Journal of
Anatomy and Physiological Studies

REVIEW ARTICLE

Cardiovascular and Nutritional Changes in Ocular Parameters

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Abstract

To ensure clear and continuous vision, the Human visual system surface acts as a functional entity that adjusts to varying environmental changes with time. This compensatory role may often be dependent on nutritional and cardiovascular alterations. This Study was designed to examine in humans, specifically executive drivers, the effect of cardiovascular and anthropometric [Body Mass Index (BMI), Weight and height) variations on visual capacities. Sixty Eight (68) executive driver staff of the Delta State University, Abraka, Delta State, Nigeria participated in the study. Subjects were grouped into four (4 groups) based on their nutritional/BMI status. With Group 1 consisting of lower than normal BMI value subjects (undernourished), Group 2 composed of subjects with normal nutritional (BMI) status (Control), with Groups 3 and 4 being over-nourished and obese participants respectively. For each sampled subject, cardiovascular [Blood Pressure (BP), Pulse Rate (PR) and Blood Glucose] and selected visual function/capacity [Visual Acuity (VA), Ophthalmoscopy and Intra-Ocular Pressure (IOP)] were obtained and compared with nutritional status [BMI]. Study observed an increase in visual functions [specifically IOP] with increased cardiovascular changes. Study also found a dependency of visual functions on cardiovascular and anthropometric variables, returning a statistically significant decrease ($p < .05$) in visual functions with increased BMI at noon than day time. We recommend a sophisticated approach to same study for other government employees across the state.

Keywords: Cardiovascular, Anthropometric, Nutritional Status

Introduction

The human nutritional status is accessed through the body mass index (BMI). BMI tended towards obesity has been shown to be independently associated with cardiovascular diseases (CVD), precisely high blood pressure (hypertension); which is seen in increased heart rates and intra-ocular pressure as related to visual function [1]. This has prompted the American Heart Association flag obesity as a major risk factor for CVD since 1998.

As obesity related researches increasingly draw global attention with rising incidences of CVDs [2], the National Institute for Health and Clinical Excellence (NICE) has described Obesity as a modern epidemic in the developed world with rising prevalence as never experienced. It reported that in England alone that 1 in every 4 adults are currently obese, with more than half the adult population overweight or obese [3]. The Foresight report [3] also predicted that if current trends continue, 60 per cent of men, 50 per cent of women and 25 per cent of children in the UK will be obese by 2050 (and a further proportion of the population would be classed as overweight.

In developing countries like Nigeria, globalization and urbanization have brought about rapid changes in lifestyle, which has negative consequences among which is decreased physical activity, associated with a rise in non-communicable diseases (cardiovascular disease, diabetes mellitus, cancer and chronic lung disease) which are becoming increasingly significant causes of disability and premature death [4].

Obesity has also become a major concern among school age children due to progressive increase in its prevalence [5]. Studies have reported that in 2010, showed 43 million children (35 million in developing countries) were estimated to be overweight and obese, while 92 million were at risk of being overweight.

In a systematic review on the prevalence of overweight and obesity of adult Nigerians, Cavdar *et al*. (2007) reported a prevalence rate of between 8.1% and 22.2 %.

In the real world, people generally become obese when, over a period of time, their energy intake exceeds their energy expenditure [6]. There is epidemiological evidence that an inverse relationship exists between physical activity (occupation) and body weight, and that body fat is more favorably distributed in individuals who are physically active

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Received: May 08, 2019; **Accepted:** May 10, 2019; **Published:** May 14, 2019

*This article is reviewed by "Dionisio Figueiredo Lopes" (Brazil)

[7]. Further, recent research into the relationship between body fatness and the different components of energy expenditure has shown that adiposity is inversely related to 'non-basal' energy expenditure [8]. From such evidence it has been suggested that the level of physical inactivity is a predisposing factor to obesity [9], and participation in regular exercise reduces major health problems associated with excess adiposity [10].

