Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

RESTING HEART RATE AND CARDIOVASCULAR ENDURANCE OF PROVINCIAL CRICKETERS AND MIDDLE-DISTANCE RUNNERS: AN OBSERVATION

Subhashis Biswas[1ABCD], Bankim Biswas[1ABCD], Ankur Biswas[2ABCD] and Gopinath Bhowmik Bhunia[1ABCD]

[1]Ramakrishna Mission Vivekananda Educational and Research Institute
[2]University of Kalyani

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Subhashis Biswas, E-mail: nayanavi.96@gmail.com
Accepted for Publication: October 25, 2022
Published: November 30, 2022

DOI: 10.17309/tmfv.2022.3s.18

Abstract

Resting heart rate is a reliable biomarker for measuring fitness in terms of cardiovascular health as well as analyzing an athlete's recovery.

The study purpose was to explore the resting heart rate and cardiovascular endurance of the cricketers and middle-distance runners of West Bengal.

Materials and methods. Forty male sub-elite athletes with a mean age of 19.8±2.4 years, height of 1.66±0.05 m, and body mass of 55.5±7.0 kg were randomly selected and categorized as cricketers (20) and middle-distance runners (20). Five-minute RR intervals were recorded during a resting state in the supine position using a Polar V800 smart watch along with a Polar H10 chest strap and a Polar H7 heart rate sensor. Cardiovascular endurance (predicted VO_2max) was measured using the Yo-Yo intermittent recovery test Level 1.

Results. Mean resting heart rate, SDNN, rMSSD, pNN50, and predicted VO_2max of cricketers and middle-distance runners have been found to be 57.2±5.9 bpm, 53.5±26.6 ms, 68.4±36.8 ms, 40.9±23.2%, and 48.4±1.7 ml/kg/min and 61.7±7.3 bpm, 47.0±18.8 ms, 59.2±27.3 ms 32.4±20.9%, and 49.0±2.2 ml/kg/min, respectively. No significant difference was observed in time domain parameters and predicted VO_2max, but a significant difference ($p=0.033$) was observed in resting heart rate of two groups. A significant negative ($r= -0.62$, $p=<0.001$) association has been observed between resting heart rate and predicted VO_2max.

Conclusions. The low resting heart rate of the cricketers may possibly have come from higher training load borne by the young players. Based on the players' predicted VO_2max, it looks like having good cardiovascular fitness is just as important in modern cricket as it is in middle-distance running.

Keywords: heart rate variability, time domain analysis, VO_2max, Polar, Yo-Yo test.

Introduction

Heart rate (HR) has been used for a range of intents under clinical, industrial, and sports settings (Nunan et al., 2010; Baggish & Wood, 2011; Nes et al., 2013). In the clinical perspective, 60-100 beats/min is taken as normal range (sinus rhythm) of resting heart rate (RHR) (Olshansky et al., 2022). Many studies have reported the resting heart rate values of the sports persons (Jensen-Urstad et al., 1997; Rexhepi & Brestovci, 2014; Biswas, 2020). Effective training programs according to the HR zone can be set if RHR is known (Plews et al., 2013; Vesterinen et al., 2013; Reimers et al., 2018). Numerous studies express that RHR increased due to parasympathetic type of overtraining (Fry et al., 1991; Jensen-Urstad et al., 1997; Berkoff et al., 2007; Reimers et al., 2018). It is well known that Yoga reduces RHR significantly because of its aerobic nature (Biswas et al., 2021). Endurance training also reduces RHR by increasing end diastolic volume (Plews et al., 2013). Studies on RHR and heart rate variability (HRV) are important to identify the training effect, health status, and presence of a clinical state (Baggish & Wood, 2011; Olshansky et al., 2022). On the other hand VO_2max is an important marker for understanding cardiovascular

efficiency (Hoque, 2019). The association between RHR and cardiovascular endurance is well documented, but limited research has been conducted on the variation of resting heart rate and cardiovascular endurance of sub-elite cricketers and specialized middle distance runners. Thus, the present study was carried out to explore the resting heart rate and cardiovascular endurance of the cricketers and middle distance runners of West Bengal.

