Causes of Visual Impairment and Blindness in a Clinic Population from Puerto Rico

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Objective: This study aimed to investigate the leading causes of visual impairment (VI) and blindness in a low vision clinic from Puerto Rico and to assess the distribution of low-vision devices and rehabilitation approaches prescribed to patients.

Methods: A retrospective cross-sectional health record study of patients evaluated at the Low Vision Clinic from the Interamerican University of Puerto Rico School of Optometry Eye Institute between 2007 and 2024 was performed. Subjects considered had a comprehensive visual examination followed by a low vision evaluation. Ocular history, causes of visual loss, best-corrected visual acuity, and non-conventional optical devices prescribed were recorded. VI and blindness were classified according to the United States' definitions.

Results: A total of 270 records of subjects older than four years of age were included. The most prevalent causes of VI and blindness were retinal dystrophy (14.8%), diabetic retinopathy (13.7%), and albinism (13.0%). The most common causes of VI by age group were albinism in the pediatric group (42.2%), retinal dystrophy in adults (24.0%), and cataracts (25.8) in the geriatric population. The predominant VI classification was moderate VI for 37.0%. The closed caption television system was the most common low-vision device prescribed to subjects (19.3%).

Conclusion: This study provided insights into the causes of VI and blindness in Puerto Rico. These findings underscore the need for targeted interventions and public health initiatives to improve accessibility to visual rehabilitation. Further research is warranted to explore additional factors influencing access to care and evaluate the effectiveness of interventions addressing VI in Puerto Rico.

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Key words: Visual impairment, Blindness, Hispanics, Low vision

Visual impairment (VI) and blindness are serious public health issues that negatively impact a person's quality of life (1). The World Health Organization estimates that 2.2 billion people worldwide are visually impaired or blind (2). In the United States, approximately 6 million people have VI, and 1 million are blind; of these, 1.6 million under 40 experience visual loss (3).

Visual impairment and blindness could have an impact on any life stage. Children with vision impairment may experience language, motor, and cognitive delays, affecting their school performance (5,6). In the adult and older population, loss of independence, well-being, and reduced quality of life can lead to economic, social, and psychological problems (1,6). The best approach for reducing the degree of disability associated with visual loss is to provide low-vision devices, assistive technology, and rehabilitation approaches to maximize residual vision (7).

In Puerto Rico, 6.6% of persons of all ages self-reported having a visual disability (8). Although the prevalence of sight-threatening diseases in Puerto Rico has been reported, it is important to understand which diseases lead to visual impairment and blindness (9). The current study aims to provide crucial information regarding the most common causes of visual loss and low vision management options in a clinic population to promote the development of successful rehabilitation strategies. This data can also be used for future studies on the visual characteristics and services necessary to improve the quality of life and independence of those with visual loss in Puerto Rico.

Methodology

A retrospective cross-sectional study determined the leading causes of visual impairment in patients who visited the Inter-American University of Puerto Rico School of Optometry Low Vision and Visual Rehabilitation specialized clinic from 2010 to 2024. A record file review of patients older than four was performed; these records were retrieved by systematic simple random selection from the clinic's electronic health records repository using the CPT codes 25601 and 25602. The age, gender, medical history, and the reported primary cause of visual impairment and blindness were retrieved. During the registration process, each patient received and signed a permission and use of information authorization form. Ethical approval was obtained from the Inter-American University of Puerto Rico Institutional Review Board (#1110090-1).

The best corrected visual acuity (BCVA) from each eye was obtained from the subjective refraction in each eye using an Early

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Treatment Diabetic Retinopathy Study (EDTRS) chart at 4m. If a participant could not read the chart at 4m, the refraction and visual acuities were obtained at 1m. A semiquantitative estimate of BCVA (hand motion, light perception, and no light perception) was obtained for those who could not read the letters at 1m. The LEA numbers chart was used for illiterate participants or those unable to read the standard chart.

