ORIGINAL ARTICLE

Cardiovascular Parameters of Nigerian Physiotherapy Students During an End of Semester Examination

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Examination and tests are routine academic task during which students engage in mental exercises, writing, and/or practical demonstrations under pressure with stress placed on the cardiovascular system. This study was aimed at investigating the cardiovascular parameters of students before, during and after an examination. The baseline hear rate (HR) and blood pressures (BPs) of 75 undergraduates physiotherapy students in a Nigerian university were measured one month to the beginning of a second semester examination, and also before, during and after a session of test in core subjects. This study shows higher HR, and systolic and diastolic BPs5 minutes to the start of the examination compared to the baseline resting values. This heightened cardiovascular parameters remained steady until the time remaining till the end of exam was announced, when the parameters spiked to levels higher than both the baseline and pre-examination levels. While the systolic, diastolic and mean arterial BPs returned to baseline levels shortly before or at about 15 minutes after exam, HR and rate pressure product did not return to the baseline levels 15 minutes after examination. Cardiovascular parameters were higher few minutes before exam than the baseline resting values and continue so until the remaining time left for the exam was announced. Future studies on aerobic fitness and physiological adaptations conferred by exercises and regular physical activity can influence cardiovascular parameters during examination are suggested.
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INTRODUCTION

Among factors that have been shown to affect cardiovascular parameters are exercise or physical activity, nutrition and medication, (McClean and Zimmerman, 2007) stress (Wendy *et al.,* 2002, Callister 1992) and mental work (Carter and Lawrence, 2007; Carter and Ray 2009). It has been observed that students in the course of their study activities may experience high level of anxiety and stress (Loft *et al.,* 2007; Sharma, 2011; Fazaila *et al.,* 2013), which may affect not only their academic performance but their overall physical and psychological wellbeing (Tucker *et al.,* 2006; Walsh *et al.,* 2010). Several past studies investigated the cardiovascular responses during test taking and around the period of examinations (Hughes, 2004; Zeller *et al.,* 2004; Loft *et al.,* 2007; Smart *et al.,* 2007; Khaksari*et al.,* 2007; Conley and Lehman, 2012; Pérusse-Lachance *et al.,* 2012).

Some studies show that fear of failure, impending examinations and academic ability have been identified as responsible for heightened cardiovascular parameters among students around examination period (Zeller *et al.,* 2004; Hughes, 2004; Loft *et al.,* 2007; Conley and Leyman, 2012). Other studies show that students who have the most intense cardiovascular responses around the time of examination and/or during examination may be at risk for developing cardiovascular disease or cardiac event in later life (Loyke, *1995;* Stewart and Barnet, 2008; Xavier *et al.,* 2009; Taelman *et al.,* 2011; Hjovtskov *et al.,* 2004). In some studies, mental work has been found to cause increases in heart rates (HR) (Ross, 2001; Martic *et al.,* 2008; Hjortskpv 2004) and blood pressures among students (Hughes, 2004),

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while elevations in systolic blood pressure (SBP) was linked with academic stress around the period of semester examination, and no such link was observed for diastolic blood pressure (DBP) or HR in another study (Conley and Lehman, 2012).

During a test involving subjects who engaged in reading a 10-page text from a lay public magazine and summarizing of the text using a word processor on a computer, the DBP and mean arterial pressure (MAP) were observed to be higher during the test (Pérusse-Lachance *et al.,* 2012). In a single arithmetic task (Durocher *et al.,* 2011) during a repeated serial-subtraction math (Schneider *et al.,* 2003) and during a non-cumulative Medical license examination (Zeller *et al.,* 2004), SBP did not change significantly but the DBP increased, while HR decreased from the values before exam. Systolic blood pressure was also observed to be higher in the male students compared to their female counterparts in the later study (Zeller *et al.,* 2004).