Materials and methods

Study participants

Forty male volunteers were randomly selected from various districts of West Bengal and categorized into two groups: cricketers (20) and middle distance runners (20). All the cricketers who were registered members of the Cricket Association of Bengal (CAB) and West Bengal Athletic Association (WBAA) affiliated 800m and 1500m runners were included in the study. All the volunteers had been trained for more than three years and had competed for their districts at the state level. According to the ECG results, all of the volunteers were free of any cardiovascular disease (Kossmann, 1953). They were also informed about the study content and provided written consent in accordance with the Ramakrishna Mission Vivekananda Educational and Research Institute's academic and research ethics code.

RR intervals recordings

The test technique was explained to all volunteers prior to the testing. The volunteers did not consume anything for at least one hour before the test. Individuals were asked to breathe normally during the RR interval recordings. After 10 minutes of relaxation in a supine position, RR intervals were continually recorded using a Polar heart rate monitor (Polar V800 smart watch with H7 Bluetooth sensor). After two minutes of stabilization, RR intervals were obtained for five (5) minutes. The data was taken in a quiet room between 11:30 a.m. and 3:30 p.m.

Cardiovascular endurance

The Yo-Yo intermittent recovery test Level 1 (YYIR1) was conducted on the same day of RR intervals recording in the afternoon session (between 4:30p.m. and 5:30p.m.) to measure predicted VO_2max. According to the YYIR1 protocol, the volunteers were instructed to perform the test (Bangsbo et al., 2008). A test run was also conducted by the researcher to clear the test protocol. The predicted VO_2max was measured using the formula of Jens Bangsbo (predicted VO_2max = IR1 total distance covered (m) × 0.0084 + + 36.4 ml/kg/min).

Data sorting

Polar flow sync app was used to export the raw data files to the computer. The Kubios HRV Standard software (version 3.3.1) was used to analyze the time domain parameters. The calculations included the NN interval (from the filtered RR interval), SDNN, rMSSD, and pNN50 (Shaffer & Ginsberg, 2017).

Statistical analysis

Shapiro Wilk normality test was applied to understand the distribution pattern of the data set and majority of individual centric data sets fitted into the normal distribution curve, so parametric significance test, paired sample T test was applied to find out the significance differences if any between the groups. According to the patterns all the data were expressed as Mean ± Standard deviation. Gnumeric spreadsheet software version 1.10.16 and IBM Statistical Package for Social Sciences (SPSS) ver. 20 and were used for analysis and graphical presentation. The level of significance was set at $\alpha \leq 0.05$.

Results

The demographic characteristics of two groups are shown in Table 1. No significant difference has been found in chronological age of the volunteers, but significant differences were found in height, body mass and BMI of two groups. The body mass of middle distance runners was significantly lower than that of cricketers. The cricketers were significantly taller than the athletes.

Table 1. Basic physical variables of cricketers and middle distance runners

Variables	Cricketers	Middle distance runners	P value
Age (years)	19.1 ± 2.1	20.4 ± 2.5	0.69
Standing height (m)	1.69 ± 0.02	1.63 ± 0.05	6.9^{e-5}
Body mass (kg)	60.3 ± 3.9	50.7 ± 6.2	2.5^{e-6}
BMI (kg/m^2)	21.1 ± 1.2	19.0 ± 1.6	1.2^{e-6}

Table 2 displays the values of NN interval, SDNN, rMSSD and pNN50 according to groups. The NN interval of middle distance runners was significantly lower than the cricket players, which indicates a higher resting heart rate of the athletes. The values of time domain parameters of HRV such as SDNN, rMSSD, and pNN50 are lower in athletes than that of cricketers. However, no significant differences are observed in the time domain parameters of two groups.

The figure 1, displayed a clear pictoral view of significant (r = -0.62, p = 1.51E-5) negative relationship between predicted VO_2max and resting HR. The regression equation to predict predicted VO_2max (Y) in reference to RHR (X) has been found Y= -0.23 X+62.01 with R2 =0.39).

Table 2. Analysis of RR intervals and time domain parameters of HRV are displayed in the below noted table using Kubios HRV Standard software (version 3.3.1).

