BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF OPTOMETRY

THE INFLUENCE OF BODY MASS INDEX ON THE CORRELATION BETWEEN SYSTOLIC BLOOD PRESSURE AND INTRAOCULAR PRESSURE

BY

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REG NO. B203228B

Research project

submitted in partial fulfilment of the requirements of the Bachelor of Science (Honours) Degree in Optometry

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Supervisor: Dr Selassie Tagoh

DECLARATION

Supervisor's Statement of approval

I, **Dr. Selassie Tagoh**, agree that I supervised this study conducted by Delight Munjanja and confirm that the project meets the standards for submission in partial fulfilment of the Bachelor of Science Honours Degree in Optometry (HBScOpt) at the Bindura University of Science Education.

Signature……………………….

Date…………………………….

Student's declaration

I**, Delight Munjanja** do declare that **The influence of body mass index on the correlation between systolic blood pressure and intraocular pressure** hereby submitted to the Bindura University of Science Education, for the Honours degree in Optometry has not previously been submitted for a degree at this or any other university; that it is my own work in design and in execution, and that all material contained herein has been duly acknowledged.

Signature…………………….

Date ………………………….

DEDICATION

This thesis is dedicated to my family, who have supported me throughout this journey, and to all those who strive to advance this field of optometry.

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- Firstly, to my parents Fanuel and Evernice Munjanja for their continued support in my academic journey
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LIST OF ABBREVIATIONS

BMI	Body mass index
SBP	Systolic blood pressure
WHO	World health organisation
IOP	Intraocular pressure
NCDs	Non-communicable diseases
BPH	Bindura provincial hospital
VA	Visual acuity

ABSTRACT

Background: Elevated systolic blood pressure (SBP) and intraocular pressure (IOP) are well-established risk factors for various cardiovascular and visual–ocular conditions. However, the relationship between SBP and IOP may be influenced by an individual's body mass index (BMI). This study aims to investigate the impact of BMI on the correlation between SBP and IOP.

Methods: This cross-sectional study included a sample of 448 adults aged 18-75 years. Participants' BMI, SBP, and IOP were measured using standardized protocols. Correlation analysis was performed to assess the relationship between SBP and IOP. The sample was then stratified by BMI categories (normal weight, overweight, and obese), and the SBP-IOP correlation was examined within each subgroup. Multiple linear regression analysis was used to model the influence of BMI on the SBP-IOP relationship while adjusting for confounding factors.

Results: The overall correlation between SBP and IOP was statistically significant (r (448) = 0.646, p < 0.001). The findings revealed diverse correlations across the BMI categories. In the underweight group, the correlation was negligible and negative (r (33) = -0.062, p = 0.730). The normal weight group exhibited a modest positive correlation (r (193) = 0.199, p < 0.001). Interestingly, the correlation in the overweight group was minimal and statistically insignificant (r (145) = 0.039, p = 0.642). Conversely, the obese group demonstrated the strongest positive correlation (r (77) = 0.381, p <0.001). The regression analysis revealed that BMI was a significant modifier of the SBP-IOP relationship (β = 0.279, p < 0.001), even after accounting for age, gender, and other relevant covariates.

Conclusion: The findings suggested that BMI is important in the correlation between SBP and IOP. Individuals with higher BMI levels exhibit a stronger association between these two parameters, which may have clinical implications for the management of cardiovascular and ophthalmic conditions.

CHAPTER 1: INTRODUCTION

1.0 Introduction

In this chapter, we provide the contextual background, problem statement, study objectives, research questions, importance of the study, conceptual framework, and definitions of key terms.

1.1 Background of the study

Obesity is a widespread health issue, classified as a modern epidemic, affecting billions of adults worldwide. According to WHO, over 1.9 billion adults aged 18 and older were reported to be overweight in 2016. Overweight and obesity are characterized by excessive fat accumulation, posing significant health risks. A body mass index (BMI) above 25 indicates overweight, while a BMI above 30 indicates obesity. Being obese increases the likelihood of developing various health conditions, including type 2 diabetes, hypertension, stroke, and eye diseases such as cataracts, diabetic retinopathy, age-related macular degeneration, and glaucoma (Semba, 2007). Elevated intraocular pressure (IOP) is a crucial and modifiable risk factor for glaucoma, with the normal range being 11–21 mmHg. Glaucoma, the second leading cause of blindness after cataracts, damages the optic nerve, potentially leading to vision loss. Obesity is associated with an increased risk of elevated IOP and systemic vascular abnormalities like hypertension and arteriosclerosis. As a result, obesity is believed to contribute to glaucoma progression through elevated IOP and vascular dysregulation.

Non-communicable diseases (NCDs) such as hypertension, diabetes, and cardiovascular diseases are major causes of morbidity and mortality worldwide, including Zimbabwe. In Zimbabwe, hypertension is highly prevalent, affecting over 30% of the adult population. Hypertension is also a risk factor for increased IOP, potentially leading to glaucoma and hypertensive retinopathy, a sight-threatening eye condition. However, the relationship between IOP and hypertension in Zimbabwe, Africa, and globally remains insufficiently understood, necessitating further research on this topic.

NCDs significantly impact the eye health of many Zimbabweans, leading to vision impairment and blindness. According to WHO, around 2.2 billion people globally have a vision impairment, with approximately 1 billion cases being preventable or requiring intervention. In Zimbabwe, estimates suggest that 80% of blindness is avoidable and treatable, emphasizing the need for comprehensive eye health strategies (The National Health Strategy for Zimbabwe, 2009 - 2013).

1.2 Problem statement

Systolic blood pressure (SBP) and intraocular pressure (IOP) are crucial physiological parameters that significantly impact individuals' health and overall well-being. Previous research has demonstrated a positive association between higher SBP and elevated IOP. However, the potential role of BMI as a confounding factor in this relationship has not been adequately explored (Leeman M et al., 2019).
BMI, a measure of body fatness, can influence both SBP and IOP through various mechanisms, including hormonal changes, vascular resistance, and ocular perfusion. Consequently, it is essential to investigate how BMI influences the correlation between SBP and IOP in diverse populations and settings. This study aims to shed light on this relationship and its potential implications for understanding the interplay between these physiological parameters among a sample of Zimbabwean patients visiting the eye unit of the Bindura provincial hospital in the suburb of Bindura-Zimbabwe.

