



A Systematic Review: What is the Normative Size of the Blind Spot Scotoma in Adults?

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Author's contribution

This work was carried out by the author MJR. Author MJR read and approved the final manuscript.

Others Article

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ABSTRACT

Background: Blind spot enlargement can be caused by a range of medical conditions and monitoring the size of the blind spot scotoma can indicate progression of disease.
Objectives: The aim of this review is to establish the size of the blind spot scotoma in adults free of ocular pathology in order to aid identification of any scotoma enlargement.
Search Methods: The following electronic databases were searched; Ovid Medline, Ovid SP, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Embase, Google Scholar and the Cochrane Central Library.
Searches were then conducted of the following individual journals; British Medical Journal, British Journal of Ophthalmology, Journal of Neurology, European Journal of Neurology, Archives of Ophthalmology, American Academy of Ophthalmology, Ophthalmology, Brain, and Eye.
Selection Criteria: No study designs were to be excluded. Few relevant articles were found and so no publication timeframes were imposed.
Results: The identified literature is reviewed and discussed in relation to the equipment used to measure the size of the blind spot scotoma. The equipment used to measure the blind spot scotoma included; Tangent Screen, Goldmann, Tubingen Computer Campimeter, Stereo-campimeter and Ferree-Rand. This review found the size of the blind spot scotoma to be dependent on the method used to measure it.
Conclusion: Clinicians need to have accurate information on the instruments they use to successfully monitor changes in the size of the blind spot scotoma. Further research

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needs to be conducted using clinically relevant equipment, such as the Octopus 900 which allows clinicians to move the kinetic stimulus at a constant speed and account for the patient's reaction time.

Keywords: Perimetry; blind spot; scotoma; visual fields; papilloedema.

1. BACKGROUND

The Blind spot anatomically named the Punctum Caecum, is medically defined as “a small area of the retina of the eye where the nerve fibres from light-sensitive cells lead into the optic nerve. There are no rods or cones in this area and hence it does not register light.” [1] This area visible through inter-ocular viewing is known as the optic disc. The optic disc creates an area of absent vision that will be referred to in this study as the blind spot scotoma. The optic disc can vary in size from small (hypoplasia) to the large (megalopapilla) and as a result create variation in the size of the blind spot scotoma.

Blind spot enlargement can be caused by a range of medical conditions including; multiple evanescent white spot syndrome (MEWS) [2], Glaucoma [3,4], peripapillary retinal pathologies (including myopic degeneration) [5], Papillitis and papilloedema. Papilloedema should alerts clinicians to investigate for raised intracranial pressure, causes vary from; space-occupying lesions, blockage of the ventricular system, obstruction of cerebrospinal fluid (CSF) absorption, diffuse cerebral oedema, severe hypertension, idiopathic intracranial hypertension (IIH) and hyper-secretion of CSF [6,7].

Monitoring the size of the blind spot scotoma can indicate progression of disease [8]. Initially patients may not notice a central scotoma however as the blind spot expands it can affect their central vision. “It is important to appreciate that uncontrolled raised intracranial pressure and persistent papilloedema can result in blindness” [9].

1.1 Aims

In order to monitor the change in size of the blind spot it is essential to know the average size of this scotoma in normal subjects. The primary aim of this review is to establish the size of the blind spot scotoma in adults free of ocular pathology in order to aid identification of any scotoma enlargement.

2. METHODOLOGY

This review follows a systematic approach. Fink [10] described a Research literature review as “a systematic, explicit and reproducible method for identifying, evaluating, and synthesizing the existing body of completed and recorded work produced by researchers, scholars, and practitioners”.

2.1 Eligibility Criteria

Although no study designs were to be excluded, Greenhalgh's hierarchy of evidence was used to prioritise study design [11]. Systematic reviews were prioritised followed by;

Randomised controlled trials, Cohort studies, Case-control studies, Cross-sectional surveys and then Case reports.

All English language and foreign language publications were included, foreign language publications that could be translated into English through available resources were then included in the literature review. Few relevant articles were found so no publication timeframes were imposed. The entire catalogues of publications for each database were searched the most recent studies prioritised. Only studies monitoring human subjects were included.