Parameters	Cricketers	Middle distance runners	P value
NN intervals (ms)	1065.2 ± 84.1	997.7 ± 111.7	0.0238
SDNN (ms)	53.5 ± 26.6	47.0 ± 18.8	0.3527
rMSSD (ms)	68.4 ± 36.8	59.2 ± 27.3	0.3633
pNN50 (%)	40.9 ± 23.2	32.4 ± 20.9	0.2524

The pooled RR intervals for cricketers and middle distance runners have been found to be 1059 ± 105ms and 987 ± 124ms respectively. All the pooled RR intervals were converted into HR. The mean RHR of the cricketers and middle

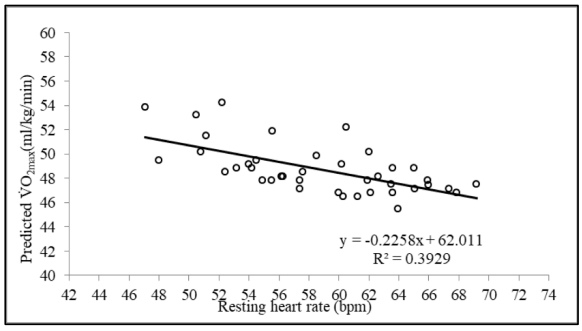

Fig. 1. Relationship between resting heart rate and predicted VO_2max

distance runners have been found 57.2 ± 5.9 bpm and 61.7 ± ± 7.3 bpm respectively. A significant difference (p = 0.0328) has been observed in pooled RHR among the two groups. The predicted VO_2max of the cricketers and middle distance runners have been found to be 48.40±1.69ml/kg/min and 48.95±2.18ml/kg/min respectively but did not exhibits any significant difference (p=0.29). Although the 95% confidence intervals for HR variation in cricketers and middle distance runners were only slightly different, it was found to be 47.8-64.8 bpm and 46.9-69.0 bpm, respectively. Wide fluctuation in the RHR has been noticed in both groups' volunteers in five-minute segments.

Discussion

The observation of taller players in cricket may have come from the natural selection process where relatively less affluent populations take part in athletics compared to cricket in India. Economic conditions might also influence the height and weight of the players in the same age group. According to chronological age, both groups are similar, but physical structure transformed them into heterogeneous groups. The values of the RHR of both groups are less than the sedentary population (Catai et al., 2002). Rapid fluctuation in RHR has been observed in both groups, which reflects parasympathetic control of the heart (Plews et al., 2013; Biswas, 2020). Although the RHR values of cricketers and athletes are the same as healthy adults in middle Norway (Nes et al., 2013). Time domain parameters such as SDNN, rMSSD, and pNN50 of two groups lie in the normal range, but a relatively high value of time domain parameters has been observed in cricketers (Plews et al., 2013; Shaffer & Ginsberg, 2017). Resting HR of two groups has been observed below normal level (Olshansky et al, 2022). Low RHR, a type of bradycardia, has been observed in both groups (Jensen-Urstad et al., 1997; Plews et al., 2013; Reimers et al., 2018). ECG recorded at rest did not exhibit any arrhythmia or changes that may indicate an abnormal condition of the heart (Kossmann, 1953). In the study, low resting HR at rest indicates parasympathetic dominance (Berkoff et al., 2007). The values of rMSSD and pNN50 also support this observation (Vesterinen et al., 2013; Shaffer & Ginsberg, 2017). The SDNN value of two groups indicates good overall HRV status. A low RHR may be caused by a parasympathetic type of overtraining (Fry et al., 1991). Alteration in the left ventricle may also be the cause of low RHR (Fernandes et al., 2011). A significantly lower RHR has been observed in cricketers compared to middle distance runners, but no significant difference has been observed in time domain parameters of HRV. From this point of view, only low RHR is unable to express a significant difference in the overall physical state and physiological ability, because the HRV parameters of both groups are merely similar. In recent years, The Cricket Association of Bengal (CAB), implements multi days tournaments (85 overs X 2 days in league stage and 85 overs X 3 days in knockout stage) at the grassroots level, which could be the cause of this acclimatization. The predicted VO_2max of the cricketers was a little higher compared to the cricketers of Kerala, India but lower than elite Australian cricketers (Hoque, 2018). Due to training adaptation, a low resting heart rate has been observed, which is also supported by SDNN and predicted VO_2max. However, the average training years of the cricketers were higher than that of middle distance runners, which may also be the cause of the significantly lower RHR. The observed relationship between resting heart rate and predicted VO_2max is also supported by the findings of Agron and Behlul (2014).

