

# Prevalence of Hypertension and Associated Co-Morbidities in Pakistan

Mehwsih Iqbal<sup>1</sup>, Muhammad Akram<sup>2,\*</sup>, Abid Rashid<sup>3</sup>, Rida Zainab<sup>2</sup>, Umme Laila<sup>2</sup>, Muhammad Talha Khalil<sup>2</sup>, Viroj Wiwanitkit<sup>3</sup>, Atheer Kadhim Ibadi<sup>4</sup>

<sup>1</sup>Institute of Management Sciences, Dow University of Health Sciences, Karachi Pakistan

<sup>2</sup>Department of Eastern Medicine, Government College University Faisalabad-Pakistan

<sup>3</sup>Department of Biological Science, Joseph Ayobabalola University, Ikeji-Arakeji, Nigeria

<sup>4</sup>Department of Pharmacy, Kufa Institute, Al-Furat Al-Awsat Technical University, 31001 Kufa, Al-Najaf, Iraq

## ABSTRACT

**Background:** Hypertension is one of the major chronic health problems found amongst the vast population of the World. **Hypothesis:** According to WHO, it is the 10th leading cause of death, and global data indicates that nearly 17 million deaths occur annually due to cardiovascular diseases, amongst which hypertension accounts for more than 7 million. **Methods:** Its prevalence has been seen most in black people. According to previous studies conducted in all four provinces of Pakistan, hypertension has now become the leading chronic disease affecting not only adults but also children, not only the urban but also the rural population. **Result:** Its incidence is increasing day by day. In more than 90% of the cases, the exact cause of hypertension is unknown, but certain predisposing factors may contribute to this disease such as excessive use of salt in diet, increased blood cholesterol, obesity, alcohol, smoking, lack of exercise and stress. It is more common in urban than rural populations. Hypertension is the most common risk factor for both cardiovascular diseases and stroke. It may also cause renal impairment and hypertensive retinopathy. If it remains uncontrolled for a long time, then it may cause death. **Conclusion:** This review is an update regarding the prevalence of hypertension and associated co-morbidities in Pakistan.

**Keywords:** Hypertension, Co-Morbidities, Stroke, Cardiovascular Disorders, Diabetes Mellitus.

## INTRODUCTION

As far as the prevalence and associated co-morbidities of hypertension are concerned, it is an important public health problem universally and is the most extensively recognized modified risk factor for cardiovascular diseases, cerebrovascular diseases and renal diseases. According to the guidelines of the national commission for hypertension, ideally, the

## Vol No: 05, Issue: 02

Received Date: January 13, 2023

Published Date: January 28, 2023

### \*Corresponding Author

#### Muhammad Akram

Department of Eastern Medicine, Government College University Faisalabad-Pakistan, Pakistan

**E-mail:** makram\_0451@hotmail.com

**Citation:** Akram M, et al. (2023). Prevalence of Hypertension and Associated Co-Morbidities in Pakistan. Mathews J Nurs. 5(1):11.

**Copyright:** Akram M, et al. © (2023). This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

target for systolic blood pressure is that it should be less than 150mmhg, and diastolic blood pressure should be less than 90mmhg in people with 60 years or older. The people who are less than 60 years of age, their systolic blood pressure should be less than 140mmhg, and diastolic blood pressure should be less than 90mmhg. The people 18 years of age or older who are suffering from diabetes or chronic kidney disease, the management goal should be 140mmhg for systolic blood pressure and 90mmhg for diastolic blood pressure.

Global prevalence for hypertension is more than 7 million per year may be obtainable by it. In practically developed countries, its prevalence ranges between 20 and 50% [1]. Worldwide data showed that nearly 1 billion had hypertension in 2000, which will increase to about 1.56 billion in 2025. RB Singh et al. accounted for the dominance of hypertension in Asian countries to be between 15 to 35% in adult people of urban areas, whereas countryside people are 2-3 times less prevalent than urban people [2]. Its prevalence varies around the globe. The smallest frequency of hypertension is established in rural India, is nearly 7% in females while 3.4% in males and the maximum prevalence in the country Poland that is 72.5% in females and 69% in males [3].