2.2 Search Strategy

The research question was broken down into components that were then used to systematically search each database [12]. These key components were then searched using the advanced search functions of the following databases; Ovid Medline, Ovid SP, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Embase, Google Scholar and the Cochrane Central Library.

Searches were then conducted of the following individual journals; British Medical Journal, British Journal of Ophthalmology, Journal of Neurology, European Journal of Neurology, Archives of Ophthalmology, American Academy of Ophthalmology, Ophthalmology, Brain (a journal of neurology), and Eye (The Royal College of Ophthalmologists).

Boolean operators along with Medical Subject Heading's (MeSH) were used to widen the search and pinpoint the articles most relevant to the literature review question. Once relevant articles were found their references were screened and any articles relevant to the review question were investigated.

Unpublished data was also searched, to obtain this grey literature a variety of sources were reviewed. The manufactures of current field analysers were contacted for technical reports. Specialists in the field were contacted and research in progress was discussed. Lectures, seminars and tutorials were requested from Sheffield University and a search of unpublished dissertations and thesis was conducted using the "Networked Digital Library of Theses and Dissertations" [13].

The keywords used in this search were; adults (MeSH 18 years and over), humans, male, female, blind spot (MeSH optic nerve head, scotoma, optic papilla), blind spot size, blind spot area, perimetry, visual field.

2.3 Study Selection

Once duplicates had been removed, a refined literature search showed a total of sixty-four potential articles. The titles and abstracts were then matched against the protocol exclusion criteria (see appendix I). Of these sixty-four articles twenty-one were selected for a full text review.

From these twenty-one articles fifteen did not provide relevant information to answer the research question these were excluded from the review but kept for future reference. Seven articles remained; five prospective cohort studies and two text-books. A Prisma Flow Diagram [14] is included to aid visualisation of the search process (Fig. 1).

