Visual Impairment in Adults Caused by Diabetes

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Abstract

Visual impairment from diabetes has been a topic of research for many years. This review explores how visual impairment is related to diabetes and how it can be prevented, more specifically among the aged population. Researchers found that various devices designed to help stop diabetes from worsening are actually poorly made in terms of accessibility for those with visual impairment from diabetes. Risks of visual impairment seem to be relatively higher among females in their old age than their male counterparts. Additionally, the level of education turns out to be related to the development of visual impairment from diabetes in old age. More studies need to be done since the amounts of samples are not enough and the regions of studies are limited to certain areas.

Introduction

Sugar, a molecule that is present in what we eat every day from morning coffee to Starbucks drinks to all the candies has become a major part of everyone's life regardless of the age group. Imagining life without sugar would almost be impossible but if it is taken on an excessive level, it can be harmful. What happens to our body when we eat food that contain high sugar? The human body constitutes a system for all the organs and if one part is disturbed, the whole body is affected in some way or another, leading to dangerous conditions. A common disease associated with high blood sugar is diabetes. One of the consequences is that it causes visual impairment.

Many people have done research on the disease itself but very few studies have been done on the relationship between diabetes and visual impairment. At first, our goal was to

discuss how type 1 diabetes affects young children and their eyesight, but there was no research done on this topic. It is very important to raise awareness on this topic because if diabetes is not controlled in children, it can become a lifelong threat.

Methodology

For this literature review on Diabetes and visual impairment, twelve sources were used. Three sources dealt with topics about visual impairment from diabetes, another three sources about accessibility issues, and the rest are about gender differences. Before we began reviewing each research, we made a preliminary search and reviewed the journals where they were published.

To find articles relevant to current Diabetes research, articles published between the years 2012 and present were used. A total of twelve articles were collected from various medical or scientific journals. Three of the collected articles focused on mechanism or causes of visual impairment from Diabetes. Another three articles dealt with accessibility issues, and the rest handled gender differences.

In order to find the articles on Diabetes, EBSCOHOST database was mostly used. Ebscohost was an effective search tool because there were more than enough studies that could be used for our review. Initially, we were going to include articles on visual impairment of children from diabetes; however, relevant articles were rare and too old for our age bracket if any. For that reason, we had to discard the topic and move on to a different one, which was accessibility issues.

The CCNY library website was used to find the articles needed. We tried using Google Scholar, but its database interface was not really familiar to us, so we continued the search with EBSCOHOST. The search terms used to find the articles were, Diabetes and visual impairment, cause of visual impairment and diabetes, Diabetes and visual impairment of children, Diabetes and gender, Diabetes and accessibility. After reading abstracts and data provided, twelve were found which were fitted for this review.

Diabetes

Diabetes Mellitus, normally known as diabetes, is a metabolic disease in which a patient's blood sugar level is at or on the abnormal level. In the human body, insulin helps regulate the sugar level by transferring it from the bloodstream to the cells so it can be stored to use for energy when we need it. However, in a diabetic patient, the body either does not make enough insulin or cannot be used effectively, resulting in high blood sugar in the blood (Watson, 2018). Because sugar (also known as glucose in the bloodstream) cannot be taken into cells, they begin to starve. Then, the sugar travels to our kidneys and is urinated. This irregular state of sugar is very dangerous for metabolic processes in the body, increasing the risk for many serious complications. It can cause damage to body organs such as the kidneys, eyes, and nerves (Watson, 2018). Other complications in people with diabetes include skin infections and disorders, glaucoma, cataracts, neuropathy-nerve damage from diabetes, foot complications, ketoacidosis and ketones, kidney disease, high blood pressure, and stroke. Unfortunately, various combinations of these complications may happen at the same time with an individual. Although complications from diabetes are thought to be complex, one thing is quite certain: diabetes

gradually damage various organs of the human body, and damaged organs hardly ever recover from the impairment. Currently, diabetes has no cure, but the good news is that an individual with diabetes can possibly prevent their conditions from getting worse or make diabetes go into remission, although the disease is still present. (American Diabetes Association).

To illustrate, diabetes are of two main types: type 1 and type 2. Type 1 diabetes is an autoimmune disorder that develops when the body destroys its own beta cells in the pancreas which are responsible for making insulin. As a result, people with type 1 diabetes do not make insulin. When insulin is not present, the amount of sugar in the bloodstream cannot be controlled. Type 2 diabetes makes a sensitivity to insulin decrease, which means the body does not make as much insulin as it needs or use it as much as necessary. Type 2 diabetes is more common of the two types.