Exercise is known to be associated with increases in adenosine triphosphate (ATP) requirements, aerobic and/or anaerobic metabolism [11]. It causes an increase in some white blood cells such as lymphocytes and neutrophils, leading to mild leucocytosis [12]. Synergy between vascular muscular damage and the products of cellular metabolism, especially adenosine diphosphate (ADP) stimulates mononuclear cells such as white cells to migrate to the circulating system [11]. Network meta-analyses also provides evidence that a combination of aerobic and resistance training should be recommended in the prevention and treatment of overweight, obesity and associated diseases [12]. In order to increase both physical and physiological capacities, continuous training (CT) which is a type of aerobic exercise is one of the established exercise modalities [10]. Contradictory results have been reported in, optimization of fat oxidation through exercise training in overweight and obese individuals [10-12].

The BMI as it were, indicates in mathematical terms, the ratio of height to weight that can be linked with body composition (or body fat percentage). It is an important index of cardiovascular health risk, and has been linked with several disease complications, including visual problems as seen in diabetic retinopathies. People with a BMI of 25 to 29.9 are considered overweight, while those with a BMI of 30 or above are considered obese [13]. Though the relationship between BMI and several other physiologic variables have been shown to vary with gender, age, ethnicity and socioeconomic status [14], A linear relationship is commonly observed between visual functions and increasing BMI [15], especially owing to the well-established effect of increased BMI with such diseases as Diabetes Mellitus (DM); which is often complicated as Diabetic Retinopathy in sufferers.

Also, there is a large body of research suggesting a BMI-related difference in visual processing and acuity by extension [16]. There are also strong evidences of age and gender related changes in BMI in relation to visual acuity (Limburg et al, 2009). However, the extent to which these differences can be used to index cortical visual processing as influenced by changes in visual acuity is yet to be systematically investigated [17].

While data from studies on the effect(s) of exercise for short-term weight loss are contradictory, research indicates that regular exercise and BMI check is the single best predictor for achieving long-term weight control. It is believed that regular exercise will also improve some BMI related health conditions, including those of ocular concerns as it relates to diabetes mellitus.

Aim of Study

With knowledge of increased intraocular pressures (that result in glaucoma) as risk factor for glaucoma, the link between glaucoma and different nutritional status of humans (assessed through the BMI) remains unclear. Current study was therefore undertaken to investigate the relationship between cardiovascular (Blood Pressure, Pulse rate and blood sugar level) and anthropometric health indicators [weight, height, waist circumference and BMI] with visual functions [visual acuity, ophthalmoscopy, and intra-ocular pressure levels] for executive staff drivers of delta State University (Delsu), Abraka, Delta State. Specifically, study;

i. Investigated the relationship between selected cardiovascular health indicators and visual functions
ii. Investigated the relationship between selected anthropometric changes with visual functions
iii. Examined the link between nutritional status and visual functions
iv. Ascertained the effect of BMI on visual acuity, intraocular pressures and ophthalmoscopy of executive staff drivers of Delsu

Materials and Methods

Study Design

Study adopted the cross sectional type of research design. Here, a total of sixty eight (68) male drivers who were full time staff of the Delta State University, Abraka, and Delta State, Nigeria were recruited for the exercise. These subjects were grouped into four (4) based to their nutritional status, using the WHO standard of 2003 (WHO, 2003);

Under-nourished (BMI < 20 kg/m^2)

Normal (BMI of 20 to 24.9 kg/m^2)

Over-nourished (BMI of 25 to 29.9 kg/m^2)

Obese (BMI ≥ 30 kg/m^2)

Study Population

Study population comprised of full time staff drivers of aforementioned institution (Delsu) who were resident in Abraka, Ole, Asaba and Oghara campuses of the institution.

Inclusion Criteria

Subjects who were driver staff of the target institution (Delsu), who regularly engaged, through driving activities, their eyes in visual processing tasks, not on long-term use of such medications like topical atropine, anti-glaucoma, anti-inflammatory drugs, cortisone and/or other steroids were selected for the study, Drivers with no symptoms of ocular conditions as conjunctivitis were also included. Non-contact lens wearing drivers no symptom of dry eye or other ocular conditions were also selected for the study.