1.3 Aim

To determine the relationship between systolic blood pressure and intraocular pressure in adults with different body mass index categories and more importantly to determine if body mass index modifies this correlation.

1.4 Objectives

The research seeks:

- To measure SBP, IOP, and BMI in a sample of patients visiting Bindura Provincial Hospital aged 18-75 years living in Zimbabwe.
- To determine the relationship between BMI and SBP, BMI and IOP, and SBP and IOP using linear regression models.
- To test the hypothesis that BMI moderates the association between SBP and IOP.

- To determine visual function among patients attending the eye unit of the provincial hospital in Bindura.
- Determine the common causes of vision problems among patients attending the eye unit of the hospital.

1.5 Research questions

The following research questions were generated to guide the study:

- What is the relationship between systolic blood pressure and intraocular pressure in adults?
- How does BMI moderate the correlation between systolic blood pressure and intraocular pressure?
- What are the possible mechanisms underlying the interaction between BMI, SBP and IOP?
- What is the state of visual function among patients visiting the BPH eye unit?
- What are the common causes of visual problems among patients attending the eye unit of BPH?

1.6 Significance of the Study

The availability of evidence-based information on eye health development is crucial for guiding policy decisions. This study aims to contribute valuable insights to the existing literature regarding the relationship between blood pressure and intraocular pressure, with a specific focus on the role of BMI in this association.

The findings of this research may have significant implications for understanding the risk factors, prevention, and management of hypertension and glaucoma, particularly in low-resource settings like Zimbabwe. It may also inform the government's universal health coverage policy by highlighting the importance of including non-communicable disease management, as these conditions are increasingly contributing to irreversible blindness.

Furthermore, this study will add to the current knowledge base on the significance of maintaining a healthy lifestyle for overall health, including eye health. Additionally, the findings may underscore the need for the integration of optometrists into public health institutions, enhancing the overall healthcare system and improving patient care, particularly in the field of eye care.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This chapter provides a comprehensive review of existing sources that focus on the relationship between body mass index (BMI) and its influence on the correlation between systolic blood pressure and intraocular pressure elsewhere and in Zimbabwe. It serves as a survey of relevant studies and literature related to this specific topic, aiming to shed light on the interplay between these physiological parameters in the context of the Zimbabwean population.

2.1 Relationship between systolic blood pressure and IOP

Systolic Blood Pressure (SBP) refers to the pressure exerted by the blood on the arterial walls during heart contraction, while Intraocular Pressure (IOP) is the pressure inside the eye caused by the vitreous humour fluid. Both SBP and IOP are crucial indicators of cardiovascular and ocular health and are associated with various diseases like hypertension, glaucoma, and diabetic retinopathy (Leeman M et al, 2019).

The relationship between SBP and IOP has been extensively studied, yet the findings are inconsistent and sometimes contradictory. Some studies have reported a positive correlation between SBP and IOP, suggesting that elevated blood pressure may increase ultrafiltration of aqueous humour due to higher ciliary artery pressure and episcleral venous pressure, contributing to glaucoma and ocular hypertension risk (Leeman M et al, 2019). Another study by Lee et al. (2016) found a positive correlation between SBP and IOP in a large Korean adult sample after adjusting for age, gender, body mass index, and diabetes. However, other studies have reported a negative correlation or no significant association, indicating that blood pressure might not significantly impact IOP (Tham Y.C et al, 2014).

The reasons for these discrepancies remain unclear but could be influenced by various factors, such as measurement methods, sample size, population characteristics, and confounding variables (Klein K et al, 2005). For instance, some studies measured SBP and IOP at different times of the day, potentially affecting results due to diurnal variations of both parameters. Additionally, variations in devices or techniques used to measure SBP and IOP in different studies may introduce measurement errors or biases.

2.2 How changes in BMI influence systolic blood pressure

BMI is a measure of body fat based on height and weight and is commonly used as a screening tool for obesity and overweight, which are major risk factors for cardiovascular diseases like hypertension (WHO, 2021). SBP is a vital sign that reflects the health of the circulatory system. Elevated SBP can lead to artery and organ damage over time, resulting in severe complications such as stroke, heart attack, and kidney failure. Several studies have established a positive correlation between higher BMI and elevated SBP. However, the exact mechanisms and pathways linking BMI and SBP remain not fully understood.

According to Caballero E (2012), an increase in BMI leads to elevated adipose tissue, which may impair endothelial function and cause insulin resistance. Endothelial dysfunction can reduce nitric oxide production, a vasodilator that helps lower blood pressure. Additionally, insulin resistance may result in hyperinsulinemia, which can stimulate the sympathetic nervous system, leading to increased heart rate and vascular resistance, thus elevating blood pressure.

Hence, changes in BMI can influence SBP by impacting various physiological processes that regulate blood pressure. Adopting lifestyle modifications like diet and exercise can effectively reduce BMI and lower SBP, thereby reducing the risk of cardiovascular complications.

2.3 Possible mechanisms underlying the interaction between BMI, SBP and IOP

The relationship between BMI, SBP, and IOP is complex and multifaceted, involving various physiological mechanisms. Several studies have explored the potential underlying processes that may contribute to the observed interactions among these parameters.

One proposed mechanism is the role of the renin-angiotensin-aldosterone system (RAAS). Obesity, as measured by increased BMI, has been associated with increased activity of the RAAS, leading to the elevation of both blood pressure and intraocular pressure (Hirooka & Kiuchi, 2022). Excess adipose tissue can stimulate the RAAS, leading to increased production of angiotensin II and aldosterone. Angiotensin II can cause vasoconstriction and increase vascular resistance, thereby contributing to elevated SBP. Aldosterone can also impact ocular fluid dynamics, potentially influencing IOP (Goyal et al., 2019).