Definitions of visual impairment, low vision, and blindness are used to classify persons with visual loss. There are no universally accepted terms for VI or low vision. For that reason, they will be used interchangeably in this manuscript. The visual acuities were further classified using the United States BCVA as worse than 20/40 (6/12 metric) in the better-seeing eye but better than 20/400 (6/120). Mild visual impairment (MVI) is categorized as BCVA from 20/40 to 20/63, moderate (MSVI) from 20/70 to 20/160, and severe 20/200 to 20/400. Profound vision impairment or blindness as a BCVA of 20/400 or worse in the better-seeing eye (7). Legal blindness is a definition that has some value for rehabilitation and is significant in determining the eligibility of certain disability benefits from the federal government. In the US, legal blindness is defined as visual acuity with the best correction worse or equal to 20/200 in the Snellen and 20/100 or worse in the EDTRS chart (7). Although peripheral visual field evaluation is considered in the definition of blindness, this criterion was excluded from the study due to the variability of techniques for quantifying a person with a visual impairment.

Each electronic health record chart was reviewed for the type of non-conventional optical devices (i.e., magnifiers, telescopes), assistive technology (i.e., APPS, tablets), and other rehabilitative approaches recommended at the low vision evaluation visit (i.e., filters, prisms, orientation, and mobility). Charts with incomplete demographic data of BCVA in either eye, causes of visual loss not diagnosed by a licensed eye care provider, and blindness by visual field defects due to testing variability were excluded from the study.

For statistical analysis, the visual acuity was converted to the logarithm of the minimal angle resolution (logMAR) score. Descriptive statistics with their means ± standard deviation (SD) was used for continuous variables. Proportions were calculated using the Chi-square ($\chi 2$) and Pearson's test with a 95% confidence interval for categorical variables as appropriate. For further analysis, ages were subdivided into the pediatric group (0 - 18), adults (19 – 64), and geriatric (65 and older) years and gender female and males (F/M). Furthermore, VI was defined as a visual acuity higher than 0.30 but less than 1.29 logMAR and blindness with a logMAR higher than 1.30. The most common causes of VI and blindness were classified by their anatomical structure. Spearman correlation analysis was used to determine the relationship between the visual acuities of the right and left eyes. The right eye visual acuity was utilized since both eyes were correlated (r = 0.54, p = <0.001). A p-value of less than 0.05 was considered significant, and all statistical analyses were conducted using IBM SPSS Statistics for Windows, version 29 software.

Results

A total of 270 subjects were eligible for the study. The age range was from 4 to 99, averaging 46.8 ± 29.1 (95% CI: 43.6 – 50.2) years. When subdivided into groups, pediatrics accounted for 30% (95% CI: 24.4 – 35.2%), adults 37% (96% CI: 31.5 – 42.6%), and geriatrics 33% (95% CI: 27.8 – 38.5%) of the sample. Gender distribution for males was 54.4% (95% CI: 4.0 – 51.9%) and 45.6% (95% CI: 48.1 – 60.0%) for females, as shown in Table 1.

The mean best corrected visual acuity was 1.06 ± 0.64 (95% CI: 0.99 - 1.13) logMAR, a Snellen equivalent of approximately 20/230. The distribution of those with VI and blindness is available in Table 2. The distribution of VI classifications was for

Table 1. Distribution of the sample by age groups and gender

Age Ranges (Years)	Total (N=270) Percent (n)	95% CI	Females (N=123) Percent (n)	95% CI	Males (N=147) n (%)	95% CI
0-9	8.5 (23)	5.2 – 11.9	6.5 (8)	2.4 – 11.4	10.2 (15)	5.4 – 15.6
10-19	22.6 (61)	17.8 – 27.4	22.8 (28)	16.3 – 30.9	22.4 (33)	16.3 – 29.9
20-29	8.1 (22)	5.2 – 11.5	9.8 (12)	4.9 – 15.4	6.8 (10)	3.4 – 11.6
30-39	3.0 (8)	1.1 – 5.2	3.3 (4)	0.8 – 6.5	2.7 (4)	0.7 – 5.4
40-49	4.4 (12)	1.9 – 7.0	3.3 (4)	0.8 - 6.5	5.4 (8)	2.0 – 9.5
50-59	12.2 (33)	8.5 – 16.3	10.6 (13)	5.7 – 16.3	13.6 (20)	8.2 – 19.0
60-69	12.6 (34)	8.9 – 16.7	13.0 (16)	7.3 – 19.5	12.2 (18)	6.8 – 17.7
70 +	28.5 (77)	23.0 – 33.7	34.1 (38)	22.8 – 39.8	26.5 (39)	19.0 – 33.3
Age groups (Years)						
< 18	30.0 (81)	25.2 – 35.6	28.5 (35)	20.3 -36.6	31.3 (46)	23.8 – 38.8
19 to 64	37.0 (100)	31.5 – 42.2	35.8 (44)	27.6 – 43.9	38.1 (56)	30.6 – 46.3
> 65	33.0 (89)	27.8 – 38.9	35.8 (44)	27.6 – 44.7	30.6 (45)	22.4 – 38.1