Diabetes and Visual Impairment

As can be seen, Diabetes has a greater risk of causing visual impairment and it gets worse as you get older. Diabetes can cause many diseases such as Glaucoma and Retinopathy. Many studies have been done to research these diseases, however, there aren't enough studies to discuss the relationship between Diabetes and visual impairment, and the few there are, focus on the younger population. For example, a study was done to figure out how Retinopathy and Glaucoma causes visual impairment but the age of the population was less than 75. Moreover, many people reported data indicating that they had visual impairment due to type 2 Diabetes. The National Health and Nutrition Committee in U.S. collected more data in the form of surveys to investigate this issue further. They found that patients who have Diabetes are more likely to

get distance Visual Impairment (both correctable and non correctable) except for the ones 80 and older (Lamasou, et al., 2018). As an illustration, non-correctable visual impairment refers to low vision that cannot be cured with medications or surgery, however, correctable can be cured.

The study mentioned in the article entitled *Near Visual Impairment Incident in Relation to Diabetes in Older people: The Three Cities Study,* which was published in the Journal of American Geriatrics Society, discusses the connection between the effect of Diabetes and visual impairment in older people aged 65 and above in three Cities of France. According to Lamasou, it was hypothesized that "older people with DM would be at greater risk of near VI and that knowledge of the risk factor profile might help in preventing near VI and limitation in ADLs" As a matter of fact, ADL refers to the activities of daily living and VI is an abbreviation for visual impairment. They mentioned in the hypothesis that by testing the relationship between Diabetes and visual impairment and analyzing this issue, they can help older people get cured earlier so that they do not have to face difficulties dealing with Diabetes, visual impairment, and ADL at the same time in future.

To conduct this study, a total of 9294 participants, aged 65 years or older, were selected from the chosen France Cities: Bordeaux, Dijon, and Montpellier (they were not institutionalized). Data of these participants was collected by interview and physical examination (Venous blood was collected after 12 hours of fasting to get accurate readings for blood glucose). In addition, BMI was measured for each participant to get accurate results for progression of Diabetes. Same data was collected again during the next 4 visits after 2, 4, and 7 years. There can be many variables in a study that might affect the results so the experimenters had to control some of them. The controlling factors included sex, living arrangement, income, and age. To

measure education level, they were considered to have low education if they received less than 7 years of education, medium with 7 years, and high if more than 7 years. Health and dietary information was also taken such as daily fruits, meat, fish intake and alcohol consumption. To control dietary factors throughout the experiment, they were given specific amounts of fruits and other foods to eat everyday.

In the study, it was concluded that Diabetes was associated with near visual impairment and was mainly seen in normal and underweight patients who should not be at risk. They should not be in danger if they are controlling their weight and Diabetes. This means that Diabetes is connected with visual impairment so we need to be more careful with older people who have Diabetes. They should get special attention by an ophthalmologist and should not only go for a regular eye exam but also be cured if they have correctable visual impairment (Lamasou, et al., 2018).

The next study discusses the same relationship between Diabetes and visual impairment but this was focused mainly on the South Indian population. It was reported that not only increased rates of cataract surgery has occurred in the past two decades, but the rate of blindness has also increased to three times compared to Asia overall. When people lose even the smallest amount of their eyesight due to Diabetes, their lives are still affected. According to the article *Four Year Incidence and Progression of Visual Impairment in a South Indian Population with Diabetes,* which was published in the Indian Journal of Ophthalmology, “Diabetes with even mildly to moderately impaired sight has a negative impact on perceived quality of life and psychosocial functioning, giving rise to feelings of vulnerability, worries about the future, and loss of independence and mobility.” As can be seen, it was very important to test the South

Indian population because they needed to figure out if Diabetes affected eyesight and if it did, they could find a way to control the visual impairment in the earlier stages for patients with Diabetes and cure them. They saw that 4% of the population was Diabetic and visually impaired in the Indian urban population. Previous reports have discussed other blindness related diseases such as Diabetic Retinopathy, Retinal Vascular diseases, Optic Neuropathy, and Glaucoma. However, no one had researched or tested the progression of visual impairment in Diabetic patients so that was the main goal of this study.

This study was focused on one city: the Chennai metropolis which has 10 zones and a population of 4.3 million. To test this study, 5999 participants who were above 40 years old were randomly selected. These participants were reexamined after 4 years in the follow up study named: SN-DREAMS II. From the 5999 people, 1175 were known to be Diabetic. By the time the follow up experiment was done, these people were excluded from the experiment: 95 people who died, 20 without gradable photos, 337 non participants, and 86 were removed due to cataract study. After deducting all of them, the final population that was left to test was 634. As an illustration, visual impairment was tested for these people using the Early Treatment Diabetic Retinopathy Study chart. Moreover, Landolt Ring test was also used to translate for those who could not speak English. Some measurements and data was collected in the form of demographic, biochemical, and ocular data to figure out the cause of visual impairment. Srinivasan describes the results as following, "Of 634 participants with diabetes at follow-up, 620 had normal vision at baseline and were therefore considered as the number at risk for incident VI...135 (21.7%) developed some form of VI after 4 years; 18.3% of participants developed mild VI, 3.4% developed moderate VI, and none developed severe VI or blindness".