Another potential mechanism involves the effects of adipose tissue on inflammatory mediators. Excess adipose tissue, characteristic of individuals with higher BMI, is associated with increased production of pro-inflammatory cytokines, such as interleukin-6 and tumour necrosis factor-alpha (Goyal et al., 2019). These inflammatory factors can contribute to endothelial dysfunction, which may impair the regulation of both systemic blood pressure and intraocular pressure.

Hormonal factors may also play a role in the interplay between BMI, SBP, and IOP. Adipose tissue is an active endocrine organ, secreting various hormones, such as leptin and adiponectin, which can influence both systemic blood pressure and intraocular pressure regulation (Konieczka et al., 2017). Thus, causing disruptions in the balance of these adipokines which have been associated with the development of obesity-related comorbidities, including hypertension and glaucoma.

Furthermore, obesity has been linked to increased sympathetic nervous system activity. Elevated sympathetic tone can lead to increased vascular resistance and blood pressure, as well as altered aqueous humour dynamics, potentially affecting IOP (Vesan et al,2001).

CHAPTER 3: RESEARCH METHODOLOGY AND DESIGN

3.0 Introduction

In this chapter, we present the research methodology utilized to investigate the impact of body mass index on the correlation between systolic blood pressure and intraocular pressure. The methodology encompasses the study design, study period, research site, target population, sample size, inclusion and exclusion criteria, data collection methods, data analysis procedures, pilot study, and ethical considerations.

3.1 Study design

The study adopted a cross-sectional research design to gather data on variables such as BMI, SBP, IOP, and other pertinent factors. A cross-sectional research design is an observational study that analyzes data collected from a sample of the population (Sedgwick, 2014). Descriptive and inferential statistics were employed to analyze the study data. Descriptive statistics, such as mean, standard deviation, frequency, and percentage, were utilized for continuous and categorical variables, respectively. To assess the relationship between SBP and IOP, Pearson's correlation coefficient was employed, and multiple linear regression was used to investigate the effect of BMI on the correlation between SBP and IOP. An alpha level of less than 0.05 will be considered statistically significant for all tests.

3.2. Study period

The study was conducted between July 2023 to July 2024.

3.3 Study site

The study was conducted at Bindura Provincial Hospital Zimbabwe

3.4 Study population

The study was conducted among patients aged 18 to 75 visiting the Bindura Provincial Hospital (Zimbabwe).

3.5 Research instruments

The study measurements included SBP, IOP and BMI.

- SBP was measured using an automated, upper arm Omron HEM-907 blood pressure monitor (Omron Healthcare, Inc).
- IOP was measured using a Diaton trans palpebral Tonometer Version 3 from BiCOM Inc.
- A digital scale was employed to measure the weight of the study participants.
- A stadiometer was used to measure the height of the participants.
- BMI was calculated as weight in kilograms divided by height in meters squared.
- Other relevant information was recorded directly from patients or their folders

3.6 Validity and reliability

Reliability refers to the consistency of a research tool in producing the same results when applied under similar conditions. On the other hand, the validity of a research study is determined by how accurately its findings represent the actual outcomes among individuals similar to those in the study's sample. Pilot studies were conducted to ensure the validity and reliability of measurements.

3.7 Sampling method

The participants for this study were chosen using a convenience sampling method. Those who met the inclusion criteria and willingly agreed to take part in the study were included, whilst ensuring that the sample includes individuals from various age groups and genders to provide adequate representation.

3.8 Sample size

Using Slovin's formula, the sample size was calculated in the following manner:

$n= N/ (1+Ne^2)$

n= sample size

N= Zimbabwe population estimate

e= margin of error (0.05)

$n = 15\,100\,000 \div [1 + (15\,100\,000 \times 0.05^2)]$

$= 399.98$

A sample size of at least 400 participants were recruited for this study.

3.9 Inclusion Criteria

The inclusion criteria for this study included individuals who met the following conditions:

- Not taking any medication that may influence blood pressure or intraocular pressure.
- Not currently pregnant or lactating.
- Patients aged between 18 to 75 years.

3.10 Exclusion criteria

Having any other medical condition that may interfere with the study measurements e.g., acute illness or infection. Alcohol or caffeine consumption within 24 hours before the measurement.

3.11 Data collection methods

Data collection involved a threefold approach, utilizing surveys, physical measurements, and medical records. Surveys were used to gather essential data on participants' demographics, lifestyle habits, and medical backgrounds. Physical measurements encompass height, weight, systolic blood pressure, and intraocular pressure. Furthermore, medical records served to corroborate any self-reported medical conditions provided by the participants.

3.12 Data Analysis Methods

The participants were categorized into four groups based on their BMI: underweight (<18.5 kg/m2), normal weight (18.5-24.9 kg/m2), overweight (25-29.9 kg/m2), and obese (≥30 kg/m2). Data collected was analyzed using the Statistical Package for the Social Sciences (SPSS) version 21 and Microsoft Excel. The analysis involved correlation analysis to examine the relationship between BMI, systolic blood pressure (SBP), and intraocular pressure (IOP). Additionally, moderation analysis was conducted to test if BMI moderates the correlation between SBP and IOP while controlling for potential confounding factors using multiple linear regression analysis.

Associations and trends between variables were assessed using the Chi-square test and Pearson correlation as appropriate. A *p*-value of less than 0.05 will determine statistical significance. The findings were presented in tables, graphs, and descriptive text to facilitate comprehension and interpretation of the data.

3.13 Ethical considerations

Before participating, all participants were required to provide informed verbal consent. The study protocol went through a thorough review and approval process by the institutional review board to ensure ethical compliance. The purpose of the study was to be fully explained to the participants, and measures were taken to guarantee their anonymity, confidentiality, and privacy.

Informed consent was obtained from all participants before the study, and they were informed of their right to withdraw from the study at any time without facing any consequences. The data collected was accessible only to the researcher and the supervisor, ensuring confidentiality. The reports generated from the study do not include any personal identifying information about the participants. Additionally, participants were informed that their participation is completely voluntary, and they can withdraw their involvement at any moment with no negative impact.

3.14 Benefits

While participants in this study did not receive any direct benefit or compensation, the findings play a crucial role in shaping preventive and therapeutic approaches for glaucoma in Zimbabwe.