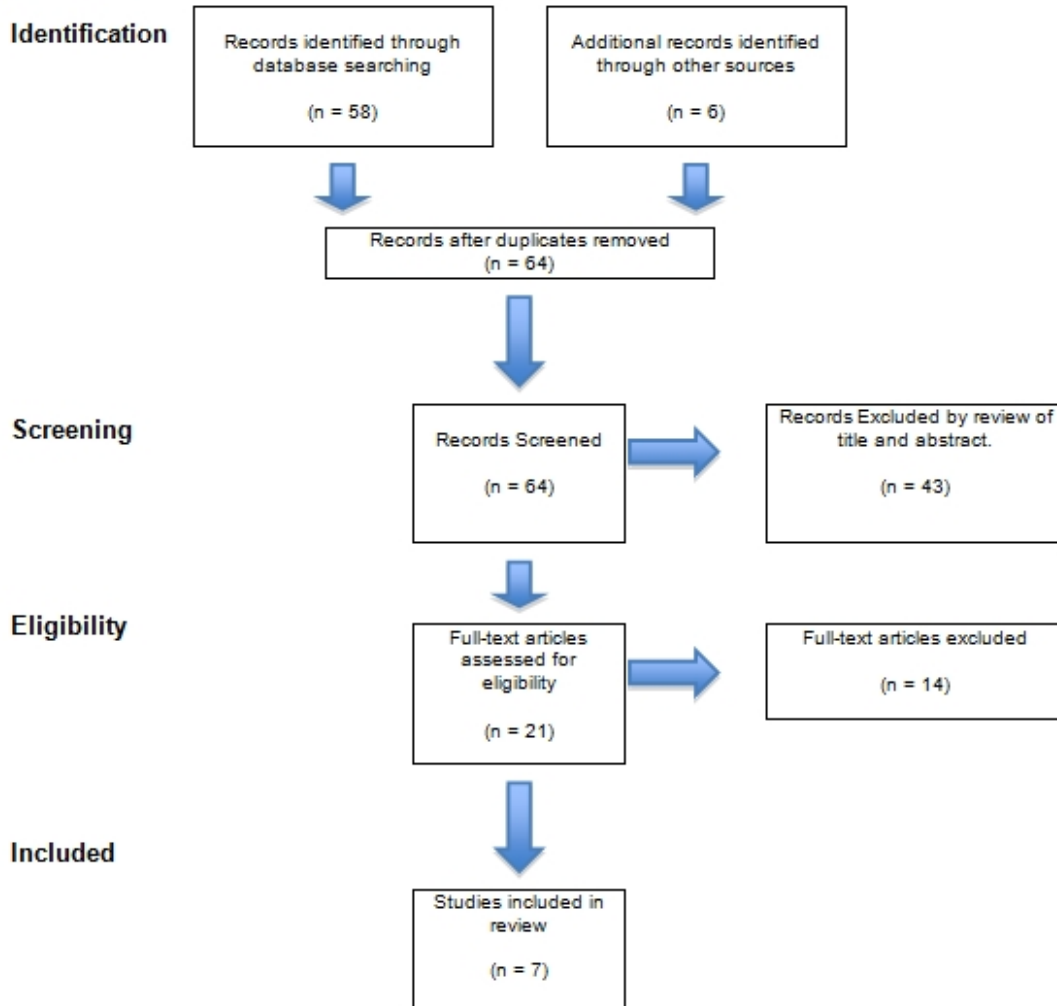


Fig. 1. Prisma flow diagram

2.4 Quality Assessment

It is essential to assess both the internal validity (bias of the study) and external validity (the amount to which trial results can be applied to other circumstances) of each of the included studies. To quality assess the selected articles a Centre of Evidence Based Medicine (CASP) score will be allocated to each study using the appropriate tools from the CASP website [15]. Where possible a risk of bias table highlighting each study's strengths and weaknesses will be made following the examples set by 'The Cochrane Collaboration's tool for assessing risk of bias' [16].

3. DESCRIPTION OF STUDIES

3.1 Design and Methods

This literature review consisted of five prospective studies and two statements from specialist textbooks. The sample population of the prospective studies, Armaly [17], Chamlin [18], Wentworth [19] and Hopkins [20] consisted of a cohort of 'normal patients', all were conducted in the United States of America with the exception of Dolderer [21] who conducted his study in Germany, subject ethnicity was not recorded.

Armaly [17] reported a sample population of 210 patients (105 male and 105 female), between the ages of 20-65 years. Only one eye was studied from each subject. All subjects had to have a visual acuity measure of 6/6 or better and a normal ophthalmic examination. Subjects were excluded if they had had any ocular complaint or had a glasses prescription of over one-dioptre spheres of myopia or hypermetropia, likewise if any astigmatism was found of over half a dioptre they were excluded.

Chamlin [18] studied eighty-nine eyes from a total of forty-five hospital personnel. The ages were not mentioned. All subjects recorded a visual acuity 6/7.5 or better. Any subject with any evidence or history of fundus disease or disease related to change in the blind spot were excluded.

Wentworth [19] studied an assortment of nurses, patients and medical staff aged between 14-55 years, no information regarding gender was provided. Two hundred subjects achieving 6/6 vision were chosen, any having 'eye pathology' or 'systemic disease' were not allowed to participate.

Hopkins [20] studied a population of 100 private patients, the age and gender of these patents were not reported. Hopkins stated that the patients were of normal ocular findings, however he did not list any exclusion criteria.

Dolderer [21] studied a prospective cohort of 20 young healthy volunteers, 5 female and 15 male aged between 20-34 years. All had been considered normal on a detailed ophthalmological examination. Prescriptions exceeding $\pm 4D$ spherically or $\pm 2D$ cylindrically were excluded.

Harrington [22] and Traquair [23] produced clinically renowned text books on the visual field, both providing information on the size and location of the visual blind spot. No research study, sample population or methodology is provided to account for this information.

Each study used different methods to obtain their data most notably the variation in the tools used to measure the blind spot. Armaly [17] used two visual perimeters, both the 1m Tangent Screen with a 1mm target and the Goldmann with a I2e target. Chamlin [18] also used a 1m Tangent screen with a 1mm target, then a 2m Tangent screen with a 2mm target. Wentworth [19] used only a Ferree-Rand perimeter with a 5.8mm target, whilst Hopkins[20] used a Steriocampimeter with a 0.68/190mm white target. Dolderer [21] used the Tübingen Computer Campimeter (TCC) using targets equating to the Goldmann stimulus II2e and III2e, they then varied the targets luminosity. Neither Harrington [22] nor Traquair [23] stated the perimeters upon which their measurements of the blind spot scotoma come from.