Existing studies on the cardiovascular response during tests were carried out in other parts of the world under divergent testing modalities including reading and typing on a computer (Pérusse-Lachance *et al.,* 2012), single Arithmetic task (Durocher *et al.,* 2011), repeated serial-subtraction math (Schneider *et al.,* 2003) and non-cumulative Medical license examination (Zeller *et al.,* 2004). To the best of the researchers' knowledge, this is the first study to focus on a semester examination as stressors among physiotherapy students. This study aimed to compare cardiovascular parameters of physiotherapy students at the University of Maiduguri, Nigeria long before exam to the values just before, during and after a written semester examination.

MATERIALS AND METHODS

Participants
A total of 75 undergraduate Physiotherapy students at the University of Maiduguri, a Federal University in the North Eastern Nigeria participated in this study. The study was approved by the Research and Ethical Committee of the University of Maiduguri Teaching Hospital. Prospective participants were contacted during a lecture period 6 weeks prior to semester examinations. The aim and objectives, procedure and possible risk of the study were explained to the prospective participants. Informed consent of the participants that met the inclusion criteria was sought and obtained. Participants with history of smoking or cardiovascular ailment and those with known co-existing medical condition or on medication that can influence their hemodynamic balance were excluded from this study. The examination was undertaken in an examination hall with a room temperature of 22^0C -25^0C in the month of July 2012 of the 2011/2012 academic session between 9:30 am to 11:30 am.

Data Collection
Based on the outcome of a pilot survey among 28 undergraduate physiotherapy student conducted 4 months prior to the main study, 5 research assistants were trained one week prior to the commencement of the study. The assistants were responsible for monitoring the blood pressure, pulse and heart rate of the participants during the second semester examination on patho-kinesiology and exercise therapy both of which are core subjects in physiotherapy.

On a day 4-5 weeks before the examination, eligible participants were invited to the laboratory and were advised on a standardized breakfast (women: 598 kcal, men: 714 kcal) not earlier than 3 hours before the visit and to avoid any caffeine drink, alcohol and vigorous physical activity 24 hrs before the test. Consented participants who did not follow these standardized procedures by Pérusse-Lachance *et al.,* (2012) were asked to return another day for their baseline measurement. The participants were given a card numbered to correspond with number assigned to their demographic form containing their data, which includes age and years in the study program and their cardiovascular parameters. Baseline heart rate (HR) and blood pressures were assessed in sitting position during the visit using a digital electronic sphygmomanometer (Life Source, Model UB-512). Thereafter, height and weight were measured with the aid of a wooden height meter and a weighing scale (Hanna bathroom scale model, Chi-

na. BNo: 29072184).

On the examination day, Participants were again briefed on the procedure and while seated in the examination hall, cardiovascular parameters were measured 5-10 minutes before the commencement of the examination. During the examination, cardiovascular parameters were again measured at 10, 30 and 60 minutes into examination. Upon completing the 2-hour long examination, the parameters were monitored again at 5, 10 and 15 minutes post examination.

Data Analysis

The data collected were entered and analyzed using Statistical Package for the Social Science (SPSS), version 20.0 for windows (SPSS Inc., Chicago, Illinois, USA). Derived indices including pulse pressure (PP), mean arterial pressure (MAP), rate pressure product (RPP), and body mass index (BMI) were also computed and entered for analysis. Descriptive statistics of mean, and standard deviation were used to describe data obtained. One way ANOVA, was used to compare the cardiovascular parameters across the different time points, and Least Significance Difference (LSD) *post-hoc* test was used to probe where the differences lies between different time frame, at a level of significance of $p < 0.05$.

RESULTS

A total of 75subjects participated in this study, of which 45 (60%) were males and 30 (40%) were females. The mean age was 24.8 ± 2.2 years and body

mass index was 21.9 ± 3.7 kg/m². The mean baseline values for their HR, SBP and DBP were 75 ± 9 bpm, 113 ± 10 mmHg and 74 ± 8 mmHg respectively whereas the values 5 minutes before the examination were 85 ± 9 bpm, 120 ± 11 mmHg and 76 ± 8 mmHg. The mean values for the derived parameters including MAP (the average pressure during the cardiac cycle), RPP (an index of myocardial oxygen uptake) and PP (a correlate of stroke volume) at different time frames are also shown on the table. The mean baseline MAP, PP, and RPP were 87 ± 9, 39 ± 6 and 8400 ± 0.9, whereas 5 min before the examination the values were 96 ± 10, 44 ± 7 and 10200 ± 100 respectively (Table 1).