This shows that as you get older, Diabetes does affect eyesight but not too severe. It was concluded that the refractive error and cataract surgery was the leading cause of visual impairment. Those with Cataract were more likely to develop visual impairment than those who weren't. Patients with Cataract and refractive error could be treated.

There are 280 million cases of visual impairment worldwide and 39 million of them face blindness. A lot of studies have researched causes and effects on different populations but not a lot of them are on Iranian population. Therefore, the next study focused on studying risk factors of visual blindness in middle aged Iranians in a Shahroud Eye Cohort Study (ShECS) over a 5 year period. To conduct this study, participants were tested from cities of Shahroud and different eye diseases were observed. According to the article, *Five Year Incidence of Visual Impairment In Middle Aged Iranians: The Shahroud Eye Cohort Study* which has been published in the Journal of Ophthalmic Epidemiology, participants were divided into two parts: ShECS 1 and ShECKS 2. In ShEKS, 1, 6311 participants were selected through random sampling and 5020 participants ended up participating and were tested from 2009-2010. Each participant was interviewed based on demographics, socioeconomic status, and medical history such as smoking, sleeping, and diet. Vision was tested using Nidek CP-770 chart projector. Other tests were taken which included ocular biometry, optical coherence tomography, perimetry, and measurement of intraocular pressure. After this, all participants were tested again using the same protocols in 2014 and these examinations were part of ShECKS 2 (Hashemi et. al.). For people who had best corrected visual acuity less than 20/60, fundus photographs were reviewed by a panel to figure out the actual scientific reason behind blindness. Patients were also tested based on Cataract by the World Health Organization (WHO). Moreover, Diabetic Retinopathy was measured using the

protocol given by Early Treatment Diabetic Retinopathy Study. Over time, many participants moved away or dropped out during the process leaving a total of 4737 participants to be tested, with a participation rate of 93%. The limitation of the study was that the BCVA was too small for proper observation of risk factors.

It was concluded that as you get older, you get more chances of visual impairment and less treatment options are available to cure the disease because of age. To prevent people from becoming visually impaired in old age due to Diabetes, low vision clinics should be opened and more diabetes programs should be developed to control Diabetes at a young age. If Diabetes reaches a higher stage, it is very difficult to cure. The ShECS will collect more data and continue doing research to help prevent Diabetes and visual impairment. As a matter of fact, this study was funded by Noor Ophthalmology Research Center and Shahrood University of Medical Sciences.

Accessibility issues with devices for diabetics

As mentioned previously, diabetes is a disease that comes in many forms, and thus there are various ways to manage diabetes before the condition worsens. The most common way to manage the condition is to measure the blood glucose levels regularly using a blood glucose meter. The way that the meter is able to determine glucose levels in the body is by using a lancet, which uses a small need to prick the skin, letting a little drop of blood out. This would then be inserted into the strip which would be read by the machine (*Managing Diabetes*, 2016). Although many people in the US are currently diagnosed with diabetes, there is a huge issue with accessibility to the devices needed in order to manage one's condition. This section will serve as

an analysis of recent studies published on the accessibility issues of those who are visually impaired and have diabetes.

In recent times, it has become very common to explore and fight for the issues of accessibility and equality for all. Of the 18 million individuals diagnosed with diabetes, 13.6% have low vision as a result of diabetic retinopathy and about 1.3 million out of the 18 have visual impairments that do not even relate to diabetes at all (Blubaugh & Uslan, 2012). The importance of accessibility for those who are visually impaired with diabetes is further elaborated on in the article entitled *Accessibility Attributes of Blood Glucose Meter and Home Blood Pressure Monitor Displays for Visual Impaired Persons*, which was published in the Journal of Diabetes Science and Technology.

Starting with brief descriptions of the technologies used to measure blood glucose levels and blood pressure levels, the study began to talk about how to screens on these machines often have low levels of contrast and high levels of glare. This introduction helps to give the audience a general sense of the issues regarding the display monitors on these health-related machines. Following this, the methodology for conducting this study was described as nine blood glucose monitors and eight blood pressure machines that were in the market as the "best selling devices". Taking these devices, the display characteristics were measured using an optical measurement system to capture and process the images of the displays (with contrast and reflection measurements in various lightings).