The prevalence of hypertension in the Pakistani population of more than 15 years of age is 18%, with its prevalence in the rural population being 16.2% and the urban population at 21.6%. The number of patients with controlled hypertension is very low in Pakistan. About 70% of patients with hypertension in Pakistan are unaware of their disease; nearly 5.5 million men and 5.3 million women suffer from hypertension in Pakistan. Only less than 3% have controlled hypertension [3-5]. A third of Pakistanis aged more than 45 years have hypertension [6].

Among the 1240 research articles, approximately 18 articles containing 42,618 contributors convene the eligibility criteria. Overall, the collective frequency of high blood pressure was 26.34%, while analysis of subgroups demonstrates elevated prevalence in the urban population, 26.61%, than the countryside residents, 21.03%. The frequency was 19.55% (18.07%, 21.05%) in the 1990s, 23.95% in 2000, and 29.95% in the 2010s. In the same way, the collective prevalence was 24.76% in females and 24.99% in males. There is documentation of the raised burden of high blood pressure

amongst the adult population of Pakistan, according to the data published in both international and local journals. The survey conducted by Pakistan national health demonstrates that high blood pressure is elevated from fewer than 10% in up to 19 years old to more than 60% in males above 70 years of age. Likewise, in women, it rises from less than 5% up to 19 years of age to hit the highest point at 70% in more than 60 to less than 70 years of age, the occurrence being elevated in females than males. Its prevalence rose sharply in both males and females after 20 years of age. Age-attuned percentiles of Blood pressure in Pakistani people and the USA population demonstrate elevated diastolic blood pressure in the population of Pakistan (PNHS, MHS, NHANES); therefore, hereditary predisposition to primary hypertension may be elevated in the population of Pakistan than people of the USA and Europe [7].

According to the American heart association, the prevalence of hypertension is more in males than females until age 45. From age 45 to 64, the ratio of men and women becomes equal. Prevalence of hypertension is 25.3% in males and 41.4% in females in Baluchistan, which is higher than in other provinces of Pakistan. The prevalence of hypertension is 23.7% in males and 28.4% in females in Pakhtoonkhah. Prevalence of hypertension is 17.3% in males and 16.4% in females in Punjab. Prevalence of hypertension is 19% in males and 9.9% in females of the Sindh province [8]. Hypertension dominance is 29.22%, amongst which nearly 78% are women while 22% are a man in people residing in twin cities of Pakistan (i.e. Rawalpindi and Islamabad).

Hypertension linked to obesity is 59.4%, and a continuous boost in hypertension with growing age. Bivariate analysis discovered that high blood pressure has a significant relationship with gender, family status, age, weight, and physical health [9]. There are certain disease conditions that, when associated with hypertension, worsen the health of the patient. High blood pressure is an asymptomatic malady; therefore, it is considered a silent destroyer. The equilibrium between arterial resistance and cardiac yield sustains standard blood pressure. In this condition, the workload on the circulatory system is amplified to distribute blood to the tissues and exerts tension on the heart and arteries. Eventually continuous tension on the cardiac system directs to cardiovascular dysfunction, which gives other diseases such as renal failure, congestive cardiac failure, dysfunction

of cardiac muscles etc. The blood pressure percentage group data created from a variety of children populace have permitted identification of subjects, which go beyond these limits, and a population of children over and above the 95th percentiles of population charts has a tendency to develop high blood pressure in later life. The tracking experience is principally strong in the youth and adolescent population. There is sufficient data to propose that children from hypertensive parents tend to develop high blood pressure in later life and that the children of hypertensive parents are inclined to have elevated percentiles of blood pressure outline in the early stages of life. The factors such as sedentary lifestyles, obesity, smoking, excessive alcohol consumption, diabetes and excessive salt intake have an intense effect on the escalating prevalence of primary hypertension in the middle and late ages of life [10]. Eating habits of people living in Asian countries signify that maybe their consumption of salt is elevated because of eating pickles, salty refreshments, ketchup, and beverages. And it is linked with an elevated prevalence of hypertension. Community health guidelines concerning salt intake are fictional in our constituency and can greatly aid in formulating area-specific precautionary guidelines. There is an immediate need to create and execute guidelines and construct mechanisms to enhance the detection and management of hypertension in the common population to decrease the healthcare burden on our financial system.