The HR values 10 minutes, 30 minutes and 60 minutes into the examination were 88 ± 9, 87 ± 9, and 101 ± 10 respectively, while the value 5, 10 and 15 minutes after examination were 86 ± 9, 81 ± 9 and 83 ± 9 respectively. The SBP values 10 minutes, 30 minutes and 60 minutes into the examination were 118 ± 10, 113 ± 10 and 126 ± 11 respectively, while the value 5, 10 and 15 minutes after examination were 107 ± 10, 109 ± 10 and 111 ± 10 respectively. The DBP values at 10, 30 and 60 minutes into the examination were 76 ± 8, 71 ± 8 and 82 ± 9 respectively, while the value 5, 10 and 15 minutes after examination were 70 ± 8, 71 ± 8 and 71 ± 8 respectively.

When values before, during and after examination were compared, HR, SBP, DBP, MAP and RPP were significantly higher ($p<0.01$) 5 minutes before

Table 1: Cardiovascular parameters before during and after examination

Variable	Physiologic	5 min BE	10 min IE	30 min IE	60 min IE	5 min AE	10 min AE	15 min AE
HR	75±9	85±9	88±9	87±9	101±10	86±9	81±9	83±9
SBP	113±10	120±11	118±10	113±10	126±11	107±10	109±10	111±10
DBP	74±8	76±8	74±8	71±8	82±9	70±8	71±8	71±8
MAP	87±9	96±10	89±9	86±9	97±10	83±9	84±9	85±9
PP	39±6	44±7	44±7	42±6	48±7	37±6	38±6	40±6
RPP	84±0.9	102±1	106±1	99±0.9	123±3.4	92±0.9	89±0.9	93±0.9

NOTE: RPP is '100'. *For example the* RPP *value at baseline is* 8400±90. **HR-** *Heart Rate,* **SBP-** *Systolic Blood Pressure,* **DBP-** *Diastolic Blood Pressure,* **MAP-** *Mean Arterial Pressure,* **PP-** *Pulse Pressure,* **RPP-** *Rate Pressure Product,* **BE-** *Before Examination,* **IE-** *Into Examination,* **AE-** *After Examination,*

Table 2: Cardiovascular parameters before during and after exams

Variable	p vs e	e vs f	f vs g	g vs h	h vs i	i vs j	j vs k
HR	75±9v85±9[a]	85±9v88±9	88±9v87±9	87±9v101±10 [a]	101±10v86±9[a]	86±9v81±9	81±9v83±9
SBP	113±10v120±11 [a]	120±11v118±10	118±10v113±10	113±10v126±11[a]	126±11v107±10[a]	107±10v109±10	109±10v111±10
DBP	74±8v76±8 [a]	76±8v74±8	74±8v71±8	71±8v82±9 [a]	82±9v70±8[a]	70±8v71±8	71±8v71±8
MAP	87±9v96±10[a]	96±10v89±9	89±9v86±9[b]	86±9v97±10	97±10v83±9[b]	83±9v84±9	84±9v85±9
PP	39±6v44±7	44±7v43±2	44±7v42±6	42±6v43±7	43±7v37±6	37±6v38±6	38±6v40±6
RPP	84±0.9v102±1 [a]	102±1v106±1	106±1v99±0.9	99±0.9v122±3.4[a]	122±3.4v92±0.9	92±0.9v89±0.9	89±0.9v93±0.9