The results showed a wide spread of data across the different devices used for both the blood glucose machines and blood pressure machines. Due to the blood glucose monitors using reflective displays (use a constant contrast value in both broad sunlight and office light

conditions), these displays are not readable at low-level lighting such as during the night. This can prove to be an issue for people who have to check their blood glucose levels throughout the night. Similarly, the blood pressure machines were all reflective and could not be read at all during the night. The brief conclusion provides readers with the knowledge that when purchasing these machines, it may prove to initially be challenging to determine the differences between the displays; however, high-quality backlit displays are slowly becoming more common, but these devices still use poor quality displays.

Articles like these are often used as preliminary possibilities to use to build future research. Although this article did provide accurate references and methodologies throughout, the fact that this study had only been conducted once with a relatively small sample size makes the claim that devices are still in poor shape questionable. Furthermore, another shortcoming of this study is that the best machines were subjective, so the entire study was based on opinions of what machines to test. The results and discussion informs the audience about the poor display in these common household medical devices and that further development is needed in order to make these devices accessible to those who are visually impaired.

An article of a similar style to the previous can be found in the same journal (Journal of Diabetes Science and Technology) entitled *Creating Low Vision and Nonvisual Instructions for Diabetes Technology: An Empirically Validated Process*. Starting with a brief introduction about the nature of both diabetes and visual impairment, Williams begins to further establish the connection between the two by mentioning the fact that the devices currently used in the healthcare system were not specifically created with those who are visually impaired in mind when nearly 20% of adults with diabetes have some form of visual impairment (Williams 2012).

This short introduction does not fall short from helping the audience get a direct understanding of the lack of accessibility in current medical devices for the visually impaired. Following the introduction, Williams goes into the methodology used by talking about the guidelines needed in instructions to produce an accessible nonvisual instruction guide for the use of insulin pens and observed the effectiveness of those guidelines with 40 visually impaired individuals while using 40 not visually impaired people as a control. The effectiveness was measured by the ability of the persons chosen to use insulin pens properly into an injection ball.

Results from this study show that from all the 40 individuals that participated in this study, all 40 of them were able to properly read and follow the instructions of using the insulin pen properly. The results show that there was no significant difference between how the experimental group (40 individuals who are visually impaired) and the control group (no visually impairment) used the insulin pen on an injection ball. This suggested that the nonvisual instructions for the visually impaired people were, at least, equally as effective as visual instructions made for people who are not visually impaired. Elaborating further on the effectiveness of the nonvisual instructions for the insulin injections, Williams began to delve deeper into the applications of the conclusions reached from this study into other fields.

The discussion section furthers the importance of using auditory instructions as not only a means of making this accessible for the visually impaired, but also those who have dyslexia, low literacy, and people who understand spoken English better than written. This advances the significance of making texts accessible to everyone by using different forms (by following the guidelines mentioned in the study).

Articles like these are used as a basis for further studies and research to be conducted, along with going to big corporations in order to implement change. Although the study had a control group in order to have a comparison of how those who can read and see differ in following instructions from those who are visually impaired, the study is still relatively small (with only 40 people in the experimental group). Furthermore, it is not elaborated in the article about how other variables that could potentially have had an effect on the results of the study were controlled, if they were controlled at all. Examples of these variables include things such as weight, height, ethnicity, and whether the people involved in the study were ESL speakers. The results and discussion inform the audience about a temporary potential solution to the lack of instructions for insulin injections for those who are visually impaired.

When discussing all these potential solutions to aid those who are visually impaired gain access to medical devices that help in managing diabetes, it is important to initially assess the accessibility of these devices before trying to create a radical change. A similar third article entitled *Accessibility of Insulin Pump Displays to People With Low Vision* can be seen in the Journal of Diabetes Science and Technology exploring the accessibility of these devices for those who are visually impaired. Starting off by mentioning that this study is an update/addition to the 2009 study done by Burton et al., the study mentions that the main aim is to determine the accessibility of insulin pumps (particularly the performance of the displays) to those with visual impairment (Reuschel & Uslan 2014). This short introduction informs the readers that this is not an original research idea, however, it is an addition to a study done a few years prior in order to keep the audience in the loop about the status of current devices for diabetes and its accessibility.

Following the brief introduction, Reuschel and Uslan delve into the methodology used for their study. They obtained four of the five insulin pumps that were available in the U.S. market in 2012 to test the display performance in the AFB Tech Optics Lab. The lab evaluated the insulin pumps on several criteria such as the contrast, font size, and reflection properties in various settings of light. Once the criteria were used to evaluate the pumps, each type of insulin pump was compared to one another in order to determine the most accessible pump.