Exclusion Criteria

Subjects with eye make-ups, systemic conditions such as hypothyroidism, diabetes mellitus were excluded.

Ethical Considerations

Ethical approval was obtained from the Bio-Research and Ethics committee of the College of Health Sciences, Delta State University, Abraka, Delta State. Also, informed written consent was sought from participants before investigation. Consent forms were administered to seek participants' permission. Only subjects who consented were actually investigated.

Procedure

Determination of BMI

Determination of BMI was based on a weight-to-height ratio that does not distinguish between muscle and fat. To obtain this, we applied the standard mathematical relation (below) after obtaining subjects weights and heights at any point;

BMI = Weight (kg)

Height (m^2)

Measurement of Cardiovascular Parameter

Participants were required to rest for 30 minutes prior to assessment and recording. This was done to ensure that the cardiopulmonary variables of interest settle to resting values which may be altered by physical activity such as walking, climbing or running (ACSM, 2006).

Blood Pressure – Systolic and Diastolic blood pressures were measured using electronic sphygmomanometer (Omron Intelli sense M6 Comfort, Japan) in sitting position for all cardiovascular parameters. The cuff was also applied to the upper arm (left or right) of the participant in sitting position.

Heart Rate (HR) – Heart rate was also recorded from the sphygmomanometer displayed during blood pressure measured and was recorded in beats per minute.

Pulse Rate - This was obtained by subtracting the diastolic blood pressure from the systolic blood pressure (PR = DBP-SBP).

Measurement of Visual Acuity

Visual acuity was assessed by means of a distant-vision illuminated snell's letter chart held at a distance of approximately 20 m in a room with normal (uncontrolled) ambient illumination. The assessment consisted of asking research participants to read the alphabets with each type of stimulus monocularly, first with the left eye occluded and then with the right eye. The Snellen ratio corresponding to the smallest font size at which this could be accomplished with fewer than two errors out of the 8 to 16 items at each font size was identified as the visual acuity estimate. Defected Participants were allowed to use any corrective lenses they had available during the testing, but we had no information about the recency, or accuracy, of their optical correction.

Results

Table 1-4; Figure 1-6

	Total Subjects by Age (Years)					
	31 - 42		**43 - 52**		**53 - 62**	
	M	**F**	**M**	**F**	**M**	**F**
	22 (32%)	0 (0%)	30 (44%)	0 (0%)	16 (24%)	0 (0%)
Total	22 (32%)		30(44%)		16 (24%)	
	68 (100%)					
Above table shows the total number of sampled subjects by age and gender. Values are expressed as total number (percentage). With no female subjects, a total of 68 (100%) males were sampled. Both accounts for about 32% (22), 44 %(30) and 24% (16) of age groups 31-42years, 43-52years, and 53-62 years respectively.						

Table I: Socio-Demographic data of sampled subjects.

Age (Years)	Weight (kg)	Height (ft.)	BMI (kg/m²)	Waist Circumference (cm)
31 - 42	58.68±8.14	177.67±53.57	29.01±5.69	76.71±8.14
43 – 52	66.11±19.93	163.71±25.88	32.00±11.16	89.09±9.03
53 – 62	57.08±9.03	164.85±22.86	27.00±4.85	71.19±19.05

Table II: Average Distribution of Anthropometric variables (by age) for Sampled Subjects

Age (Years)	Systolic	Diastolic	Heart Rate
31 - 42	117.46±16.29	70±6.64	79±10.96
43 – 52	129.28±20.44	78±8.72	80±12.81
53 – 62	124.89±37.66	72±15.01	82±24.72

Table III: Average Distribution of Cardiovascular selected health indicators (by age) in Participants
Above table (table 4.3) shows the average systolic and diastolic blood pressures of subjects with their heart rates. Values are presented as mean ± standard deviation

	BMI	Heart Rate	Systolic Pressure	Diastolic Pressure
BMI	1			
Heart Rate	0.00012	1		
Systolic Pressure	0.01938	0.193722	1	
Diastolic Pressure	-0.085	0.055843	0.625222	1
Values are expressed as coefficients of Pearson Product Moment correlation (p) where p < 0=negatively correlated, p=1=perfectly correlated, and p > 0 and p< 1=not correlated				