P value is **"a"** *when P≤ 0.01 and P value is* **"b"** *when P≤ 0.05*
NOTE: RPP *is '00'. For example the RPP value at baseline is 8400±90.* **HR-** *Heart Rate,* **SBP-** *Systolic Blood Pressure,* **DBP-** *Diastolic Blood Pressure,* **MAP-** *Mean Arterial Pressure,* **PP-** *Pulse Pressure,* **RPP-**Rate Pressure Product. **p-** *denotes baseline physiological value,* **e-** *denotes 5 minutes before the examination,* **f –** *denotes 10 minutes into the examination,* **g-** *denotes 30 minutes into the examination,* **h-** *denotes 60 minutes into the examination,* **i-** *denotes 5 minutes after the examination,* **j –** *denotes 10 minutes after the examination and* **k-** *denotes 15 minutes after the examination.*
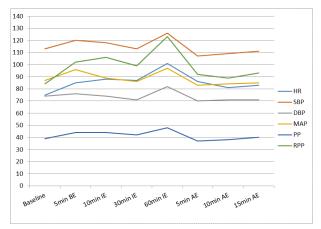

Figure 1: Cardiovascular parameters before, during and after examination
HR- *Heart Rate,* **SBP-** *Systolic Blood Pressure,* **DBP-** *Diastolic Blood Pressure,* **MAP-** *Mean Arterial Pressure,* **PP-** *Pulse Pressure,* **RPP-** *Rate Pressure Product ('00),* **BF-** *Before Examination,* **IE-** *Into Examination,* **AE-** *After Examination,*

exam compared to the baseline values (85±9 v 75±9, 113±10v120±11, 74±8v76±8, 87±9v96±10 and 84±0.9v102±1 respectively). No significance difference was observed in any of these cardiovascular parameters at 10 and 30 minutes into the examination when compared to the values 5 minutes before the examination, while only the MAP (89±9v86±9) was significantly higher (P<0.05) at 10 minute into the examination compared to the values 30 minute into examination (Table 2). Significantly higher values (P<0.01) were observe for HR, SBP, DBP and RPP 60 minutes into the examination when the time left for the exam was announced, compared to the corresponding values at all other time frames. There was no significant difference in all the CV parameters measured 5 minutes compared to values 10 minute after the examination and between the values 10 minute after exams compared to the values 15 minutes after the examination.

Overall, the result showed increased HR and BP responses 5 minutes prior to the start of the examination when compared to the resting physiological values taken at least four weeks before examination. The increased HR, SBP and DBP remain so

during the examination. Except for MAP which was significantly higher 30 minutes into examination compared to the values 10 minutes into examination, no difference were observed in the pre-examination values compared to values 10 and 30 minutes into examination for HR, SBP, and DBP. While HR, SBP, DBP, MAP and RPP at 60 minutes was significantly higher ($p<0.05$) than the corresponding values at all other time frames, the values 5, 10 and 15 minutes after examination were not significantly different from each other.

DISCUSSION
When compared to the baseline resting physiological value, the present study shows higher HR, SBP and DBP response. This finding is comparable to that reported by Pérusse-Lachance *et al.,* (2012) which showed an increase in HR and DBP during the period of mental work when compared to their resting values. It is also comparable to that of Durocher *et al.,* (2011) that showed an increase in both systolic and diastolic blood pressure during mental stress when compared to the 5 minutes pre-examination baseline value. It is however not as comparable to the findings in other previous study which showed that, SBP did not change significantly while DBP increase and HR decrease from the values just before medical license examinations (Zeller *et al.,* 2004).

Our study shows that RPP increases significantly during examination; consistent with the report by Wendy *et al.,* (2002) who compared mental stress and physical stress, and another study that reported higher RPP during a mental arithmetic examination than during static hand grip procedure (Raven *et al.,* 2006). Pulse pressure is the only parameter that did not change throughout from the baseline through post examination, consistent with findings by Carter and Lawrence, (2000) and this may be attributed to the fact that baroreceptors responds more rapidly to a rising arterial pressure than when arterial pressure nears the peak value (Guyton and Hall, 2006).