The discussion and conclusion sections took the results from following the methodology and interpreted it in regards to the topic at hand. According to the results, none of the meters used in the study exhibit good low vision accessibility in terms of the various criteria used to consider (contrast, font size, and reflection properties in various settings of light). Following the conclusion that was reached, Reuschel and Uslan go into a discussion of the different systems tested and which of the systems had made the most dramatic improvements in terms of accessibility since 2009. Both Uslan and Reuscheul maintain an optimistic view of what the future has to hold for insulin pumps as they close off the article by mentioning that the continued development of insulin pumps makes the idea of an accessible pump being available soon sound plausible. However, before encouraging manufacturing companies of creating huge changes in their devices in order to make it more accessible, both stress the importance of further research being conducted in order to develop threshold levels that each manufacturing company can be held accountable for. This informs the audience about the potential for a great future with accessible medical devices but also stresses the importance of further research needed to be conducted.

Articles like these are often used as a basis in future developments in the respective fields. Although the study did have more than one criteria to judge it upon, there needs to be a more holistic approach to reviewing what makes a device more accessible (something more than three criteria). Additionally, although it is easier to stick with the same five manufacturers throughout the experiment, it is imperative to explore the insulin pumps (and other devices) produced from new manufacturers in order to inform the visually impaired community who have diabetes if there is actually an insulin pump in the world that is completely accessible. Another important criteria to explore in the Diabetes research is its effect on men and women.

Factors associated with diabetes and the effects/influence on gender

As mentioned above, Diabetes is a critical disease that has been affecting many people around the world and through the examination of its causes and association with visual impairment and ways to manage the condition, the general awareness on this issue has increased. However, when it comes to diabetes, there has not been much concern brought on the fact of whether there is an association or influence diabetes exhibits between males and females. Previous research has found that males were more susceptible to developing Diabetes than females in the circumstances of a lower level of body mass index/BMI (Roche & Wang, 2014, p 77) which indicates a gender difference associated with Diabetes. As a result, various studies expanded on the idea of gender differences and conducted research to examine the factors in diabetic males and females and how they affect the genders differently.

In one study, researchers focused on determining the factors associated with Diabetes by looking into present factors between males and females who were diagnosed in the early stages

versus the ones who were diagnosed in the later stages. There were a total of 7101 individuals who were incorporated throughout the study which included participants that were 25 years and older with 48 percent being males and 52 percent being females. Consent was acquired for the utilization of information and the study was carried out using the administrative and survey data from Newfoundland and Labrador, Canada, with four databases: The Canadian Chronic Disease Surveillance System (CCDSS), the Canadian Community Health Survey (CCHS), the Clinical Database Management System (CDMS), and the MCP Fee-For- Service Physician Claims Database (Roche & Wang, 2014, p 78). The first database, CCDSS, was used to identify individuals with diabetes based on the fulfilled requirements of having either a hospitalization record or two or more physician claims for additional treatment on a diabetes diagnosis. The second database, CCHS, was a cross-sectional survey which collected information pertaining to the health status and the utilization of health systems among 130,000 Canadians. The third database, CDMS, is an accessible source for hospitals to record all information regarding patients that were admitted into health care facilities and the last database, the MCP system, was used to provide information on the services that Diabetic patients received for paying for additional treatment. In regards to the classification of groups, the CDMS and MCP systems were used to identify when symptoms occurred using a 6 month period range (Roche & Wang, 2014, p 79). Diabetic patients without any diabetes related conditions or complications within 6 months before or after their date of diagnosis were considered the early diagnosed group, and the patients with one or more diabetes related conditions were defined as the late diagnosis group (Roche & Wang, 2014). Analyses were done using the logistic regression, chi-square tests,

t-tests, and other independent variables such as demographic and lifestyle variables were also incorporated.

Results displayed that certain independent variables were associated with the development of diabetes, including the status of diagnosis of Diabetes. A total of 21.1% of males were diagnosed with Diabetes early and 78.9% were diagnosed late. In females, 31.5% were diagnosed early and 68.5% were diagnosed late (Roche & Wang, 2014, p 80). Males who were diagnosed late with Diabetes were more likely to be overweight/obese and were mostly from rural areas. When compared to females with a late diagnosis, they were more likely to be physically inactive and received social assistance. This shows that there are different causes of Diabetes between the two genders and certain environmental factors also contribute to Diabetes. A common association found between the genders was that males and females with late diagnoses were potentially older than those with early diagnosis. Therefore, this indicates a higher risk factor for individuals of older ages and the period of detecting diabetes is crucial.