Table IV: Showing Correlation coefficients (Pearson Product) between BMI, Heart rate, Systolic and Diastolic Pressures of participants

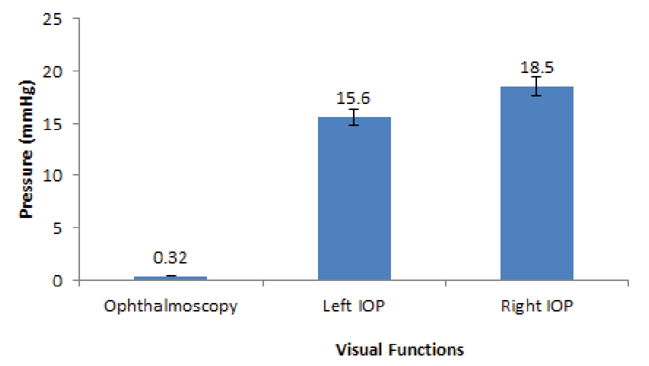

Figure I: Comparative differences in average Intra-Ocular Pressures (IOP) between eyes of Delsu Staff Drivers.

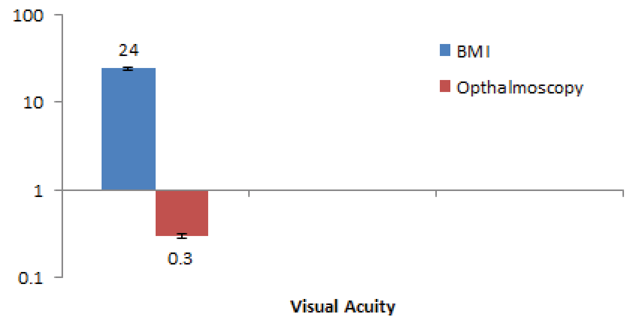

Figure IV: Comparative Changes in BMI and Ophthalmoscopy among Delsu Drivers.

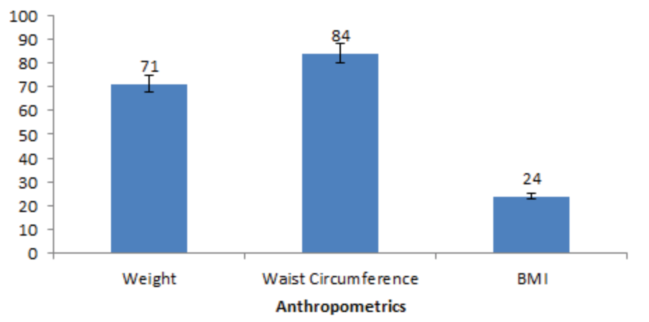

Figure II: Comparative difference in Selected Anthropometric variables of Delsu Drivers.

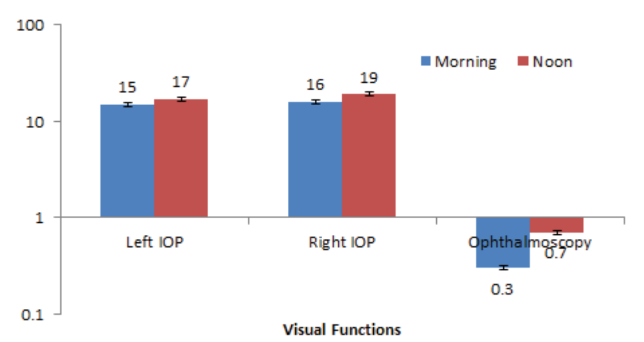

Figure V: Changes in Intra-Ocular Pressures with Ophthalmoscopy at different time of the day in Delsu drivers.