### Cardiovascular Diseases

The risk of cardiovascular diseases doubles for every 10-point increase in diastolic BP or every 20-point increase in systolic BP. High blood pressure increases the heart's workload, and it makes the heart become thick and stiffened. Hypertensive patients have 2.03 times greater chance of developing cardiovascular diseases [11]. Expanded arterial stiffness may enhance cardiovascular diseases and fatality because of an elevation of systolic blood pressure (SBP), which increases left ventricular after the load, and due to a decrease in diastolic blood pressure, which changes coronary effusion [12]. A prevalence study was performed in the city of Karachi, which exposed that there is insufficient general awareness of high blood pressure among patients with cardiovascular diseases, and they are unable to identify the significance of high systolic blood pressure levels. Approximately 82% were not even known that high blood

pressure is also called hypertension.

In contrast, nearly 97% of people sampled for the study were unaware that systolic blood pressure is the top extent of blood pressure, while only 25% appropriately acknowledged that normal systolic blood pressure should be less than 140mmhg. The frequency of patients who consulted their physicians for high blood pressure once or twice per month is nearly 7.5%. Most frequently identified risk factors by the participants were excessive salt intake [13].

High blood pressure is linked with markers of cardiovascular end-organ damage, such as left ventricular hypertrophy. Left ventricular hypertrophy is usually known to be the lasting end of hypertension, while some information suggests that the expended left ventricular mass head is the beginning of hypertension. In Pakistan, the disease burden of ischemic heart disease has been estimated as 5.09375 million. Ischemic heart diseases were seen more in men than women [14]. The most widespread type of hypertension is systolic blood pressure, and people over 60 years are more inclined to it. Research studies demonstrate that it is more essential to manage systolic blood pressure than diastolic blood pressure [15]. The researches that have carried out on the universal burden of high blood pressure stated that around 25% of adults have high blood pressure, and hypertension-related events are responsible for causing deaths in overall 9.2% of people. Data from various studies demonstrate that atherosclerotic events account for 49% and hypertension for 35% of all cases of cardiac failure [16]. Management and control of blood pressure minimize the risk of cardiovascular diseases. Four years national health survey of Pakistan (i.e. from 1990 to 1994) reveals that around 70 to 85% of patients with high blood pressure in Pakistan were unaware of their disease, showing inadequate knowledge about hypertension. While there is not enough information available as if the patients are aware about the importance of their normal systolic blood pressure level [13].

### Stroke

Amongst western countries, stroke has the third commonest cause of death and maybe the commonest cause of disability. Around 200 people amongst the 100000 population will have a first stroke every year in US [17]. In Pakistan, approximately 250/100000 people may have a stroke yearly. Nearly 15 million people worldwide suffer from stroke

annually; amongst these, more than 5.5 million die. Razzaq et al. [18] and Khan et al. [19] investigated hypertension as a risk factor for stroke [18,19]. This study was conducted in Ayub medical hospital between 2003 and 2005. Patients with features of stroke were selected for the study. Other risk factors were smoking, cardiovascular disease, dyslipidemia and diabetes mellitus. Most important risk factor for stroke was hypertension in this study. Fifty-one patients were suffering from hypertension out of 91 cases. A number of male and female patients was 35 and 16, respectively. Most stroke cases were observed between 51-70 years of age. Khan et al. [19] conducted a study to investigate the incidence of stroke in hypertensive patients [19,20]. This study was conducted at Liaquat University of Health and Medical Sciences, Jamshoro, Pakistan. Total number of patients investigated was 100. Number of the male and female patients was 64 and 36, respectively.