Although this study provided several risk factors in diabetes which impacts males and females differently, there were certain limitations. The study was a cross-sectional study which makes the material not as robust as other types. There may have also been a misidentification in the number of patients classified as diagnosed early or late due to the imposed specified time range of 6 months since diabetic complications may be developed outside of the time range which influenced the data. Another issue was that the increased sample size resulted from combined cycles using the CCHS system which did not eliminate a small sample size (Roche & Wang, 2014, p 83). This designates for more research on how diabetes is developed in males and

females and when they are diagnosed in order to provide more liability in the differences of associated factors.

Another study focused on exploring the gender differences in the risk/susceptibility of developing other health complications in type 2 Diabetes along with other influencing factors. Yao et al's research focused on determining the differences in the risk of getting coronary heart disease and stroke between Chinese male and female patients and its relationship with metabolic syndrome. A total of 1514 patients were included in the study which consisted of 796 males and 718 females in the ages from 30 to 79 years old. Patients who were diagnosed with any other type of Diabetes besides type 2 or has coronary heart diseases or a stroke were excluded (Yao et al, 2016, p 2).

Before conducting the study, all medical history of each patient was recorded and were required to go through a physical examination that checked their height, weight, and blood pressure (the average of two blood pressure measurements was used). Blood was collected after 8 to 12 hours of fasting to determine each patient's blood glucose level, total cholesterol, triglycerides (TG), and high-density lipoprotein cholesterol (HDL-c). There were two components to the process of the study which were divided into establishing the criteria for metabolic syndrome and the assessment of coronary heart disease and stroke. For the first component, the researchers followed the Asian Guidelines of National Cholesterol Education Program Adult Treatment Panel III (Yao et al, 2016). The conditions consisted of abdominal obesity (the waist circumference is greater than or equal to 90 cm for males or greater than or equal to 80 cm for females), having high blood TG levels (either greater than 1.7 mmol/L or is receiving treatment), having reduced blood HDL-c levels (a value less than 1.04 mmol/L for

males or less than 1.29 mmol/L in females), the presence of a systolic blood pressure/diastolic blood pressure (greater than or equal to 130/85 mmHg, or is receiving treatment/had a previous diagnosis of hypertension), and high blood glucose levels (greater than or equal to 5.6 mmol/L, receiving treatment/previous diagnosis of type 2 diabetes) (Yao et al, 2016). Three of the five conditions were required for metabolic syndrome to be present. As for the second component, the UK Prospective Diabetes Study was used to calculate the risks of coronary heart disease and stroke on a ten-year basis with each patient's current conditions. After these were completed, groups were determined by gender, age, and the level of risk, and statistical analysis was done and compared between the groups.

The results displayed that females were at a lower risk of developing coronary heart disease and stroke and metabolic syndrome were positively correlated to the risk. When compared between the group with type 2 diabetes alone, females had a 15.3% CHD risk and an 8.4% stroke risk while males had a 26.3% CHD risk and a 10.3% stroke risk. In the metabolic syndrome group, females had a 16.2% CHD risk with an 8.9% stroke risk and males had a 28.4% CHD risk with a 10.6% stroke risk (Yao et al, 2016, p 3). Through the comparison, metabolic syndrome increases the risk of CHD and stroke and this makes metabolic syndrome another determining factor of diabetes as well as a constituent for other health complications. Furthermore, the majority of the data brings to the conclusion that males were more prone to getting CHD and stroke instead of females and this is conflicting since some previous studies have concluded that females had a higher risk for CHD. A reason for the occurrence may be due to genetic differences that exist between gender and race which causes one group to be more

susceptible over the other. As a result, more studies are needed to provide validity and further research is needed to decrease these complications.

A third study continued to explore health complications in diabetic patients and as mentioned previously, diabetes is related to visual impairment which is another critical health risk. The researchers' main focus was on gender differences in diabetic retinopathy and its progression and Kajiwara et al's research consisted of a total of 383 Japanese type 2 diabetic patients with 245 males and 138 females. All patients went through a diabetic retinopathy diagnosis by an opthamologist and the categories of diabetic retinopathy were grouped into no retinopathy, non proliferative diabetic retinopathy (NPDR), and proliferative diabetic retinopathy (PDR) using the criteria from a national ophthalmology conference. Two measures were tested in the study: the incidence of DR and the progression to PDR. The incidence of DR is defined as having no initial symptoms in both eyes but NPDR or PDR symptoms are found later in either eye at follow up and the progression to PDR is when there are no initial PDR symptoms but are found in either eye during follow up (Kajiwara et al, 2014). Statistical analysis was done afterwards using the logistic regression, t-tests, and the Kaplan Meier Method for analysis and comparison and the patients' clinical characteristics were also incorporated.