CHAPTER 4. RESULTS

4.0 Introduction

This chapter presents the findings from the analysis of the relationship between systolic blood pressure (SBP), intraocular pressure (IOP), and body mass index (BMI) in a sample of 448 adult participants. The primary objective of this study was to evaluate the influence of BMI on the correlation between SBP and IOP.
The chapter begins with a description of the demographic and clinical characteristics of the study sample, including the mean and standard deviation of age, BMI, SBP, and IOP. This is followed by an assessment of the overall correlation between SBP and IOP in the entire study population.

To investigate the influence of BMI, the analysis was stratified by BMI categories (normal weight, overweight, and obese). The strength of the SBP-IOP correlation was compared across these BMI subgroups. Additionally, a multiple linear regression model was employed to quantify the effect of BMI on the relationship between SBP and IOP, while adjusting for potential confounding factors.
Sensitivity analyses were conducted to evaluate the robustness of the findings, including the assessment of the SBP-IOP correlation after excluding outliers or influential data points. The chapter concludes a summary of the key results and their implications for understanding the interplay between body weight, blood pressure, and intraocular pressure.

4.1 Sample characteristics

4.1.1 Overall Descriptive Statistics

A total of 448 patients visiting the Bindura Provincial Hospital Eye Unit were included in the study. The mean age of the participants was 35.71±13.31 years, with a range of 18 to 85 years. Of the total sample, 263 (58.7%) were female and 185 (41.3%) were male. The mean BMI of the participants was 25.17kg/m^2, ± 5.3kg/m^2, indicating a range from normal weight to obese individuals. The mean systolic blood pressure was 123 mmHg, ±16mmHg. The mean OD intraocular pressure was 15 mmHg, ± 3 mmHg. The mean OS intraocular pressure was 15mmHg ± 3mmHg.

Table 1. Demographics and descriptive statistics for participants

Variable	Gender	Mean	Standard deviation	Minimum	maximum
Age					
	Male	36	14	18	61
	Female	36	13	18	72
BMI					
	Male	24.3	4.9	16.9	40.1
	Female	26	5.4	15.4	46.0
SBP					
	Male	122	15	91	162
	Female	124	18	90	198
IOP					
	Male	15	3	8	24
	Female	15	3	7	23
Total participants					
	Male	185			
	Female	263			

4.1.3 Descriptive statistics by BMI categories

Table 2. Descriptive statistics by BMI categories

BMI categories	Mean age	Mean IOP	Mean SBP
Underweight	22	11	104
Normal	29	14	114
Overweight	44	16	129
Obese	44	19	147
Total participants	448		

4.2 Correlation between SBP and IOP

Figure 1 plots the correlation between systolic blood pressure and intraocular pressure across all participants. The analysis revealed a statistically significant correlation between systolic blood pressure and intraocular pressure (r (448) = 0.646, $p < 0.001$).

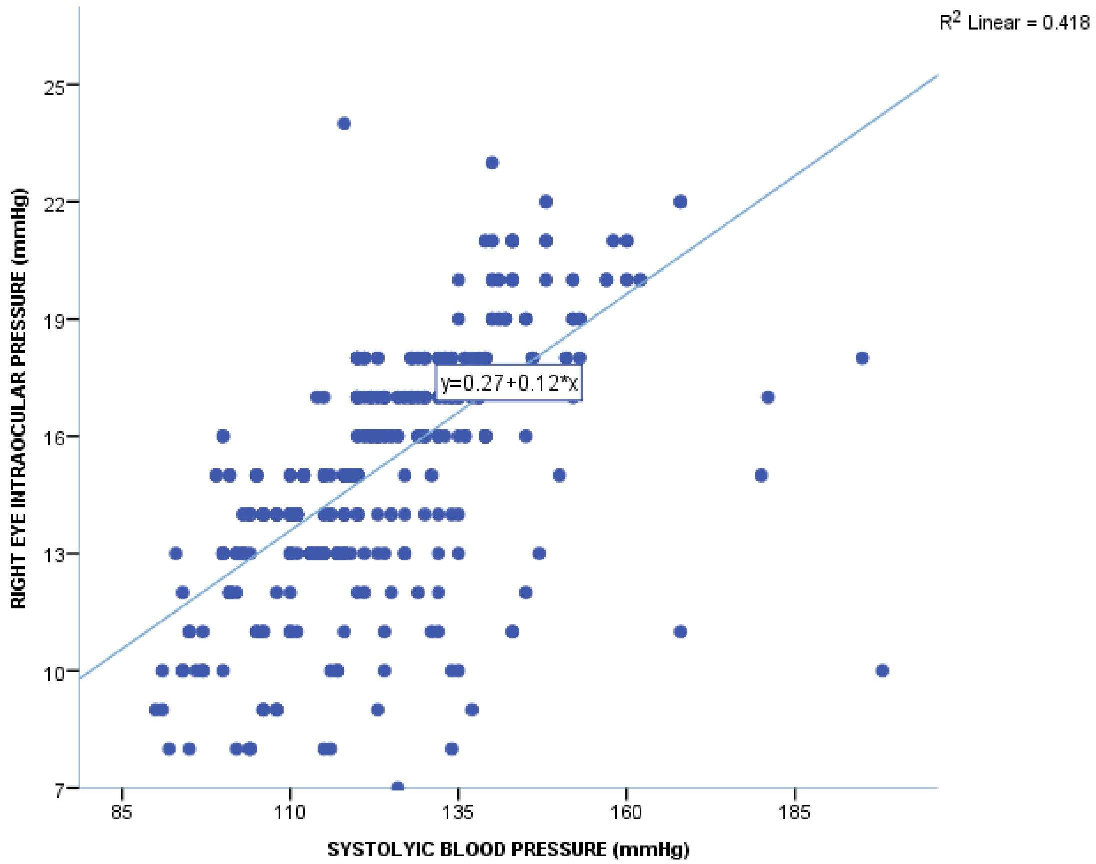

Figure 1.Overall correlation between SBP and IOP.