Table 2. Distribution of low vision and blindness by age group

Age Groups	Low Vision < 20/40 to > 20/200 Percentage (n)	95% CI	Blindness ≤ 20/200 Percentage (n)	95% CI	p value
Less than 18	64.2 (52)	54.3 – 74.1	35.8 (29)	25.9 – 45.7	0.010
19-64	42.0 (42)	32.0 – 52.0	58.0 (58)	48.0 – 58.0	0.11
Older than 65	48.3 (43)	37.1 – 58.4	51.7 (46)	41.6 – 62.9	0.75
Total	50.7 (137)	44.1 – 56.7	133 (42.9)	43.3 – 55.6	0.80

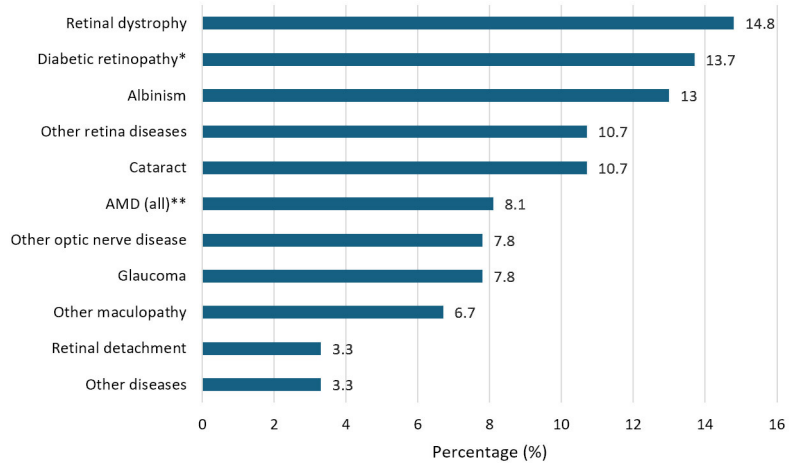
MVI 13.7% (95% CI: 10.0 – 17.8%), MSVI 37.0% (95% CI: 31.5 – 43.0%), severe VI 30.4% (95% CI: 24.8 – 35.9%), and for profound VI or blindness 18.9% (95% CI: 11.1 – 27.8%).

Low vision and blindness distribution by age range is also available in Table 2. When age groups were compared, there was a significant difference between low vision and blindness only in the pediatric group (Table 2). When VI categories were analyzed by age groups, although there was no significant difference ($\chi 2 = 14.86$; $p = 0.137$), MSVI was more likely in the 0-18 year group with 48.1% and those older than 65 with 33.7%. Severe VI was found more frequently in the 19-64 age group by 40.0%. There was no significant difference between genders ($\chi 2$: 0.15, $p = 0.72$); nonetheless, males experienced higher frequency MSVI (38.8%) and severe VI (32.0%) than females (35.0% and 28.5%), respectively.

Figure 1 shows the distribution of the main causes of visual loss. Retinitis pigmentosa was the most common retinal dystrophy in the sample, accounting for 87.5% of the cases. The most frequent causes of low vision were albinism and retinal dystrophy for blindness (Table 3). Albinism accounts for the most common cause of visual impairment in the group of 0 to 18 years (9.6%), retinal dystrophy (8.9%) in the 19 to 63-year group, and cataracts (8.5%) in those older than 65 years (Table 4). In males, albinism and retinal dystrophy were the most common causes of visual loss by 8.1%, respectively, and in females, retinal dystrophy was more common by 6.8%.

From the sample, of those with visual loss, 54.4% were prescribed some type of low-vision device. For the remaining 45.3%, the traditional visual correction was indicated. In other cases, the patients were not interested in or qualified for optical devices. The most common low-vision devices prescribed are available in Figure 2.