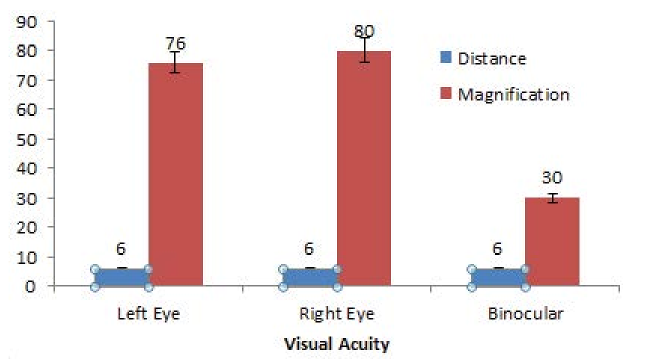

Figure III: Comparative difference in Visual Acuity for sampled subjects.

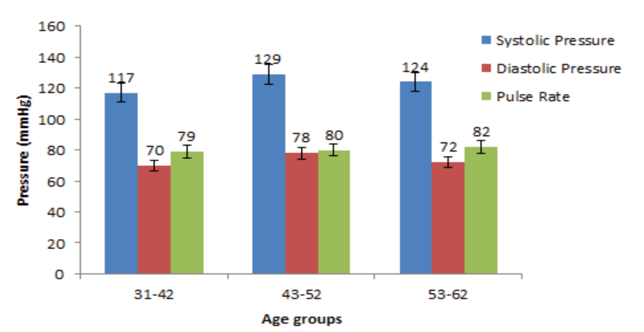

Figure VI: Shows Cardiovascular variations in Blood Pressures (with age) for Delsu Executive Drivers.

Discussion

Body mass index (BMI) is a mathematical ratio of height to weight that can be linked with body composition (or body fat percentage) and with indices of health risk. People with BMI of 25 to 29.9 are considered overweight, and people with a BMI of 30 or above are considered obese. A high BMI assumes a higher percentage of body fat, which places a person at greater risk for developing chronic diseases such as diabetes mellitus, hypertension, heart disease, and even cancer [18, 19]. However, for some people the BMI is not a reliable indication of health. A highly muscled individual who is very fit and healthy may have a somewhat heavy body weight because muscles pack on a lot of pounds. This person may have a high BMI that improperly puts him or her in the overweight or obese categories. Likewise, thin individuals who have a low body weight with very little muscle and a higher percentage of fat may have a normal BMI, which would be an incorrect indication of healthiness.

This study investigated the possible physiological effects continuous engaging the eyes on visual processing tasks (through driving) on anthropometric and cardiovascular health indicators in underweight, overweight and obese executive staff drivers of the Delta State University, Abraka, Delta State. The study was thus based on the effects of the effect of nutritional status on the selected health indices of the anthropometric and cardiovascular profiles in relation to visual function.

A total of sixty eight (68) participant drivers of aforementioned institution were recruited and assigned into four study groups based on their nutritional (BMI) status. With Group 1 consisting of lower than normal BMI subjects (undernourished), Group 2 composed of subjects with normal nutritional (BMI) status (Control), with Groups 3 and 4 being over-nourished and obese participants respectively. For each sampled subject, cardiovascular [Blood Pressure (BP), Pulse Rate (PR) and Blood Glucose] and selected visual function/capacity [Visual Acuity (VA), Ophthalmoscopy and Intra-Ocular Pressure (IOP)] were obtained and compared with nutritional status [BMI].

From current study (Table I), of the 68 samples collected, 68 (100%) of them were males of age rage 31-42, 43-52 and 53-62 years old. Apparently from table II, high, higher and highest BMI range of sampled subjects were respectively seen in age ranges 31-42, 43-52, and 53-62 years old respectively.

Table II also shows the mean Distribution of Weight, Height, and BMI (by age) in sampled subjects. From the table, higher values are seen in average aged subjects of about 43-52 years old than any others. One traceable cause for this difference in values of Weight, and BMI with age is likely to be the tendency of the body to build adipocytes with increasing age (Guyton 2006). Thus, this may explain some of the difference in BMI as seen from table II. Also, it is worth noting that BMI is a function of weight / Height, not solely dependent on weight. This finding agrees with that of Dua (Dua *et al*., 2014) and Yufuf (Yusuf *et al*., 2005) even though it slightly disagrees with that of Srikant (Srikant *et al*., 2011) who found BMI and weight as in underage than aged in his study.