An overview of the study characteristics can be displayed in Table 1.

Table 1. Summary of study characteristics

Author, Year and Country	Study Design	Sample population	Sample Size and Selection	Perimeter (target)	Inclusion	Exclusion
Wentworth (1931) USA Phila- delphia	Prospective cohort	14-55 years nurses, patients, health care assistants.	N = 200 M? F?	Ferree-Rand With 30 degree Tangent Screen (5.8mm target)	20/20 VA or better	Any eye pathology or Systemic disease
Hopkins (1941) USA Brooklyn	Prospective cohort	Age not reported Private Patients	N = 100 M? F?	Stereo-campimeter (white targets 0.68/190m)	Normal patients	Not reported
Traquair (1948) Chamlin (1960) USA New York	Text book Prospective cohort	Not reported Age not reported Hospital personnel	Not reported N= 45 (89 eyes) M? F?	Not reported 1m Tangent (1mm Berens) & 2m Tangent (2mm Berens)	Not reported 20/25 VA or better	Not reported No evidence or history of fundus disease or disease related to change in the blind spot Any ocular complaint
Armaly (1969) USA Iowa City	Prospective cohort	Age 20-65yrs	N = 210 M = 105 F = 105	1m Tangent Screen (1/1000) & Goldmann (I2e)	20/20 VA or better Normal ocular examination	Ammetropia >1 diopter Astigmatism >0.5 diopter Not reported
Harrington (1976) Dolderer (2006)	Text book Prospective cohort	Not reported 20-34 years Healthy volunteers	Not reported N=20 M =15 F=5 (two excluded)	Not reported Tubingen Computer Campimeter	Not reported Normal ocular findings	Prescription exceeding $\pm 4DS$ or $\pm 2DC$ History of eye trauma

3.2 Study Bias

Study design quality varied both in terms of methodology and reporting. Table 2 displays the risk of bias for each study, 'The Cochrane Collaboration's tool for assessing risk of bias' (Cochrane Collaboration, 2012) was used to create a table appropriate for this review. The final column displays a CASP score, this was determined using the appropriate CASP checklist [15]. The checklist was scored out of 12 with the CASP scores being further broken down into three categories; 'good', 'can't tell' and 'negative' to further highlight the studies quality.

Table 2. Bias summary, including CASP weighting

	Study design	Recruitment (Selection bias)	Outcome measured to avoid bias (Performance and detection bias)	Can the results be applied to the general population (External validity)	CASP point score (+ = good ? = can't tell - = negative)
Wentworth (1931)	+	+	+	-	+ = 10 ? = 1 - = 1 10/12
Hopkins (1941)	+	-	+	-	+ = 7 ? = 3 - = 2 9/12
Traquair (1948)	?	?	?	?	+ = 0 ? = 12 - = 0 0/12
Chamlin (1960)	+	+	+	-	+ = 9 ? = 1 - = 2 9/12
Armaly (1969)	+	?	+	-	+ = 9 ? = 2 - = 1 9/12
Harrington (1976)	?	?	?	?	+ = 0 ? = 12 - = 0 0/12
Dolderer (2006)	+	+	+	-	+ = 10 ? = 1 - = 1 10/12

+ = low risk of bias; ? = unclear risk of bias; - = high risk of bias.

The prospective studies, Armaly [17], Chamlin [18], Wentworth [19], Hopkins [20] and Dolderer [21] asked clearly focused questions and each had a clear measured outcome.

Wentworth [19] clearly specified its population recruiting both staff and patients. Hopkins [20], Chamlin [18] and Dolderer [21] all used convenience sampling; with Hopkins [20] opting for a group of private patients and Chamlin [18] recruiting hospital personnel. Armaly [17] failed to accurately describe its recruitment strategy, as did Harrington [22] and Traquair [23] the later two failing to provide any methodology in which to gauge study bias.

The authors of the prospective studies used sound methods in order to limit performance and observer bias to the best of their ability. The results however cannot be easily related to

the general population, as the instruments used to obtain these measurements are no longer manufactured or seen in active service in ophthalmology clinics.