The data points exhibit a positive linear relationship, as indicated by the linear regression line shown on the plot. The R-squared value of 0.418 suggests that the linear model explains about 41.8% of the variation in the data. The linear regression equation is displayed as y = 0.27 + 0.12x, indicating that for every 1 mmHg increase in systolic blood pressure, the right eye intraocular pressure is predicted to increase by 0.12 mmHg on average.

4.3 Correlation between BMI and IOP

Figure 2 plots the correlation between BMI and IOP for the right eye. Our results show a statistically significant association between BMI and IOP. (r (448) = 0.7, p <0.001).

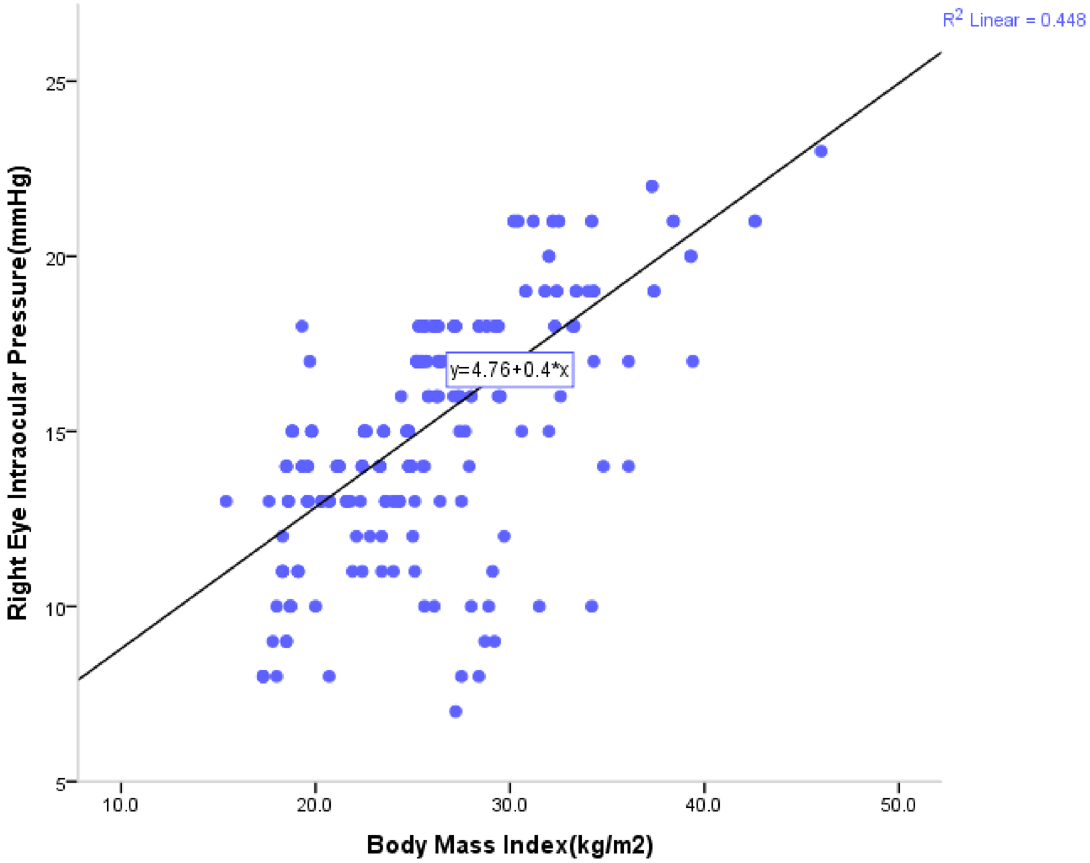

Figure 2. Correlation between BMI and IOP.

The black line represents a linear regression line with the equation y=4.76+0.41x, where y represents IOP in the right eye and x represents BMI. This equation suggests that for every unit increase in BMI, Right Eye IOP increases by approximately 0.41 units. The R-squared value is 0.448, indicating that approximately 44.8% of the variability in IOP can be explained by BMI.

4.4. Correlation between BMI and SBP

Our results show a statistically significant correlation (*r* (448) = 0.745, *p* = <0.001)

Figure 3. Correlation between BMI and SBP.

The trendline equation of y = 63.73 + 2.37x, indicates that for each unit increase in BMI, SBP increases by 2.37 mmHg on average. And an R-squared value of 0.555 suggests that about 55.5% of SBP variance can be explained by BMI

4.5 The impact of age and BMI on the relationship between SBP and IOP

The study population was stratified into four BMI categories: underweight ≤ 18.5 kg/m², normal weight (18.5 <BMI < 25 kg/m²), overweight (25 ≤ BMI < 30 kg/m²), and obese (BMI ≥ 30 kg/m²). The correlation between SBP and IOP was then calculated separately within each BMI subgroup. In the underweight group (n=33) there was no significant correlation between SBP and IOP (r (33) = -0.062, p = 0.73), Normal weight (r (193) = 0.199, p < 0.001), among the overweight (r (145) = 0.039, p = 0. 642). In the obese group (r (77) = 0.381, p < 0.001). The data was further analysed in different age groups as indicated in figure 4.3.1 below.