Patients were examined and investigated for a CT scan of the brain, electrocardiogram, serum creatinine, blood urea, blood glucose and blood pressure measurements. Haemorrhage and infarction were identified as hyperdense and hypodense areas on a brain CT scan, respectively. Patients with stroke due to other risk factors or not confirmed on CT scans were excluded from this study. Number of stroke patients due to hypertension was 74. Number of patients with severe hypertension was 36. Chief anatomical site affected in hemorrhagic stroke was hypothalamus and putamen. The chief site of infarction stroke was internal capsule and corona radiata. This study showed that hemorrhage is less common in cerebral stroke as compared to hypertensive stroke patients and hypertension is major risk factor for the development of stroke.

### Diabetes Mellitus

Diabetes mellitus is a disease correlated with hypertension, and if not treated properly, it can lead to cardiovascular and other diseases [21]. High blood pressure can contribute to diseases and fatality amongst diabetic patients [22]. Approximately 3 million Americans have both diabetes and high blood pressure found simultaneously. High blood pressure is two times more common in diabetic patients as compared to normal persons, while recent data suggests that hypertensive persons are more prone to develop diabetes [23]. Global prevalence of diabetes amongst adults was 6.4% affecting nearly 285 million adults in 2010, and there

is a risk to increase upto 7.7 percentage affecting 439 million adults by 2030 prevalence of high blood pressure in diabetic patients of Pakistan is 64%. According to the Pakistan national blindness and visual impairment survey 2003, 15% of diabetic patients have retinopathy, and their risks were higher in hypertensive diabetic patients. Hypertension is also responsible for causing renal failure and retinopathy [24]. Diabetic retinopathy is usually observed in patients with diabetes mellitus [25]. Serious visual disability occurs in untreated diabetes mellitus [26]. A study was conducted to investigate the prevalence of diabetic neuropathy in hypertensive diabetic patients. Cross-sectional study was conducted on hypertensive diabetic patients compared to normotensive diabetic patients. Total number of patients investigated was 200. Number of hypertensive diabetic subjects was 107 and number of non-hypertensive diabetic patients was 93. These 200 hundred patients were investigated for presence of retinopathy. Prevalence of hypertension and retinopathy was 53.5% and 51% of the total diabetic subjects respectively. Cases of retinopathy were more in hypertensive diabetic patients as compared to non-hypertensive diabetic subjects. Diabetic patients have more chances of retinopathy and hypertension [27]. Prevalence of retinopathy is more in hypertensive diabetic than non-hypertensive diabetic patients. Hassan et al (2010) conducted a study to investigate the lipid profile, retinopathy and HbA1c in patients attending diabetic clinics and government hospitals in Faisalabad, Pakistan. Prevalence of retinopathy was 41.1% in the subjects investigated. Prevalence of retinopathy was more in subjects with HbA1c >8%. Smoking status, history of hypertension, duration of diabetes and the age of patients were significantly associated with the prevalence of retinopathy [28]. Khanzada et al. (2011) investigated the prevalence of diabetic retinopathy in people of Hyderabad, Pakistan [29]. This study was conducted in the Ophthalmology Department at Liaquat University of Health and Medical Sciences. Total number of patients investigated was 244, and all the patients were above the age of 30 years. All the patients were investigated for retinopathy, and other risk factors such as hypertension, treatment type, duration of diabetes mellitus, gender and age were evaluated for their possible association with retinopathy. The number of male and female patients investigated out of 244 was 149 and 95, respectively. Prevalence of diabetic retinopathy was 40.94%. Retinopathy was found in patients who had been suffering