Overall the subjects cardiovascular parameters was characterized by heightened responses observable few minutes before exam which remain so until the remaining time left for the exam was announced, when the parameters spiked to surpass the levels at all other time frames. Following exam, HR trended lower and did not return to the baseline levels at 5, 10 and 15 minutes after exam while the SBP also trended lower and was below baseline levels 5 minutes after exercises before it then trended upward to approximate the baseline levels at 15 minutes after exam. The DBP stayed below baseline level 5 minutes after exam and until 15 minutes after examination while the MAP trended lower than baseline level 5 and 10 minutes after exam before trending higher to approximate baseline level 15 minutes after exam.

Compared to the baseline values, CV parameters found to be increased 5 minutes to the examination may be attributed to anxiety in anticipation of the examination which attenuates the baroreflex-mediated sympatho-inhibition (Durocher *et al.,* 2011), and also cause reduction in cardiac parasympathetic modulation (Hjortskov *et al.,* 2004). Heightened CV parameters around the period of exam can also be attributed to the complex psychological process in examination preparation such as could be experienced as students observe sleepless nights which is believed to further stimulate the arousal system. The steady or slightly lower CV responses during the course of exam taking could be attributed to the improved baroreflex function as a consequence of the stress becoming persistent (Durocher *et al.,* 2011). The later spike in the CV response when the time remaining was announced may be attributed to an acute stress that triggers heightened anxiety and increased mental effort needed to finish up.

CONCLUSION
Cardiovascular parameters few minutes before exam were higher than the baseline resting values and remain so until the remaining time left for the exam was announced, when the parameters spiked to surpass the levels at all other time frames including the resting baseline and the pre-exam levels. Following exam, while the SBP, DBP, PP, and MAP responses approximated the baseline levels shortly before, or at 15 minutes after exam, HR and RPP

did not return to the baseline levels 15 minutes after examination.

COMPETING INTERESTS

The authors declare that they have no competing interests.

REFERENCE

Callister R., Suwarno N.O. and Seals D.R. (1992) Sympathetic activity is influenced by task difficulty and stress perception during mental challenges in humans. *Journal of Physiology* 454, 373-387.

Carter J.R. and Ray C.A. (2009) Sympathetic neural responses to mental stress: responders, non-responders and sex differences. *American Journal of Physiology - Heart and Circilatory Physiology* 296, H847-H853.

Carter J.R. and Lawrence J. (200) Effect of menstrual cycle on sympathetic neural responses to mental stress in humans. *Journal of Physiology* 585, 635-641

Conley K.M, and Lehman, B.J. (2012) Test Anxiety and Cardiovascular Responses to Daily Academic Stressors. *Stress and Health* 28 (1), 41-50.

Durocher J.J., Klein J.C., and Carter J.R. (2011) Attenuation of sympathetic baroreflex sensitivity during the onset of acute mental stress in humans. *American Journal of Physiology - Heart and Circilatory Physiology* 300, H1788-H1793.

Fazaila S., Farah R.S. and Muhammad N.B. (2013) Assessment of stress among physiotherapy students at Riphah Centre of Rehabilitation Sciences. *Journal of Pakistan Medical Association* 63, 346

Guyton A.C. and Hall J.E. (2006) Text book of Medical Physiology, In Nervous Regulation of the Circulation, and Rapid Control of Arterial Pressure, 11th ed. Elsevier Saunders Pp 210-212

Hjortskov N., Rissén D., Blangsted A.K., Fallentin N., Lundberg U. et al. (2004) The effect of mental stress on heart rate variability and blood pressure during computer work. *European Journal of Applied Physiology* 92, 84-89.

Hughes B.M. (2004) Academic Study, College Examinations, and Stress: Issues in the Interpretation of Cardiovascular Reactivity Assessments with Student Participants. *Journal of Applied Biobehavioural Research* 9, 23–44.

Khaksari M., Mahmoodi M., Rezvani M.E., Sajjadi M.A., Karam G.A. and Hajizadeh S. (2007) Differences between male and female student in cardiovascular and endocrine responses to examination stress. *Journal of Ayub Medical College Abbottabad* 17(2), 15-19.