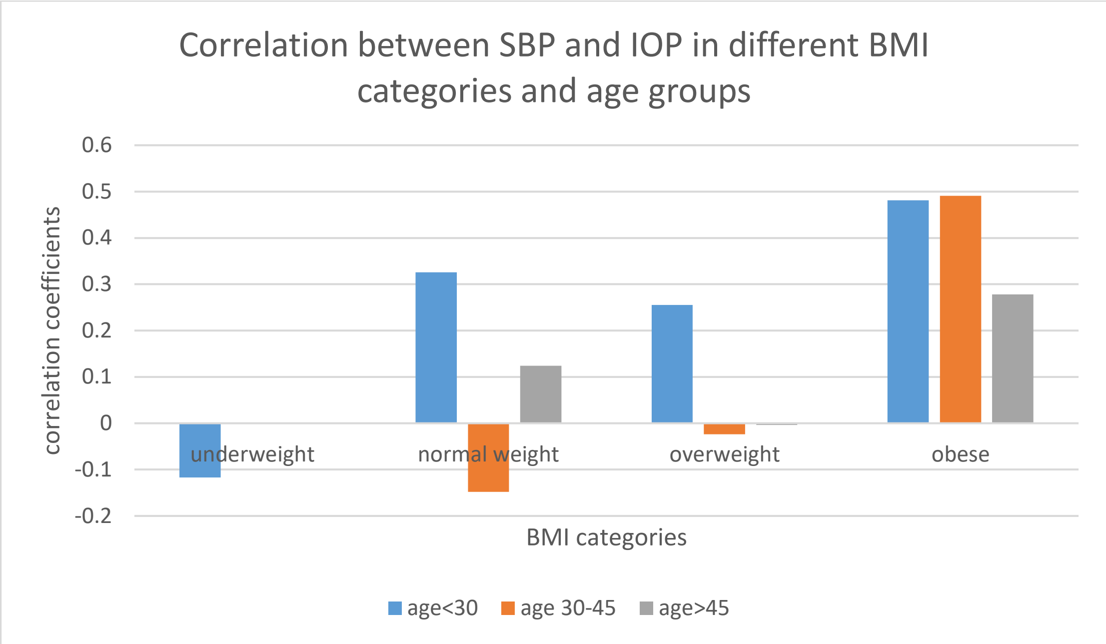

Figure 4. Correlation between SBP and IOP in different BMI categories and age groups.

Bar graph showing the variation in correlation coefficient for different BMI classes. In the underweight BMI category (first blue bar), a slightly positive correlation between BMI and IOP for the age group under 30, which becomes slightly negative for the age groups 30-45(orange bare) and above 45. In the normal BMI category, a moderately positive correlation for all three age groups, with the highest correlation observed for the age group under 30 (blue bar). In the overweight BMI category, the correlation is positive for the age group under 30 but decreases and becomes slightly negative for the older age groups. In the obese. BMI category, a strong positive correlation for the age group under 30, but decreased significantly for the older age groups, becoming slightly negative for the age group above 45. Overall, the graph suggests that the relationship between BMI and IOP varies across different age groups, with the strongest positive correlation observed in the younger age group (under 30) and the correlation becoming weaker or even slightly negative in the older age groups.

4.6 Effect of BMI on the Correlation between SBP and IOP

4.6.1 Analysis of Correlation Findings

There was a strong positive relationship between SBP and IOP (r (448) = 0.646, p < 0.001). The partial correlation coefficient between SBP and IOP, controlling for Body Mass Index (BMI) was (r (445) = 0.275, p <0.001).

Table 3. Correlation between SBP and IOP

Variable	Pearson correlation	Significance (2-tailed)	N
IOP	1	.000	448

SBP	0.646	.000	448

Note. All correlations are between the two variables and are significant at $p < .001$

Table 4. Partial correlation between SBP and IOP, controlling for BMI

Variable	Pearson correlation	Significance (2-tailed)	df
IOP	1	.000	445
SBP	0.275	.000	445

Note. Partial correlation coefficients are reported, controlling for the effect of BMI. df is the degree of freedom

The influence of BMI on the SBP-IOP correlation was determined by comparing the Pearson correlation (r (448) =0.646) and the partial correlation (r (445) =0.275). The lower partial correlation than the correlation suggested that BMI had a positive influence on the correlation between SBP and IOP. In other words, the influence of BMI partially explained the strong positive correlation between SBP and IOP. The difference between the Pearson correlation (r (448) =0.646) and the partial correlation (r (445) =0.275) was 0.371, which meant that BMI accounted for approximately 37.1% of the overall correlation between SBP and IOP.

4.6.2 Moderation analysis on the influence of BMI on SBP-IOP relationship

The multiple regression model with SBP and BMI as predictors explained a significant portion of R^2= 0.515 i.e. 51.5% of the variance in IOP, indicating that these two variables had a substantial combined effect on intraocular pressure.

The ANOVA table provided strong evidence that the multiple regression model was statistically significant ($p < 0.001$) and that the independent variables (SBP and BMI) were jointly effective in predicting the dependent variable (IOP). A very large F-statistic of 236.141 indicate that the regression model explained a significant amount of the variation in IOP.

The unstandardized regression coefficient (*B*1) for BMI was 0.279, which meant that for a 1kg/m^2 increase in BMI, IOP was expected to increase by 0.279 mmHg, holding SBP constant. The unstandardized regression coefficient for (*B*2) SBP was 0.056, which meant that for a 1mmHg increase in SBP, IOP was expected to increase by 0.056 mmHg, holding BMI constant. Both the BMI and SBP coefficients were statistically significant ($p < 0.001$), indicating that they are both important predictors of IOP. The standardized coefficients (Beta) showed that BMI (0.467) had a stronger effect on IOP than SBP (0.298), suggesting that BMI is a more influential predictor of IOP

4.6 Visual function among patients visiting the BPH eye unit

Table 5. Overall visual function analysis

Visual Acuity Category	Frequency (OD)	Proportion (OD)	Frequency (OS)	Proportion (OS)
Normal Vision (6/6)	121	31%	116	30%
Moderate Visual Impairment (<6/18 but =>6/60)	217	55%	218	55%
Severe Visual Impairment (<6/60 but =>3/30)	45	12%	45	12%

Blindness (<3/30)	9	2%	13	3%

Note. A total sample size of 392 was used

A sample size of 392 was used from the 430 due to the some of the patients having severe visual impairment which made it difficult for VA to be taken and also some had cognitive impairments such as dementia and developmental delays and they could not understand or follow instructions properly, which made it difficult for their VAs to be recorded and lastly some did not fit into WHO classifications of Visual impairment Visual acuities were obtained from 392 participants from the 430 because some of the patients had cognitive impairment.