from diabetes mellitus since 13 years. Prevalence of diabetic retinopathy was mostly observed in patients with age of 40-60 years. Shakil et al., (2008) evaluated the influence of diabetes mellitus and hypertension on senile cataract [30]. A proforma was filled after selecting the subjects for investigation. Patients were asked to attend the laboratory after fasting of 12 hours. Samples were investigated and blood pressure was measured. Patients were divided into groups such as control group A (normoglycemic, normotensive with cataract), group B (hypertensive with cataract), group C (diabetic with cataract) and group D (diabetic, hypertensive with cataract). Study showed that hypertension and diabetes mellitus are modifiable risk factors that are positively involved in the senile cataract development. Arbab et al., (2008) investigated hypertension as a risk factor for the development of diabetic retinopathy in patients with diabetes mellitus. Total number of patients was 100. This study was conducted in Sir Syed Hospital, Karachi Pakistan. Number of male and female patients was equal. Age of patients was between 40 and 70 years. All the patients were investigated for presence of diabetic retinopathy. Patients were grouped into two such as patients with diabetic retinopathy and patients without diabetic retinopathy. Blood pressure, HbA1c, random blood sugar and fasting blood sugar were investigated in all patients. Blood pressure was significantly higher in patients with retinopathy than in patients without retinopathy. In this study, significant correlation was found between hypertension and retinopathy [31].

### Obesity

The frequency of increased weight and obesity is increasing. It is anticipated to be the foremost leading cause of death and morbidity, likely causing more than 2.5 million demises globally and 2.3% of the total global burden of disease. The rising prevalence of obesity is progressively recognized as one of the most significant risk factors for developing high blood pressure and enhanced risk of cardiovascular disease [32,33]. Usually, body mass index is between 20-25, while 25-29 are considered overweight. Whereas 30 or greater than this is measured as obese. For the reason of the observed discrepancy between populations, the global organization for the Study of Obesity and the global Obesity Task Force have recommended lower body mass index cutoff standards for the explanations of obesity (25.0 kg/m or greater) and overweight (23.0-24.9 kg/m ) in the population

of Asia [34]. After cigarette smoking, it is now considered the second leading cause of avoidable death in the United States. Globally, the Asian population is among those at maximum risk of developing cardiovascular diseases. In Pakistan, the frequency of obesity is 56%, [35] in females and 30% in males. While the frequency is 2 to 2.6% increases in metropolitan regions compared to rural areas and more frequent in women than men, the considerable increase in obesity in this preceding decade appears to be a corresponding boost in the incidence of hypertension. It is also linked with high blood pressure in childhood. The occurrence of hypertension is greatly elevated in obese people in contrast with non-obese children (i.e. 13.7% vs 0.4%). The rise in BP is strongly linked to the extent of weight gain, and even reasonable weight gain is related to an amplified risk of developing high blood pressure. Loss of weight is considered the most efficient non-medicinal therapy for reducing blood pressure in corpulent hypertensive persons. There is a dosage and response relationship between the level of weight loss and the decrease in blood pressure that is not dependent on sodium intake. Even moderate weight loss of up to 10 percent of body weight is linked with clinically considerable reductions in blood pressure. In the case of both males and females, the frequency of high blood pressure rises with age in persons who are overweight. It has been revealed that the incidence of high blood pressure in corpulent and overweight is from 23 to 45% [36]. Likewise, a distressing aspect from a community health viewpoint is the incidence of persistent hypertension and corpulence in school-going children. A research study from Chennai of around two thousand four hundred and sixty-seven fit and well school going children from 11 to 17 years of age reported a frequency of 6.6% in metropolitan and 2.5% in countryside India. This setback is likely to be provoked since childhood obesity is rising in cities and in prosperous families and it is an international phenomenon including to the area that obesity is not common.

### CONCLUSION

Persistently raised blood pressure may damage various body organs, including vital organs, and sometimes it may become life-threatening or fatal. Its global burden is increasing daily due to some abysmal changes in our lifestyles, such as decreased activity and exercise, increased salt intake, smoking, alcohol, etc. Pakistan needs better strategies for

preventing and managing hypertension, which requires a rational plan of action to avoid it while improving existing policies against hypertension. Although we established many small to intermediary-level studies in different regions of the country that anticipated high blood pressure, there is no countrywide study on the frequency of hypertension. All should take steps to decrease its burden by making lifestyle changes by performing surveys, early detection and medication to prevent any serious or life-threatening complications in later life.