Figure 1. Frequency of the most common causes of visual impairment in the sample



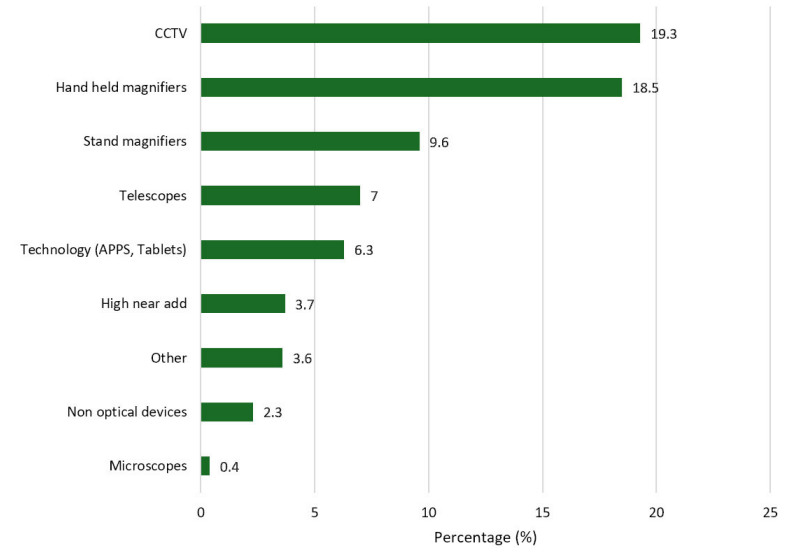
*Includes no proliferative and proliferative diabetic retinopathy.
**Includes dry and wet macular degeneration

Discussion

This retrospective study explored the leading causes of visual impairment in a specialized visual clinic in Puerto Rico. Because this study used retrospective clinical data, the prevalence of the most frequent causes of impaired vision and blindness may differ from that of the general Puerto Rican population. Although prior research investigated the prevalence of ocular disorders on the island, characteristics such as visual acuities, associated visual impairment, and visual rehabilitation approaches have never been documented in a population older than four years of age (9-12). This information is essential to creating public health initiatives, such as counseling and preventive measures, to lessen the burden of vision loss and provide appropriate interventions to improve the quality of life for persons with visual impairment.

It has been reported that persons with visual impairment have benefited from visual rehabilitation interventions to improve their quality of life (13). The average visual acuity in those referred for visual rehabilitation was poorer than in previous research. Brown et al. discovered a mean BCVA of 20/96 Snellen equivalent in

Figure 2. Distribution of the most commonly low-vision interventions prescribed



CCTV = closed-caption television. Other = Braille, text-to-speech, prisms, orientation, and mobility. Non-optical devices = Filters, enlargement, and typoscopes.

Table 3. Primary causes of low vision and blindness

Ocular disease	Low vision <20/40 to > 20/200 Percentage (n=137)	Blindness ≤ 20/200 Percentage (n=133)
Albinism	19.7 (27)*	6.0 (8)*
AMD	5.8 (8)	10.5 (14)
Cataracts	11.7 (16)	9.8 (13)
Diabetic retinopathy	13.9 (19)	13.5 (18)
Glaucoma	7.3 (10)	8.3 (11)
Retinal detachment	1.5(2)	5.3 (7)
Retinal dystrophy	12.4 (17)	17.3 (23)
Other optic nerve	7.3 (10)	8.3 (11)
Other maculopathy	6.6 (9)	6.8 (9)
Other retina	10.2 (14)	11.3 (15)
Other diseases	2.9 (4)	3.8 (5)

* P = 0.003 only for albinism. AMD = Age-related macular degeneration

a sample of persons with impaired vision; however, our study's mean BCVA was 20/230. This finding revealed that most patients referred to a low vision evaluation experience blindness by the US definition. Previous research has suggested that the late referral process has an impact on the timely provision of low-vision rehabilitation services; however, other factors, such as accessibility barriers, referral process challenges, out-of-pocket costs, lack of motivation, and acceptance by the visually impaired, have been reported to contribute to a person obtaining rehabilitation services. Additional research is needed to identify the challenges to accessing low-vision rehabilitation programs (14-17).

The Centers for Disease Control and Prevention estimated that in 2023, approximately 3% of children younger than 18 had a visual loss (18). Children with vision impairment face challenges in executing educational activities such as writing, reading, and moving around unfamiliar environments. It has been found that children with visual loss may benefit from low vision rehabilitation, which can assist the patient in using their residual vision efficiently (19-20). Our study found that moderate vision impairment was the most common type of visual loss in school-age children. This finding is of utmost importance because the BCVA is better than 20/200, consistent with other clinical investigations conducted in children with impaired vision. Given that the average letter print size is 20/50 (8pt font), a patient with moderate visual loss may be able to read with an appropriate low-vision intervention (20-21).