Loft P., Thomas M.G., Petrie K.J., Booth R.J., Miles J., and Vedhara K. (2007) Examination stress results in altered cardiovascular responses to acute challenge and lower cortisol. *Psychoneuroendocrinology* 32, 367-375.

Loyke H.F. (1995) Cold pressor test as a predictor of the severity of hypertension. *South Medical Journal* 88, 300–304.

Martin E.A., Tan S.L., MacBride L.R., Lavi S., Lerman L.O., Lerman A. (2008) Sex differences in vascular and endothelial responses to acute mental stress. *Clinical Autonomic Research* 18, 339-345.

McLean B. and Zimmerman J.L. (2007) Fundamental Critical Care Support (4th edition) Lange 4, 50-53.

Pérusse-Lachance E., Tremblay A., Chaput J.P., Poirier P., Teasdale N., Drapeau V.,Sénécal C. and Brassard P. (2012) Mental Work Stimulates Cardiovascular Responses through a Reduction in Cardiac Parasympathetic Modulation in Men and Women. *Bioenergetics* 1, 001

Raven P.B., Fadel P.J., Ogoh S. (2006) Arterial baroreflex resetting during exercise: a current perspective. *Experimental Physiology* 91, 37-49.

Ross A.E., Flaa A., Hieggen A., Reims H., Eide I.K., Kjeldsen S.E. (2001) Gender specific sympathetic and hemorrheological responses to mental stress in healthy young subjects. *Scandinavian Cardiovascular Journal* 35, 307-312

Sharma B., Wavare R., Deshpande A., Nigam R. and Chandorkar R.(2011) A study of aca-

demic stress and its effect on vital parameters in final year medical students at SAIMS Medical College, Indore, Madhya Pradesh. *Biomedical Research* 22 (3), 361-365.

Taelman J., Vandeput S., Vieminck E., Spaepen A., Van Huffel S. (2011) Instantaneous changes in heart rate regulation due to mental load in simulated office work. *European Journal Applied Physiology* 3011 (111), 1497-1505.

Tucker B., Jones S., Mandy A. and Gupta R. (2006) Physiotherapy students' sources of stress, perceived course difficulty, and paid employment: comparison between Western Australia and United Kingdom.*Physiotherapy Theory and Practice* 22, 317-28.

Walsh J.M., Feeney C., Hussey J. and Donnellan C. (2010) Sources of stress and psychological morbidity among undergraduate physiotherapy students. *Physiotherapy* 96, 206-212.

Wendy L., Wasmund E., Westerholm C., Donald E. and Stephen L.(2002) Cardiovascular controland interactive effects of mental and physical stress. *Journal of Applied Physiology* 92, 1828-1834.

Wright R.A., Stewart C.C. and Barnett B.R. (2008) Mental fatigue influence on effort-related cardiovascular responses; extension across the regulatory (inhibitory) non-regulatory

performance dimension. *International Journal of Psychophysiology* 69, 127-133.

Wright R.A., Stewart C.C. and Barnett B.R. (2006) Mental fatigue influence on effort-related cardiovascular responses; extension across the regulatory (inhibitory) non-regulatory performance dimension. *International Journal of Psychophysiology* 69, 127-133.

Schneider G.M., Jacobs D.W., Gevirtz R.N. and O'Connor D.T. (2003) Cardiovascular haemodynamic response to repeated mental stress in normotensive subjects at genetic risk of hypertension: evidence of enhanced reactivity, blunted adaptation, and delayed recovery. *Journal of Human Hypertension* 17(12), 829-840.

Xavier J., Peter J.B., Sylva E., Murriel T. (2009) Excessive heart rate increase during mild mental stress in preparation for exercise predicts sudden death in the general population. *European Heart Journal* 30, 1700-1710.

Zeller A., Handschin D., Gyr N., Martina B. and Battergay E.(2004) Blood pressure and heart rate of students undergoing a medical licensing examination. *Journal of Experimental Psychology and Human Perception and Performance* 13(1), 20-24.