#### ABBREVIATIONS

Not applicable

#### DECLARATIONS

#### ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

#### CONSENT FOR PUBLICATION

Not applicable.

#### AVAILABILITY OF DATA AND MATERIAL

Not applicable.

#### COMPETING INTERESTS

Authors declare no conflict of interest

#### FUNDING

Not applicable

#### ACKNOWLEDGEMENTS

Not applicable.

#### REFERENCES

1. Erem C, Hacıhasanoglu A, Kocak M, et al. (2008). Prevalence of prehypertension and hypertension and associated risk factors among Turkish adults: Trabzon Hypertension Study. *Journal of public health*. 31(1):47-58.
2. Singh R, Suh I, Singh V, et al. (2000). Hypertension and stroke in Asia: prevalence, control and strategies in developing countries for prevention. *Journal of human hypertension*. 14:749-763.
3. Kearney PM, Whelton M, Reynolds K, et al. (2005). Global burden of hypertension: analysis of worldwide data. *The lancet*. 365(9455):217-223.
4. Soomro MA, Abro GY, Shah SIA. (2013). Frequency of hyperlipidemia in patients of hypertension in chandka medical college hospital larkana. *Medical Channel*. 19(3):26-30.
5. Ahmed N, Abdul Khaliq M, Shah SH, et al. (2008). Compliance to antihypertensive drugs, salt restriction, exercise and control of systemic hypertension in hypertensive patients at Abbottabad. *J Ayub Med Coll Abbottabad*. 20(2):66-69.
6. Ghaffar A, Reddy KS, Singhi M. (2004). Burden of non-communicable diseases in South Asia. *BMJ*. 328(7443):807-810.
7. Aziz K, Aziz S, Patel N, et al. (2005). Coronary heart disease risk-factor profile in a lower middle class urban community in Pakistan. *East Mediterr Health J*. 11(3):258-272.
8. Jafar TH, Levey AS, Jafary FH, et al. (2003). Ethnic subgroup differences in hypertension in Pakistan. *J Hypertens*. 21(5):905-912.
9. Ishtiaq S, Ilyas U, Naz S, et al. (2017). Assessment of the risk factors of hypertension among adult & elderly group in twin cities of Pakistan. *J Pak Med Assoc*. 67(11):1664-1669.
10. Freitas SRS, Cabello PH, Moura-Neto RS, et al. (2007). Combined analysis of genetic and environmental factors on essential hypertension in a Brazilian rural population in the Amazon region. *Arq Bras Cardiol*. 88(4):447-451.
11. Iqbal R, Ahmad Z, Malik F, et al. (2012). A statistical analysis of hypertension as cardiovascular risk factor. *Middle East J Sci Res*. 12(1):19-22.
12. Laurent S, Boutouyrie P, Asmar R, et al. (2001). Aortic stiffness is an independent predictor of all-cause and cardiovascular mortality in hypertensive patients. *Hypertension*. 37(5):1236-1241.
13. Bilal M, Haseeb A, Lashkerwala SS, et al. (2016). Knowledge, awareness and self-care practices of hypertension among cardiac hypertensive patients. *Glob J Health Sci*. 8(2):9-19.
14. Abbas S, Kitchlew A, Abbas S. (2009). Disease burden of Ischemic Heart Disease in Pakistan and its risk factors. *Ann Pak Inst Med Sci*. 5:145-150.
15. Levine CB, Fahrback KR, Frame D, et al. (2003). Effect of amlodipine on systolic blood pressure. *Clinical*