4. SYNTHESIS OF FINDINGS

Each study used a different but acceptable method to measure the size of the blind spot scotoma. The articles; Armaly [17], Chamlin [18], Wentworth [19], Hopkins [20], Harrington [22] and Traquair [18] measured both the height and the width of the blind spot scotoma, Wentworth [19] also provided the area of the blind spot scotoma. Dolderer [21] measured only the area in degrees². A summary of the results can be found in Table 3.

Table 3. Summary of Study Results

Author, Year and Country	Results																		
Wentworth (1931) USA Philadelphia	Area: 11.4sq cm (range 6.8-17.5 sq cm) (mean deviation of 1.6 sq cm) Width: 3.16cm (2.4-4.3cm range) (Mean deviation of 0.30) Height: 4.56cm (3.6-5.6cm range) (Mean deviation of 0.38)																		
Hopkins (1941) USA Brooklyn	Width of blind spot : 25.8mm Height above horizontal fixation point : 7.3mm Height below horizontal fixation point : 19.6mm																		
Traquair (1948)	<i>"In width it measures approximately 5.5 degrees and in height 7.7 degrees. Its centre lies about 15.5 degrees to the lateral side of the fixation point and 1.5 degrees or slightly more below the horizontal meridian, so that two thirds of its vertical diameter lie below the horizontal meridian."</i>																		
Chamlin (1960) USA New York	1m Tangent Screen Average height: 7.15±0.39 tangent degrees (138.69±8.78mm) (error 5.5%) Average width: 6.75±0.37 tangent degrees (129.4±7.88mm) (error 5.5%) 2m Tangent Screen Average height: 7.43±0.37 tangent degrees (281.77±14.53mm) (error 5.0%) Average width: 6.87±0.34 tangent degrees (260.7±13.27mm) (error 4.9%)																		
Armaly (1969) USA Iowa City	<table border="1"> <thead> <tr> <th></th> <th>R (n=106)</th> <th>L (n=104)</th> </tr> </thead> <tbody> <tr> <td></td> <td colspan="2"><i>Mean (degrees) with standard deviation of the mean.</i></td> </tr> <tr> <td></td> <td>Tangent Screen 1/1000</td> <td>Height:10.8±0.13 Width:7.9±0.11</td> </tr> <tr> <td>EXAM 1</td> <td>Goldmann 12e</td> <td>Height:14.9±0.18 Width:10.2±0.11</td> </tr> <tr> <td></td> <td>Tangent Screen 1/1000</td> <td>Height: 10.0±0.13 Width:7.0±0.10</td> </tr> <tr> <td>EXAM 2</td> <td>Goldmann 12e</td> <td>Height:13.4±0.19 Width:9.4±0.17</td> </tr> </tbody> </table>		R (n=106)	L (n=104)		<i>Mean (degrees) with standard deviation of the mean.</i>			Tangent Screen 1/1000	Height:10.8±0.13 Width:7.9±0.11	EXAM 1	Goldmann 12e	Height:14.9±0.18 Width:10.2±0.11		Tangent Screen 1/1000	Height: 10.0±0.13 Width:7.0±0.10	EXAM 2	Goldmann 12e	Height:13.4±0.19 Width:9.4±0.17
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EXAM 2	Goldmann 12e	Height:13.4±0.19 Width:9.4±0.17																	
Harrington (1976)	<i>"The normal blind spot is remarkably constant in position and size. It is vertically oval with steep edges. Its centre is located 15.5 degrees temporal to fixation and 1.5 degrees below the horizontal meridian. It is 5.5 degrees wide and 7.5 degrees high."</i>																		
Dolderer (2006)	Area with III2e = 26deg ² Area with II2e = 31deg ²																		

Armaly [17] found the Goldmann to measure the size of the blind spot scotoma as larger than that found on the Tangent screen. Sizes were similar when comparing both the right and left eye. Armaly [17] concluded that each test has its own limits and that you could not compare the results of the Tangent screen with that of the Goldmann, see Table 3.