The findings of time domain parameters in the study, such as SDNN and rMSSD values, are lower than elite American track and field athletes (Berkoff et al., 2007). The findings of the RHR of athletes and cricketers are relatively lower than the observations of Jensen-Urstad et al. (1997) and Martinelli et al. (2005). A higher SDNN value has been observed in cricketers than in Brazilian athletes (Martinelli et al., 2005). The findings of the RHR of the cricketers are lower than those of Indian field hockey players (Manna et al., 2009) but higher than the findings of Finland's marathon training runners (Vesterinen et al., 2013).

Conclusions

Bradycardia was discovered in the cricketers and middle-distance runners. The study explores the resting heart rate and predicted VO_2max of the cricketers and middle distance runners, which will help coaches and physical trainers to create HR guided training regimens, understand morning readiness as well as overtraining syndrome. RHR derivate regression equation can be useful for determining predicted VO_2max of grassroots level players.

Acknowledgement

The author acknowledges the support from Prof. Asis Goswami, Prof. Subhankar Ghosh, all the volunteers along with their respective district association who participated in the study, and finally to the Vice Chancellor, RKMVERI, for continuing inspiration in the work.

Conflict of interest

The authors declare no conflict of interest for this study.

References

Nunan, D., Sandercock, G. R. H., & Brodie, D. A. (2010). A Quantitative Systematic Review of Normal Values for Short-Term Heart Rate Variability in Healthy Adults: Review of Short-Term Hrv Values. *Pacing and Clinical*

Electrophysiology, 33(11), 1407-1417. https://doi.org/10.1111/j.1540-8159.2010.02841.x

Baggish, A. L., & Wood, M. J. (2011). Athlete's Heart and Cardiovascular Care of the Athlete: Scientific and Clinical Update. *Circulation, 123*(23), 2723-2735. https://doi.org/10.1161/CIRCULATIONAHA.110.981571

Nes, B. M., Janszky, I., Wisløff, U., Støylen, A., & Karlsen, T. (2013). Age-predicted maximal heart rate in healthy subjects: The HUNT Fitness Study: Maximal heart rate in a population. *Scandinavian Journal of Medicine & Science in Sports, 23*(6), 697-704. https://doi.org/10.1111/j.1600-0838.2012.01445.x

Olshansky, B., Ricci, F., & Fedorowski, A. (2022). Importance of resting heart rate. *Trends in Cardiovascular Medicine,* S1050173822000731. https://doi.org/10.1016/j.tcm.2022.05.006

Jensen-Urstad, K., Saltin, B., Ericson, M., Storck, N., & Jensen-Urstad, M. (1997). Pronounced resting bradycardia in male elite runners is associated with high heart rate variability. *Scandinavian journal of medicine & science in sports, 7*(5), 274-278. https://pubmed.ncbi.nlm.nih.gov/9338944/ https://doi.org/10.1111/j.1600-0838.1997.tb00152.x

Rexhepi, A. M., & Brestovci, B. (2014). Prediction of vo2max based on age, body mass, and resting heart rate. *Human Movement, 15*(1). https://doi.org/10.2478/humo-2014-0003

Biswas, S. (2020). A Study on Resting Heart Rate and Heart Rate Variability of Athletes, Non-athletes and Cricketers. *American Journal of Sports Science, 8*(4), 95. https://doi.org/10.11648/j.ajss.20200804.13

Plews, D. J., Laursen, P. B., Stanley, J., Kilding, A. E., & Buchheit, M. (2013). Training Adaptation and Heart Rate Variability in Elite Endurance Athletes: Opening the Door to Effective Monitoring. *Sports Medicine, 43*(9), 773-781. https://doi.org/10.1007/s40279-013-0071-8

Vesterinen, V., Häkkinen, K., Hynynen, E., Mikkola, J., Hokka, L., & Nummela, A. (2013). Heart rate variability in prediction of individual adaptation to endurance training in recreational endurance runners: HRV and endurance training adaptation. *Scandinavian Journal of Medicine & Science in Sports, 23*(2), 171-180. https://doi.org/10.1111/j.1600-0838.2011.01365.x

Reimers, A., Knapp, G., & Reimers, C.-D. (2018). Effects of Exercise on the Resting Heart Rate: A Systematic Review and Meta-Analysis of Interventional Studies. *Journal of Clinical Medicine, 7*(12), 503. https://doi.org/10.3390/jcm7120503