- therapeutics. 25(1):35-57.
16. Lawes CM, Vander Hoorn S, Rodgers A. (2008). Global burden of blood-pressure-related disease, 2001. *The Lancet*. 371(9623):1513-1518.
  17. Rabinstein A. (2000). Neurological emergencies: acute stroke. *J Neurol Neurosurg Psychiatry*. 69(6):836-837.
  18. Razzaq A, Kakakhail MAA, Ahmad F, et al. (2012). Frequency of modifiable risk factors in stroke patients admitted to teaching hospitals in Bannu district. *Gomal Journal of Medical Sciences*. 10(1).
  19. Khan J, Shah AA, Jielani A. (2006). Frequency of hypertension in stroke patients presenting at Ayub Teaching Hospital. *J Ayub Med Coll Abbottabad*. 18(1):59-61.
  20. Abbasi MA, Sammo J, Sheikh M. (2007). Incidence of stroke in context of hypertension in local population. *Pakistan Journal of Physiology*. 3.
  21. Nayak SB, Mohammed SB, Nayak AS. (2017). Controlling Lipids AIDs in the Prevention of Type 2 Diabetes, Hypertension, and Cardiovascular Diseases. *International journal of preventive medicine*. 8.
  22. Hsieh YT, Tu ST, Cho TJ, et al. (2012). Visit-to-visit variability in blood pressure strongly predicts all-cause mortality in patients with type 2 diabetes: a 5• 5-year prospective analysis. *Eur J Clin Invest*. 2012; 42(3):245-253.
  23. Sowers JR, Epstein M, Frohlich ED. (2001). Diabetes, hypertension, and cardiovascular disease: an update. *Hypertension*. 37(4):1053-1059.
  24. Eriksson AGZ. Sentinel lymph nodes in endometrial carcinoma: Mapping, diagnostic accuracy and oncologic outcome. 2018. p. 1-102. Available at: <https://www.duo.uio.no/bitstream/handle/10852/66002/1/PhD-Eriksson-2018.pdf>
  25. Lu CD, Kraus MF, Potsaid B, et al. (2014). Handheld ultrahigh speed swept source optical coherence tomography instrument using a MEMS scanning mirror. *Biomed Opt Express*. 5(1):293-311.
  26. Lotfy M, Adeghate J, Kalasz H, et al. (2017). Chronic complications of diabetes mellitus: a mini review. *Curr Diabetes Rev*. 13(1):3-10.
  27. Lovshin JA, Shah BR. (2017). Inadequate screening for retinopathy among recent immigrants with type 2 diabetes despite universal health care: A population-based study. *J Diabetes Complications*. 31(4):664-668.
  28. Hassan M, Akhtar M, Akhtar N. (2010). Prevalence of retinopathy and its associated factors in type-2 diabetes mellitus patients visiting hospitals and diabetic clinics in Faisalabad, Pakistan. *Pakistan Journal of Zoology*. 42.
  29. Khanzada MA, Narsani AK, Shaikh F, et al. (2011). Frequency and types of diabetic retinopathy in type II diabetes; a hospital base study. *JLUMHS*. 10(3):143-146.
  30. Shakil M, Ahmed ST, Samiullah S, et al. (2008). Influence of hypertension and diabetes mellitus on senile cataract. *Pakistan Journal of Physiology*. 4(2):30-32.
  31. Arbab TM, Hanif S, Iqbal S, et al. (2008). Hypertension as risk factor in diabetic retinopathy in type 2 diabetes. *Pak J Ophthalmol*. 24:201-204.
  32. Galal OM, Hulett J. (2005). Obesity among schoolchildren in developing countries. *Food Nutr Bull*. 26(2 Suppl 2):S261-S266.
  33. Flegal KM, Carroll MD, Ogden CL, et al. (2002). Prevalence and trends in obesity among US adults, 1999-2000. *JAMA*. 288(14):1723-1727.
  34. Choo V. (2002). WHO reassesses appropriate body-mass index for Asian populations. *The Lancet*. 360(9328):235-235.
  35. Zahid N, Meyer HE, Kumar BN, et al. (2011). High levels of cardiovascular risk factors among Pakistanis in Norway compared to Pakistanis in Pakistan. *J Obes*. 2011:163749.
  36. Brown CD, Higgins M, Donato KA, et al. (2000). Body mass index and the prevalence of hypertension and dyslipidemia. *Obes Res*. 8(9):605-19.