4.7. Common causes of vision problems in patients visiting BPH

Table 6. Frequency and Proportion of commonly diagnosed conditions

Condition	Frequency(n)	Proportion %
Allergic conjunctivitis	51	11.9
Refractive errors	97	22.6
Cataracts	77	17.9
Pseudophakia	31	7.2
Uveitis	9	2.1
Pterygium	25	5.8
Bacteria conjunctivitis	9	2.1
Vernal cattarh	2	0.5
Glaucoma	11	2.6
Corneal ulcer	27	6.4
Traumatic Iritis/uveitis	16	3.7
left eyelid laceration	1	0.2
Chalazion	6	1.4
Pingueculitis	24	5.6
Stye	7	1.6

Foreign Bodies	6	1.4
Blunt Trauma	10	2.3
Blepharitis	3	0.7
Episcleritis	4	0.9
Diabetic Retinopathy	4	0.9
Endophthalmitis	1	0.2
Keratitis	1	0.2
Ophthalmia Neonatorum	1	0.2
lens capsule opacification	3	0.7
Ptosis	4	0.9

Note. A total of 430 sample size was used.

430 participants were used in this study which is different from that used in Table 5 above as it reflects a subset of 392 participants for whom reliable visual acuity measurements were obtained, since participants with certain eye conditions were excluded from the visual acuity analysis since their conditions prevented accurate VA measurements to be obtained.

CHAPTER 5. DISCUSSION

5.1 Introduction

This chapter presents a discussion of the findings of the research. The discussion is structured to address the main objectives of the study such as determining the relationship between BMI and SBP, BMI and IOP, and SBP and IOP among patients visiting BPH.

Followed by assessing the effect of BMI on the association between SBP and IOP. Then determining visual function and common causes of vision problems among patients attending the BPH eye unit. These objectives are discussed in the context of similar studies that have been conducted in the past.

A cross-sectional study was conducted to gather data on variables such as BMI, SBP, IOP, and other relevant factors among patients attending the eye unit. Descriptive and inferential statistics were employed to analyze the study data. Overall, the results suggest that there is a positive correlation between BMI and IOP, BMI and SBP, also that BMI positively affects the relationship between SBP and IOP among patients. Notably, the majority of patients attending BPH had normal and mild visual impairments, of the different eye conditions diagnoses most common causes of visual impairment were either refractive error, cataracts or some form of conjunctivitis respectively.

The relationship between BMI and IOP observed in this study is supported by the findings of a meta-analysis conducted by Geloneck et al. (2015) They reported a positive correlation between BMI and IOP, with mean IOP values of 11 mmHg, 14 mmHg, 16 mmHg, and 19 mmHg for underweight, normal weight, overweight, and obese individuals, respectively Geloneck et al. (2015). These values are almost identical to the IOP means reported in Table 2.

A statistically significant positive correlation between SBP and IOP across all participants (r (448) = 0.646, $p < 0.001$) was found in this study, which aligns with the findings of several previous studies. For instance, a meta-analysis by Geloneck et al. (2015) reported a pooled correlation coefficient of (p= 0.18) between SBP and IOP, indicating a positive relationship between the two variables. The linear regression analysis in Figure 4.2.1 further quantified this relationship, showing that a 1 mmHg increase in SBP is associated with a 0.12 mmHg increase in IOP on average. This is consistent with the findings of a study by Cohen et al. (2016), who reported a similar linear relationship between SBP and IOP.

The correlation between SBP and IOP was found to be strongest in the obese BMI category (r (77) =0.381, p <0.001) and weakest in the underweight category (r (33) = -0.062, p = 0.73). This aligns with the findings of a study by Ahn et al. (2020), who also reported a stronger positive correlation between SBP and IOP in individuals with higher BMI. Furthermore, the study revealed that the correlation between SBP and IOP tended to increase with age, with the highest values observed in the 45+ age group, especially for the overweight and obese BMI categories. This is consistent with the results of a longitudinal study by McLeod, S. D et al (1990) which found that the association between SBP and IOP became stronger as participants aged.

A strong positive correlation between SBP and IOP (r (448) = 0.646, $p < 0.001$) was found however, when controlling for the effect of BMI, the partial correlation coefficient between SBP and IOP was lower (r (445) = 0.275, $p < 0.001$). This difference suggests that BMI has a positive influence on the correlation between SBP and IOP, accounting for approximately 37.1% of the overall correlation. These findings align with previous research by Yasukawa et al (2022) which also reported a significant positive correlation between SBP and IOP but found that this correlation was attenuated after adjusting for BMI. Similarly.

Moderation analysis was also conducted, which revealed that both SBP and BMI were significant independent predictors of IOP, with BMI (β = 0.467) having a stronger effect than SBP (β = 0.298). This is consistent with a 2020 study by Kim et al. which found that the influence of BMI on IOP was stronger than that of SBP.

The overall visual function analysis among patients visiting the BPH eye unit indicated that a significant proportion of patients had some degree of visual impairment, using the international classifications (Visual Health, 2019) 31% had Normal vision (6/6) and 55% had moderate visual impairment (<6/18 but =>6/60) And 12% had severe visual impairment (<6/60 but =>3/30) and less than 5% were categorized under blindness (<3/30). A study by Tagoh et al (2020) in Mashonaland province found a higher prevalence of visual impairment being due to uncorrected refractive errors and cataracts among the rural dwellers of Zimbabwe. In their study, the prevalence of visual impairment was 56.8% and blindness was 13.1% which is much higher than those found in this study of the actual patients who seek optometric service at BPH which caters for the whole Mashonaland province thus highlighting the importance of public health education, access to refractive error services, and cataract surgery to mitigate this high burden of visual impairment.

The most frequently diagnosed condition at BPH in this study was found to be refractive errors, affecting 22.6% of the participants. The high prevalence underscores the importance of regular vision screening and access to corrective lenses. Cataracts were the second most common condition, accounting for 17.9% of cases. Effective cataract surgery programs are essential to address this significant public health issue. Allergic conjunctivitis was diagnosed in 11.9% of participants, reflecting findings from other studies that highlight the commonality of this condition, especially in regions with high allergen exposure (Singh et al., 2010). Public health measures to reduce allergen exposure and improve the management of allergic reactions are crucial in reducing the burden of this condition. Pseudophakia, a condition where the natural lens of the eye has been replaced with an artificial lens following cataract surgery, was present in 7.2% of participants. This statistic indicates the ease of access to cataract surgery in the population and the success of such interventions in restoring vision. Other notable conditions included corneal ulcers (6.4%), pterygium (5.8%), and Pingueculitis (5.6%). The prevalence of corneal ulcers highlighted the need for prompt treatment of eye infections and injuries to prevent serious complications. Pterygium and pingueculae are often related to environmental factors such as UV exposure and wind which are present in Bindura. From these findings, it is important to emphasize the need for protective eyewear and public awareness campaigns. Less common but still significant conditions included glaucoma (2.6%), uveitis (2.1%), and traumatic iritis/uveitis (3.7%). The presence of glaucoma among participants is particularly concerning given its potential to cause irreversible vision loss. These findings support the need for regular IOP monitoring and early intervention to manage glaucoma effectively and now in addition patients with high BMI must also be advised to maintain a healthy weight to improve glaucoma management prognosis in addition to maintaining general health.