Most research on visually impaired persons focuses on inherited and age-related ocular diseases, with scarce information available regarding young adults with VI. Young adults with VI have irreversible or progressive visual disorders that may impact their transition from school to employment. Visual impairment has been reported to affect young adults in work-related activities, social skills, well-being, and daily living activities (22-26). In this study, most people aged 18 to 64 who visited a low-vision clinic experienced severe visual impairment. It is difficult to compare our findings to previous research because data on the classification of vision loss in the young population is scarce. Nonetheless, more research is needed to explore this age group's visual characteristics and needs.

It has been reported that visual impairment and blindness increase because of age-related sight-threatening diseases (27-28). Our results demonstrated moderate VI was the most common classification of visual loss in those older than 65. Although caution should be exercised in this clinic-based study, the findings could be ascribed to a lack of accessibility for a low vision evaluation, mainly because it is not covered by Medicare or any other medical insurance, challenges with the referral process, and a lack of motivation. When comparing genders, there was no significant difference between males and females; however, VI was more common in males. It has been documented that women are more likely to seek healthcare services than men due to many comorbidities, which become more common with older age (29-30). This demographic information provides an opportunity to develop campaigns to raise awareness among males about the importance of a visual evaluation for early detection of sight-threatening visual problems.

Albinism was the most common underlying cause of low vision. In Puerto Rico, the most prevalent type of albinism is Hermansky-Pudlak, which includes oculocutaneous and ocular albinism, with a prevalence of 2.01 for every 10,000 live births (31-32). Persons with albinism have high refractive errors, foveal hypoplasia, and nystagmus, contributing to visual loss. In our study, the mean visual acuity in those with ocular or oculocutaneous albinism was 0.76 +/- 0.23 logMAR (20/115 Snellen equivalent). These persons could improve their functional vision with appropriate low-vision evaluation and management.

The most common cause of blindness was inherited retinal dystrophy, with retinitis pigmentosa being the most prevalent. The condition's prevalence in Puerto Rico is 0.4%, with an autosomal recessive mutation as the most common trait (10, 33). Patients with retinitis pigmentosa could experience decreased visual field,

Table 4. Primary causes of visual impairment by age groups

Ocular disease	Less 18 Percentage (n=81)	19-64 Percentage (n=100)	Older 65 Percentage (n=89)
Albinism	32.2 (26)	9.0 (9)	0 (0)
AMD	0 (0)	2.0 (2)	22.5 (20)
Cataracts	3.7 (3)	3.0 (3)	25.8 (23)
Diabetic retinopathy	0 (0)	20.0 (20)	19.1 (17)
Glaucoma	4.9 (4)	6.0 (6)	12.4 (11)
Retinal detachment	1.2 (1)	6.0 (6)	2.2 (2)
Retinal dystrophy	17.3 (14)	24.0 (24)	2.2 (2)
Other optic nerve	12.3 (10)	7.0 (7)	4.5 (4)
Other maculopathy	4.9 (4)	10.0 (10)	4.5 (4)
Other retina	18.5 (15)	11.0 (11)	3.4 (3)
Other diseases	3.7 (3)	3.0 (3)	3.4 (3)

AMD = Age-related macular degeneration

nyctalopia, and photophobia (10). The visual acuity of those with retinal dystrophy in the study was 1.00 +/- 0.46 logMAR (20/200), similar to a previous study performed in Puerto Rico (10).

Furthermore, when the causes of visual loss in the sample were studied by age, albinism was the most common in the children's group, followed by inherited retinal dystrophy in the 19-64 age group. Cataracts were the most common cause of visual impairment in the older population. The prevalence of cataracts in Puerto Rico was estimated at 22.1% in persons older than 40 years, similar to results from other studies (9,27,34-35). Visual loss was substantially worse in older adults than in younger groups with a BCVA of 1.10 +/- 0.86 logMAR (20/251 Snellen), which requires a higher magnification to read the standard print size (20/50 Snellen). In Puerto Rico, most persons older than 65 are beneficiaries of Medicare; it has been reported that although the surgery is covered, there are associated expenses that are sometimes unaffordable by this population (36). Other possible causes are patient motivation, accessibility, and contraindications (37).