The results indicated that females had a higher prevalence in developing diabetic retinopathy than males. During the initial results, it was found that 89 (23.2%) patients had NPDR and 59 (15.4%) had PDR. For the incidence of DR, the average was 58.5 per 1000 person-years which included 76.1 for females and 51.6 for males. The progression to PDR was 7.6 per 1000 person-years with 7.9 for females and 7.5 for males (Kajiwara et al, 2014, p e8). Females were also at a higher risk for developing PDR when compared to males at 21.0% for

females and 12.2% for males which is quite a big difference. As a result, females are more likely to be affected and experience visual impairment in type 2 diabetes and progress to the most advanced stage (PDR). Previous studies have found that older age and BMI were risk factors associated with diabetic retinopathy in females and in this study, longer diabetes duration, higher HbA1c level, systolic blood pressure, and BMI were more apparent in the female gender. This calls for precaution and early treatment in females.

Although there is sufficient data, there are still some limitations to the study. The sample size is too small and there may have been a lack of detailed clinical information from the patients (Kajiwara et al, 2014). It is important for the sample size to be large in order to avoid discrepancies in the results. Thus, through the three studies, it is evident that males and females are affected differently through diabetes and different factors are associated with each depending on the circumstances. Further studies are needed to expand on this topic and the results would be more constructive if research from various countries was done and compared. The next study continued to focus on explaining the risk of Diabetes and many people who are affected by it.

As mentioned before, Diabetes is a common disease that anyone can diagnose in their life time if they don't control what they consume. For example, the amount of sugar they eat in a day and what things they can not overdose or else it can lead them to many diseases such as Diabetes. Things that people take in is what most people don't think about, and that leads them to diagnosing diabetes in their later life or having the risks of diagnosing Diabetes. In one of the studies called Community- Based diabetes screening and risk assessment in rural West Virginia, they did a study on how Diabetes had affected 29.1 million Americans, and what were the risks on them getting Diabetes. The methodology for this study is that they tested people who were

mostly highschool graduate or educated people, like people who attended school. They found volunteers that were highly in risks of diagnosing Diabetes, and participants were chosen based on how they would determine who to use for the study were chosen by many factors like; age, weight, height, delivering large babies (large babies means that the mother can have Gestational Diabetes), and etc. Those factors were important because you can tell who will be in risks of diagnosing Diabetes in later life, or whose highly in rise of getting diabetes. They had a very large age range which is 18-89. Having a large data set, and a large set of age range would help the results to have a higher percentage of accuracy which is good because we wanted to see the gender difference in people who are at risk of getting Diabetes.

In the journal research page, we can see that females have a higher percentage of not getting diabetes than males which means males are the ones that outrages the percentage of high risks in getting diabetes, and females are the ones that would have a low risk of getting Diabetes. But in this study they used more females than males. For a better study on males versus females, they should have an even amount of males and females. But the outcome also shows that females were the ones that had a higher percentage of having Diabetes. On the table, Diagnosed Diabetes by HCP, you can see that female has percentage of 69.1 and males has a percentage of 30.9 and that's more than half of the males percentage. Even though there were more female participants than males, we can still use this data and say that males are at a higher risk of getting diabetes in their later life than females would get in their later life because according to the results males had a higher percentage, and that shows that males are the ones that are at a higher risk, and should be careful when it comes to healthcare in their later life.

When it comes to Diabetes there are many types. The next article that will be used is "Risk factors for visual impairment and blindness amongst black adult diabetics receiving treatment at government healthcare facilities in Mopani District, Limpopo province, South Africa". In this study they are testing on a well known disease called Diabetes Mellitus (DM), and test to see what this disease would lead them to, or cause them to get in the diagnoses in the future. There are two results that researchers would want to see when it comes to Diabetes Mellitus in adults. They want to see whether it would lead to Diabetic Retinopathy or visual impairment. This would lead to the focus of visual impairment because we want to see if more males or females who are affected by Diabetes, and what causes them to be visually impaired. To conduct this experiment there are many things that needs to be tested and since they are now using people for their study, adults who have diagnosed Diabetes and maybe going through other health problems. Since we want to see whether males or females would have a higher risk of getting visual impairment, this article would be good to used for our focus because they have a clear data from their studies on male and female.

They basically used the same methodology and selected participants health records, meaning their their height, weight, waist, whether they are heavy smokers or not and other more health history. These factors would be important because different people have different health issues, and that maybe the cause for type 2 diabetes, which would occur in their later life. This study took place in Mopani District, limpopo province, South Africa. They did their study in two different hospitals to test Diabetes Mellitus (DM) disease among Black South Africans. In total they would have a total of 225 participants, with 161 female participants and 64 male participants. They used a range of ages from 40-90 years adults. The result was that 41.3% had

visual impairment and 3.6% had lost their eyesight completely. They used more females than males in this study which makes the male and female data different. Since South Africa has a very high percentage of visual impairment caused by Diabetes, they wanted to find a way to decrease the result of blindness. In order for the percentage to decrease, they would have to have more eyecare programs to help those who have vision problems, and what caused them to become blind.