Fry, R. W., Morton, A. R., & Keast, D. (1991). Overtraining in Athletes: An Update. *Sports Medicine, 12*(1), 32-65. https://doi.org/10.2165/00007256-199112010-00004

Berkoff, D. J., Cairns, C. B., Sanchez, L. D., & Moorman, C. T. (2007). Heart rate variability in elite american track-and-field athletes. *Journal of Strength and Conditioning Research, 21*(1), 227-231. https://doi.org/10.1519/00124278-200702000-00041

Biswas, S., Biswas, A., & Bandhyopadhyay, N. (2021). Effects of Four Weeks Intervention of Yogic Practices on Cricket Specific Motor Fitness. *Journal of Advances in Sports and Physical Education, 4*(5), 125-130. https://saudijournals.com/media/articles/JASPE_45_125-130.pdf

Hoque, N. (2019). Game Specific Fitness Profile of Male Cricket Players from Kerala. *IOSR Journal of Sports and Physical Education, 5*(6), 34-42.

Kossmann, C. E. (1953). The Normal Electrocardiogram. *Circulation, 8*(6), 920-936. https://doi.org/10.1161/01.CIR.8.6.920

Bangsbo, J., Iaia, F. M., & Krustrup, P. (2008). The Yo-Yo Intermittent Recovery Test: A Useful Tool for Evaluation of Physical Performance in Intermittent Sports. *Sports Medicine, 38*(1), 37-51. https://doi.org/10.2165/00007256-200838010-00004

Shaffer, F., & Ginsberg, J. P. (2017). An Overview of Heart Rate Variability Metrics and Norms. *Frontiers in Public Health,* 5, 258. https://doi.org/10.3389/fpubh.2017.00258

Catai, A. M., Chacon-Mikahil, M. P. T., Martinelli, F. S., Forti, V. A. M., Silva, E., Golfetti, R., Martins, L. E. B., Szrajer, J. S., Wanderley, J. S., Lima-Filho, E. C., Milan, L. A., Marin-Neto, J. A., Maciel, B. C., & Gallo-Junior, L. (2002). Effects of aerobic exercise training on heart rate variability during wakefulness and sleep and cardiorespiratory responses of young and middle-aged healthy men. *Brazilian Journal of Medical and Biological Research, 35*(6), 741-752. https://doi.org/10.1590/S0100-879X2002000600016

Fernandes, T., Hashimoto, N. Y., Magalhães, F. C., Fernandes, F. B., Casarini, D. E., Carmona, A. K., ... & Oliveira, E. M. (2011). Aerobic exercise training–induced left ventricular hypertrophy involves regulatory MicroRNAs, decreased angiotensin-converting enzyme-angiotensin II, and synergistic regulation of angiotensin-converting enzyme 2-angiotensin (1-7). *Hypertension, 58*(2), 182-189. https://doi.org/10.1161/hypertensionaha.110.168252

Martinelli, F. S., Chacon-Mikahil, M. P. T., Martins, L. E. B., Lima-Filho, E. C., Golfetti, R., Paschoal, M. A., & Gallo-Junior, L. (2005). Heart rate variability in athletes and nonathletes at rest and during head-up tilt. *Brazilian Journal of Medical and Biological Research, 38*(4), 639-647. https://doi.org/10.1590/S0100-879X2005000400019

Manna, I., Khanna, G., & Dhara, P. (2009). Training induced changes on physiological and biochemical variables of young Indian field hockey players. *Biology of Sport, 26*(1), 33-43. https://doi.org/10.5604/20831862.890173

ЧСС У СТАНІ СПОКОЮ ТА СЕРЦЕВО-СУДИННА ВИТРИВАЛІСТЬ ПРОВІНЦІЙНИХ ГРАВЦІВ У КРИКЕТ І БІГУНІВ НА СЕРЕДНЮ ДИСТАНЦІЮ: СПОСТЕРЕЖЕННЯ

Субхашіс Бісвас[1ABCD], Банкім Бісвас[1ABCD], Анкур Бісвас[2ABCD], Гопінат Бхоумік Бхунія[1ABCD]

[1]Місія Рамакрішна Вівекананда Навчально-дослідний інститут
[2]Університет Кальяні

Реферат. Стаття: 5 с., 2 табл., 1 рис., 21 джерело.