Near-low vision devices were the most prescribed equipment for near-point-related tasks. Reading was the most common goal for those attending the low vision evaluation. The prescription of low-vision devices depends on the patient's goals, residual vision, and cognitive ability to manage the non-conventional optical equipment. The digital closed circuit television system (CCTV) was the most recommended equipment since it offers greater magnification, various contrast settings, and a larger field of view depending on the monitor size. These features provide school-age children with a better reading speed than other devices. Nonetheless, one of the disadvantages of CCTV systems is their high price and lack of portability in certain styles (38).

Hand-held magnifiers were the second most prescribed equipment among adults and the elderly because of their affordable price and accessibility. Although hand-held magnifiers are routinely prescribed, the device's downsides include a limited field of view with high magnification, variable illumination sources, and difficulty using the device by persons with tremors. There are many non-conventional optical devices for persons with visual loss. With the advancement of technology, numerous resources are available for the visually impaired. Smartphones and tablets are popular electronic devices that can be used in the patient rehabilitation process. Numerous APPS available in various marketplaces can provide magnification, enhanced contrast, and text-to-speech, among other features, at a low cost, with ease of use and portability (39). Other APPS help the visually impaired with daily activities like color and money identification, GPS for navigation and mobility, and object recognition. Although this concept is relatively new, it has been used more frequently in rehabilitation (40). In this study, many APPS were recommended for those under age 65, with the primary objective of magnifying letters or images. The most typical obstacle when using this new tool involves installing the app on an electronic device and the cost of some applications. Overall, it is an excellent resource for the visually impaired.

Conclusions

Visual impairment (VI) and blindness pose significant challenges to individuals across all age groups and substantially affect their quality of life. The study's findings revealed that a considerable proportion of individuals in Puerto Rico experienced VI or blindness, with retinitis pigmentosa, albinism, and cataracts as the most common conditions affecting vision. Additionally, disparities in access to low-vision devices and rehabilitation services were highlighted, indicating the need for improved accessibility and awareness campaigns.

Furthermore, the study emphasized the importance of early detection and intervention in mitigating the impact of VI, particularly in children and young adults transitioning into adulthood. Implementing public health initiatives and preventive measures tailored to the specific needs of this population can help alleviate the burden of vision loss and improve overall outcomes.

Overall, the findings underscore the necessity of developing targeted rehabilitation strategies and fostering collaboration among healthcare providers and the community to enhance the quality of life and independence of individuals with visual impairment. Further research is warranted to explore additional factors influencing access to care and to evaluate the effectiveness of interventions aimed at addressing visual impairment and blindness in this population.

Resumen

Objetivo: Investigar las principales causas de discapacidad visual (DV) y ceguera en una población clínica en Puerto Rico, los dispositivos de baja visión y las intervenciones rehabilitación más recetados. Métodos: Se realizó un estudio retrospectivo transversal de expedientes de pacientes evaluados en la Clínica de Baja Visión del Instituto del Ojo de la Escuela de Optometría de la Universidad Interamericana de Puerto Rico entre el periodo del 2007 al 2024. Los sujetos considerados obtuvieron una evaluación visual completa seguida de una de baja visión. Se recopilaron las causas de DV, agudeza visual mejor corregida y dispositivos no convencionales recetados. Se utilizaron las clasificaciones de visión baja y ceguera según las definiciones de Estados Unidos. Resultados: Se incluyeron 270 expedientes de sujetos mayores de cuatro años. Las causas más prevalentes de DV fueron la retinitis pigmentaria (14.8%), retinopatía diabética (13.7%) y albinismo (13.0%). Las causas más comunes de DV por grupo de edad fueron el albinismo (42.2%) en el grupo pediátrico, retinitis pigmentaria (24.0%) en adultos y cataratas (25.8%) en la población geriátrica. DV moderada fue la más común con el 37.0%. El sistema de televisión de circuito cerrado fue el dispositivo de baja visión más recetado (19.3%). Conclusión: Este estudio proporcionó información sobre las causas de DV en Puerto Rico. Estos hallazgos subrayan la necesidad de intervenciones e iniciativas de salud pública para mejorar la accesibilidad a la rehabilitación visual. Se necesitan más estudios para explorar factores adicionales sobre el acceso y la efectividad de las intervenciones para las personas con DV en Puerto Rico.

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