Another study also talked about visual impairments that happened in China. They did free vision test for their participants, and so they wanted to know what causes them to get visual impairment (participants; lifestyle, or medical histories). Other questions that were asked included anything that would lead them to be visually impaired in their life. Visual impairment is a common disease that most people would get in their life, some even in their childhood and can be caused by many factors. One reason people would get visual impairment is because of other health histories such as Diabetes that would cause them to have visual impairment maybe in their later life. Visual impairment can also lead to many other mental health issues that's why knowing the cause and to prevent people from getting it later in their life is very important. In this study, "Social-economic status, visual impairment and the mediating role of lifestyles in developed rural areas in China", they tested participants that were not all educated, and they vary from different classes. This makes the study widespread, and somewhat understanding because poor people in China wouldn't be able to pay their medical bill if they would go check up every once in a while. Another factor that would cause visual impairment is their socioeconomic status. Compared to the USA, countries in Asia are different, they differ from classes. Not everyone outside of America can afford to pay for their medical bills. There are

many people who are living outside of the USA that couldn't afford a simple yearly check up. This can lead many people in trouble because not all Diabetes are reversible, and without knowing that they are diagnosed can even lead them to death.

In this study they used a large amount of participants. In total they had 12,233 participants and 6,233 were all males. This study would be a very good study to used because it's almost 50% males and 50% females. Since we want to know the difference between males and females having visual impairment, 50-50 would be the best choice, then the solution we get can be more accurate, and sufficient because the amount of data is very large. They had results for people with different lifestyles, age, gender and medical histories for example, whether or not they had diabetes. In this study there were actually more females that were visually impaired than males. Females had 196(63.23) and males had 114(36.77), and there were slightly more male participants. The results also showed that people who had lower education would also have a higher risk of getting visual impairment, if we do the comparison between low education and high education you will see the major differences and the amount doubled. Participants that had a diabetic health history actually had a lower percentage of being visually impaired than participants that did not get diagnosed with visual impairment. This means that most of the people who get visual impairment are due to other causes other than just diabetes that will affect their vision.

Conclusion

The reviewed literature suggests that visual impairment in old age is closely related to diabetes. The studies have revealed that visual impairment from diabetes can happen and worsen

among old age groups, and this process can only be prevented at an early stage of the disease. At a later stage of the disease, it becomes much harder to stop visual impairment or loss of vision from developing.

Individuals with diabetes are frequently encouraged to check their glucose level on a regular basis, day and night. Researchers have found that, despite their sophisticated technology, most manufacturers of the devices fail to consider accessibility to those devices for the visually impared. Checking the glucose level is thought to be an essential part of efforts to stop Diabetes from worsening, and individuals with visual impairment from Diabetes are the people that need to get access to the devices that measure their glucose level.

There seems to be slight differences in developments of diabetes between male and female. Males tend to develop diabetes in the early stages, while females do so in the later stages. One especially outstanding finding is that women in the older ages are more prone to visual impairment than their male counterparts. Certain factors are closely related to the higher occurrences of visual impairment among females in their older ages, and it seems to be worth doing research on the nature of these factors: whether they are biological ones or socio-economic ones.

Community-based attempts to screen Diabetes and assess risk factors of Diabetes are noteworthy in that Diabetes can only be prevented or delayed. A wide variety of attempts of some communities to screen diabetes might help those exposed to diabetes or its complications stay alert about seriousness or consequences of the disease. The related research implies that more educated individuals are more receptive to community-based approaches. As a result, community-based approaches can benefit the educated more than they benefit the less educated.

In conclusion, the effects of diabetes on visual impairment seem to be quite well disclosed by the research quoted even if the scope of the research and the number of samples are limited. However, one can find a crucial implication of the research: the visual impairment from diabetes unevenly affects those with diabetes. In particular, women in their older age as well as in poverty appear to be most vulnerable. Considering that diabetes can be prevented in some cases and that its complications can be delayed in their early stage, a reasonable solution to this matter might be improving the healthcare system so that it can provide better outreach to poor communities. Despite advanced medicine, healthcare system in many countries fail to address the needs of the poor. It benefits the rich and punishes the poor, for example the healthcare system of the United States. Fixing the healthcare system is far from an individual matter of choice, but a collective issue that can only be resolved politically. Therefore, further studies should be directed towards the political economy of diabetes.

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