Also, tables III and IV show a significant change in mean Distribution of Blood Pressure and Pulse Rate (with age) in participant subjects. For the former (table III) average systolic pressure between subjects at different age was observed to vary with age, proving highest at about the age range of 43-52 years (129 mmHg) than other age groups. Average Diastolic pressure was also seen to be highest (78 mmHg) in same group. From the latter also (table III), Obesity apparently was observed to have increased with increase systolic blood pressure (129 mmHg).

Physiologically, the reason for these differences may not be far-fetched from dietetics and/or sedentary life styles. Studies have shown that changing lifestyles over the last century, including increased calorie consumption and reduced physical activity, all have played a key role in the prevalence of obesity across the globe (irrespective of gender). In developing nations, the availability of wider food options has reportedly contributed to a change in eating habits. While such food choices offer convenience, they also tend to be high in fat, sugar, and calories. The finding of Clark [20] is in agreement with this study.

Figure I of this study compares average Intra-Ocular Pressures (IOP) for left and right eyes each amongst Delsu executive drivers. From the result, there was a statistically significant decrease ($p < .05$) in ophthalmoscopy outcome, suggesting increased intraocular pressure with a relatively low opacity in visual function. Also, a noticeable increase in average intra-ocular pressure (IOP) for right eye than that of the left (Left IOP) was observed for sampled subjects. This difference was noticed irrespective of age and/or duration of active service. This finding agrees that those of previous literature, specifically from the works of Ebeigbe *et al.,* 2014, who reported age and gender independent changes in BMI in relation to visual acuity (Araoye et al, 2003); even though the extent to which these differences were used in the assessment of cortical visual processing as influenced by changes in intraocular pressure was poorly assayed [17-19].

Again from figure II, a comparison on average anthropometric variables (selected) in sampled participants was made. Here, most sampled drivers were observed to have increased weight with accompanying BMI and waist circumferences, even though their average BMI was apparently lowest on comparison with other sampled parameters. The implication of this is that, average BMI for Executive drivers was relatively low compared to their high level of weight gain. The reason for this may not be far-fetched, and could implicate consisted work as against sedentary life style that ordinarily should increase BMI, as against weight gain. Though few studies have reported on the relationship between anthropometric variables in executive drivers *(*Saleh *et al, 2006),* the report of Doughty *et al* (2007), apparently supports the results of this study, positing that continuously engaging in mild to moderate exercises (as seen in these drivers) may improve on anthropometric health indicators like the BMI.

Also assayed in participants was a relationship between the BMI and ophthalmic changes (figure IV). Ophthalmic examinations as this can reveal the presence of several disorders as simple visual problems to infections such as conjunctivitis and trachoma. It may also reveal other health problems like high blood pressure, diabetes mellitus, and brain tumors. For this study, we observed a statistically significant change between BMI and visual opacity (as returned by ophthalmoscopy) in the average of .3%; suggestive of a .3% average prevalence of glaucoma in sampled participants.

Worth mentioning in this study is the observed changes in

Intra-Ocular Pressures with Ophthalmoscopy at different time of the day in in sampled subjects (Figure V). By this, intraocular pressure was seen to be higher at noon day than early hours of the morning; apparently posing highest in the right than the left eyes. By implication, the IOP build up at noon may be traceable to increased driving activity (probably due to increased environmental temperatures) that could exacerbate the human blood pressure, building up the intracranial pressure that may ultimately affect the IOP. This finding concurs with those of Christopher et al (2016).

Conclusion

Based on results from current study, it is seen that both continuous and Interval exercise training programs can beneficially improve anthropometric, cardiovascular, and visual function indicators of sampled participants. Hence, continuous avoidance of sedentary lifestyle and regular visual capacity check and usage may therefore be an effective adjunct, non-pharmacological and non-dietary management alternative to healthy nutritional lifestyle.

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Citation: Ohwin PE, Abadom EG (2019) Cardiovascular and Nutritional Changes in Ocular Parameters. J Anat Physiol Stud 3: 001-006.