Показник частоти серцевих скорочень у стані спокою є надійним біомаркером для вимірювання фізичної підготовленості в частині здоров'я серцево-судинної системи, а також для аналізу відновлення спортсмена.

Метою дослідження було вивчення ЧСС у стані спокою та серцево-судинної витривалості гравців у крикет і бігунів на середню дистанцію зі штату Західна Бенгалія (Індія).

Матеріали та методи. Учасниками дослідження стали 40 висококласних спортсменів регіонального рівня чоловічої статі середнім віком 19,8±2,4 року, зростом 1,66±0,05 м та з індексом маси тіла 55,5±7,0 кг, які були відібрані випадковим чином і поділені на категорії гравців у крикет (20) та бігунів на середню дистанцію (20). Реєстрували п'ятихвилинні кардіоінтервали (RR-інтервали) у стані спокою в положенні лежачи на спині з використанням смарт-годинника «Polar V800» разом із нагрудним ременем-пульсометром «Polar H10» і датчиком ЧСС «Polar H7». Вимірювання показників серцево-судинної витривалості (прогнозоване значення максимального споживання кисню – МСК) здійснювали за допомогою інтервального тесту на відновлення Йо-Йо, Рівень 1.

Результати. Було встановлено, що середні показники ЧСС у стані спокою, статистичного відхилення нормальних RR-інтервалів (SDNN), стандартного відхилення RR-інтервалів (rMSSD), відсотку послідовних RR-інтервалів із відмінністю понад 50 мс (pNN50) та прогнозованого МСК гравців у крикет і бігунів на середню дистанцію дорівнюють 57,2±5,9 уд./хв, 53,5±26,6 мс, 68,4±36,8 мс, 40,9±23,2%, 48,4±1,7 мл/кг/хв та 61,7±7,3 уд./хв, 47,0±18,8 мс, 59,2±27,3 мс, 32,4±20,9%, 49,0±2,2 мл/кг/хв відповідно. Жодної статистично значущої різниці параметрів у часовій області та прогнозованого МСК не спостерігалося, але спостерігалася статистично значуща різниця (p=0,033) показників ЧСС у стані спокою двох груп. Спостерігався статистично значущий негативний (r= -0,62, p=<0,001) зв'язок між ЧСС у стані спокою та прогнозованим МСК.

Висновки. Низький показник ЧСС у стані спокою гравців у крикет, можливо, є результатом вищого тренувального навантаження, яке несуть молоді гравці. З огляду на прогнозований показник МСК гравців, здається, що наявність гарного функціонального стану серцево-судинної системи є не меншою мірою важливою в сучасному крикеті, ніж у бігу на середню дистанцію.

Ключові слова: варіабельність серцевого ритму, аналіз у часовій області, МСК, Polar, тест Йо-Йо.

Information about the authors:

Subhashis Biswas: nayanavi.96@gmail.com; https://orcid.org/0000-0003-2516-1831; Department of Sports Science and Yoga, Ramakrishna Mission Vivekananda Educational and Research Institute, Belur Math, Howrah, West Bengal, 711202, India.

Bankim Biswas: biswas.bankim88@gmail.com; https://orcid.org/0000-0002-7059-6853; Department of Sports Science and Yoga, Ramakrishna Mission Vivekananda Educational and Research Institute, Belur Math, Howrah, West Bengal, 711202, India.

Ankur Biswas: ankurmotek98@gmail.com; https://orcid.org/0000-0002-4113-8546; Department of Physical Education, University of Kalyani, Nadia, West Bengal, 711202, India.

Gopinath Bhowmik Bhunia: gopinathbhowmik1990@gmail.com; https://orcid.org/0000-0002-8458-4116; Department of Sports Science and Yoga, Ramakrishna Mission Vivekananda Educational and Research Institute, Belur Math, Howrah, West Bengal, 711202, India.

Cite this article as: Biswas, S., Biswas, B., Biswas, A., & Bhunia, G.B. (2022). Resting Heart Rate and Cardiovascular Endurance of Provincial Cricketers and Middle-Distance Runners: An Observation. *Physical Education Theory and Methodology, 22*(3s), S132-S136. https://doi.org/10.17309/tmfv.2022.3s.18

Received: 02.09.2022. Accepted: 25.10.2022. Published: 30.11.2022