P =0.003), indicating that the Bhr increases as the age decreases.
- The mean Bhr is negatively associated with the positive stress on echocardiogram (yes =0, no =1) (PSE), (P =0.056),

indicating that the Bhr is higher of the DSE cardiac patients with having PSE.

- The mean Bhr is positively associated with the baseline electrocardiogram diagnosis (normal=0, equivocal=1, MI=2) (ECG) (P = 0.110), indicating that the Bhr is higher of the DSE cardiac patients with ECG at the MI level.

- The joint gamma model analysis of the peak heart rate (Phr) on the remaining other variables / factors yields the following associations:

- The mean peak heart rate (Phr) is negatively associated with the systolic blood pressure (Sbp) (P<0.001), indicating that the Phr increases as the Sbp decreases.

- The mean Phr is positively associated with the maximum heart rate (Mhr) (P<0.001), indicating that the Phr increases as the Mhr increases. Note that the Mhr is a function of Phr.

- The mean Phr is positively associated with the double product of maximum dobutamine dose and Mbp (DPMdoMbp) (P<0.001), indicating that the Phr increases as the DPMdoMbp increases.

- The mean Phr is negatively associated with the gender (male=0, female=1) (P=0.076), indicating that the Phr is higher for the DSE male cardiac patients than female.

- The mean Phr is positively associated with the resting wall motion abnormality on echocardiogram (yes=0, no = 1) (Rtwma) (P=0.042), indicating that the Phr is higher of the DSE cardiac patients with no Rtwma.

- The mean Phr is positively associated with the history of diabetes mellitus (yes=0, no=1) (HDM) (P=0.003), indicating that the Phr is higher of the DSE cardiac patients with no HDM.

- The joint gamma model analysis of the maximum heart rate (Mhr) on the remaining other variables/factors shows the following associations:

- The mean maximum heart rate (Mhr) is positively associated with the peak heart rate (Phr) (P<0.001), indicating that the Mhr increases as the Phr increases. Note that the Mhr is a function of Phr.

- The mean Mhr is positively associated with the systolic blood pressure (Sbp) (P<0.001), indicating that the Mhr increases as the Sbp increases.

- The mean Mhr is negatively associated with the double product of Phr and Sbp (DPhrSbp) (P<0.001), indicating that the Mhr increases as the DPhrSbp decreases.

- The mean Mhr is positively associated with the percent maximum predicted heart rate (PMhr), (P<0.001), indicating that the Mhr increases as the PMhr increases.

- The mean Mhr is negatively associated with the maximum blood pressure (Mbp) (P<0.001), indicating that the Mhr increases as the Mbp decreases.

- The mean Mhr is positively associated with the double product of maximum dobutamine dose and Mbp (DPMdoMbp) (P<0.001), indicating that the Mhr increases as the DPMdoMbp increases.

- The mean Mhr is negatively associated with the age (P<0.001), indicating that the Mhr increases as the age decreases.

- The mean Mhr is positively associated with the ejection fraction on dobutamine (DobEf) (P=0.056), indicating that the Mhr increases as the DobEf increases.

- The mean Mhr is positively associated with the chest pain (y=0, n=1) (CtPain) (P=0.121), indicating that the Mhr is higher of the DSE cardiac patients with no CtPain.

- The mean Mhr is positively associated with the recent bypass surgery (y=0, n=1) (NeCABG) (P=0.128), indicating that the Mhr is higher of the DSE cardiac patients with no NeCABG.

- The mean Mhr is positively associated with the history of diabetes mellitus (y=0, n=1) (HDM) (P=0.057), indicating that the Mhr is higher of the DSE cardiac patients with no HDM.

- The mean Mhr is positively associated with the history of angioplasty (yes=0, no=1) (HPTCA) (P=0.003), indicating that the Mhr is higher of the DSE cardiac patients with no HPTCA.

The determinants and their associations with the mean model of the basal, peak, and maximum heart rates have been noted here only. There are many more determinants of the variance model for these heart rates. The detailed discussion of these mean-variance association of the heart rates will be appeared in our subsequent report. Joint effect of dobutamine dose with other factors are highly associated with the heart rates. So, care should be taken on using dobutamine dose to the cardiac patients. Blood pressures are highly associated with the heart rates. All individuals should care on blood pressure. Medical practitioners, researchers and the cardiac patients will be benefited from the report.

References

1. American College of Sports Medicine (2000) ACSM's guidelines for exercise testing and prescription, MD: Lippincott Williams & Wilkins (6thedn), Baltimore, USA.

2. Fletcher GF (1997) How to implement physical activity in primary and secondary prevention: A statement for healthcare professionals from the task force on risk Reduction, American Heart Association. Circulation 96: 355-357.

3. Boutcher SH, Stein P (1995) Association between heart rate variability and training response in sedentary middle-aged men. Eur J Appl Physiol Occup Physiol 70: 75-80.

4. Lauer MS (2009) Autonomic function and prognosis. Cleve Clin J Med 76: S18-S22.

5. Cole CR, Foody JM, Blackstone EH, Lauer MS (2000) Heart rate recovery after submaximal exercise testing as predictor of mortality in a cardiovascularly healthy cohort. Ann Intern Med 132: 552-555.

6. Danieli A, Lusa L, Potocnik N, Meglic B, Grad A, et al. (2014) Resting heart rate variability and heart rate recovery after submaximal exercise. Clin Auton Res 24: 53-61.

7. Krivokapich J, Child JS, Walter DO, Garfinkel A (1999) Prognostic value of dobutamine stress echocardiography in predicting cardiac events in patients with known or suspected coronary artery disease. J Am Coll Cardiol 33: 708-716.

8. Lee Y, Nelder JA, Pawitan Y (2006) Generalized linear models with random effects: Unified analysis via h-likelihood, Chapman & Hall, London, UK.

9. Das RN, Park JS (2012) Discrepancy in regression estimates between log-normal and gamma: some case studies. J Applied Statistics 39: 97-111.

10. Firth D (1988) Multiplicative errors: Log-normal or gamma? J R Statist Soc B 50: 266-268.