CHAPTER 6.

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study explored the influence of body mass index (BMI) on the correlation between systolic blood pressure (SBP) and intraocular pressure (IOP). The findings revealed a strong positive relationship between SBP and IOP, which BMI significantly moderated. Specifically, BMI accounted for approximately 37.1% of the overall correlation between SBP and IOP, suggesting that higher BMI amplifies the effect of SBP on IOP. The multiple regression analysis further confirmed that both SBP and BMI are significant predictors of IOP, with BMI exerting a stronger influence. These results underscore the importance of considering BMI in the assessment and management of IOP, particularly in hypertensive and obese populations. Understanding this relationship can help in developing more effective strategies for preventing and managing conditions like glaucoma, which are influenced by elevated IOP.

6.2 Study Limitations

The small sample size used in this study may limit the ability to generalize the results to the broader population. Equally, the cross-sectional design of the study can only demonstrate associations between variables (body mass index, systolic blood pressure, and intraocular pressure) at a single point in time. It cannot determine causal relationships or the direction of causality nor even provide insights into how these factors might influence each other over time. Hence longitudinal studies would be necessary to explain such causal linkages.

Moreover, the study was conducted at a specific healthcare facility and may not be fully representative of the broader population or region, thus multi-centre investigations would be helpful to corroborate the current observations.

Furthermore, the research did not take into account potential confounding factors such as dietary practices, physical activity, and genetic susceptibility. Finally, the study did not consider temporal fluctuations in intraocular pressure that can vary based on time of day, seating posture, and other transient factors.

6.3 Recommendations

Non-communicable disease management needs to be included in the government's universal health coverage policy, as these conditions are increasingly contributing to irreversible blindness. Additionally, there is a need for the integration of optometrists into public health institutions which would help enhance the overall healthcare system and improve patient care, particularly in the field of eye care.

Future research should employ longitudinal designs to better understand the causal relationships between SBP, BMI, and IOP over time. This approach would help in identifying temporal patterns and long-term effects.

Developing and implementing public health strategies aimed at maintaining a healthy lifestyle for overall health including weight management and hypertension control, focusing on their potential benefits for ocular health. Educational programs can also help raise awareness about the importance of maintaining a healthy BMI and blood pressure for better eye health as well as the need for regular health and eye consultations.

Eye care professionals should consider integrating BMI and blood pressure assessments into routine eye examinations when evaluating patients at risk for elevated IOP and related conditions.

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APPENDIX 1:ETHICAL CLEARANCE

RES CS COMMITTEE

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P. Bag 1020
BINDURA, Zimbabwe

BINDURA UNIVERSITY OF SCIENCE EDUCATION [BUSE]

09 April 2024

Mr Delight Munjanja (B203228B)
Bindura University of Science Education
Faculty of Science & Engineering
P. Bag 1020
Bindura

Dear Mr Munjanja

RE: INSTITUTIONAL RESEARCH COMMITTEE ETHICAL CLEARANCE-APPROVAL NUMBER: BUSEREC/0040/2024

Your application for research ethical clearance related to the topic '**The influence of body mass index on the correlation between systolic blood pressure and intraocular pressure**' has been approved and allocated approval Number: **BUSEREC/0040/2024**. You are to quote this approval number for all correspondences inclusive of consent forms and any other documents as and when appropriate. The approval period is as stated below:

Type of Meeting	:	14th Research Ethics Committee
Approval Date	:	09/04/2024
Expiry date	:	08/04/2025

The project will automatically discontinue on the expiry date. You can apply for renewal three months before the expiry date. The renewal application should be accompanied by a progress report.

You are not expected to make any changes/adjustments to the protocol including the consent documents. Any trials involving drugs, devices and biologics require approval of the Medicines Control Authority of Zimbabwe before commencement. All problems to do with the safety of participants must be reported to BUSEREC (buserec2022@buse.ac.zw) within three (3) working days.

Upon termination of the study, a report has to be submitted to BUSEREC.

Yours sincerely

[redacted]

BUSEREC CHAIRPERSON

APPENDIX 2: APPROVAL LETTER

THE MEDICAL SUPERINTENDENT
BINDURA PROVINCIAL HOSPITAL

17 APR 2024

P BAG 940, BINDURA
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FACULTY OF SCIENCE AND ENGINEERING
DEPARTMENT OF OPTOMETRY

Received Approved

16th April, 2024

TO WHOM IT MAY CONCERN

PERMISSION TO CONDUCT PROJECT STUDY AT YOUR FACILITY

This letter serves to confirm that Delight Manjonja is a bona fide student of the Bindura University of Science Education, Department of Optometry, currently enrolled in the 4th year Honours Degree program with a registration number.

The research on the topic" The influence of body mass index on the correlation between systolic blood pressure and intraocular pressure

We have carefully reviewed and complied with all the necessary ethical guidelines and regulations required for conducting research at healthcare institutions. Additionally, we have attached the Institutional Review Board (IRB) Approval documents, demonstrating that these researches have been reviewed and approved by the university's ethics committee.

Your institution is kindly requested to assist in granting sincere permission to undertake the research process. All information provided will be treated strictly as confidential and purely for academic purpose.

Looking forward to your favourable response,

Thank you.

Yours Sincerely

BUSE Optometry Department
Email: optometryclinic@buse.ac.zw

OPTOMETRY CLINIC

16 APR 2024