Chamlin [18] measured the size of the blind spot scotoma with both the 1m and 2m tangent screens. With the 1m Tangent screen the scotoma height was measured as 7.15 ± 0.39 tangent degrees (138.69 ± 8.78 mm) and its width 6.75 ± 0.37 tangent degrees (129.4 ± 7.88 mm). Using the 2m Tangent screen they found the height of the blind spot scotoma to measure 7.43 ± 0.37 tangent degrees (281.77 ± 14.53 mm); its width 6.87 ± 0.34 tangent degrees (260.7 ± 13.27 mm). Chamlin [18] found that the percentile error in the mean variant was slightly lower using the 2m Tangent screen, the 2m screen "...giving somewhat more constant and, therefore, more accurate results in measuring the actual size of the blind spot".

Wentworth [19] measured the size of the blind spot scotoma in centimetres upon the Ferre-Rand. The Average height was 4.56cm with a mean deviation of 0.38, its width 3.16cm with a mean deviation of 0.30. The mean area was 11.4 sq cm (mean deviation of 1.6 sq cm).

Hopkins [20] used the Stereocampimeter to measure the size of the blind spot scotoma and recorded a height of 26.9mm and a width of 25.8mm. No standard deviations were recorded.

Dolderer [21] had the advantage of using up-to-date technology, using the TCC they could correct for participants reaction times and move the stimulus target at a constant speed. Moving the targets at a speed of $2^\circ/\text{sec}$, Dolderer [19] found that the blind spot measured significantly smaller with the larger III2e target than the II2e target (26deg^2 and 31deg^2 respectively, 95%CI 5.0-64 deg^2). The study also found the area of the blind spot decreased in size with increasing stimulus intensity ($P < 0.001$).

Harrington [22] failed to specify the instruments and sample used to determine such results but recorded the size and location of the blind spot scotoma to be; *"The normal blind spot is remarkably constant in position and size. It is vertically oval with steep edges. Its centre is located 15.5 degrees temporal to fixation and 1.5 degrees below the horizontal meridian. It is 5.5 degrees wide and 7.5 degrees high."*

Traquair [23] lacked any reporting in terms of methodology but recorded the size and location of the blind spot scotoma as follows; *"In width it measures approximately 5.5 degrees and in height 7.7 degrees. Its centre lies about 15.5 degrees to the lateral side of the fixation point and 1.5 degrees or slightly more below the horizontal meridian, so that two thirds of its vertical diameter lie below the horizontal meridian."*

This review contained five prospective cohort studies and two abstracts from clinically renowned textbooks which measured blind spot scotoma. Although the studies for this literature review comprised of the best literature available they have limited clinical use due to the equipment used to measure the blind spot scotoma. Few reports were comprehensive in their details regarding recruitment and five out of seven failed to describe the sample population accurately.

All of the included studies provide information relative to the review question, showing the size of the blind spot scotoma in terms of height and width. All of the literature reports that

the scotoma measures taller than it does wide. Wentworth [19] and Dolderer [21] also recorded the area of the blind spot scotoma.

The results also reiterated Armaly's [17] conclusion that each test has its own limits and that you could not compare the results of one test with another. This point is further exemplified in the variety of units used to measure the blind spot scotoma, there has been no standard way of recording the scotoma. This review shows that clinicians need to have accurate information on the instruments they use to successfully monitor changes in the size of the blind spot scotoma.

5. DISCUSSION

Jonas [24] conducted a major review on the evaluation of the optic nerve head, describing the shape of the optic nerve head as "...being of a slightly vertically oval form, the vertical diameter being approximately 7-10% larger than the horizontal one". This blind spot shape corresponds to the literature reviews finding stating that the blind spot scotoma measures taller than it does wide. Hermann [25] measured the mean disc area of the optic nerve head of healthy adults to be 1.82 mm² (SD 0.39).

Meyer [26] also correlated a link between the topography of the optic nerve head and the size of its relative blind spot, however he found that "...the prominent nasal part of the optic disc appears less 'blind' than the shallow temporal part, probably because of more intense light scattering by the prominent nasal part of the disc". This implies that one cannot simply assume that the projected blind spot scotoma will be a direct comparison to the size of the optic nerve head.

This concept can be further complicated by the presence of papilloedema. When investigating patients with papilloedema Corbett [6] found that with the addition of plus spherical lenses the size of the blind spot scotoma could be reduced, this however was not the case in participants without papilloedema. This is due to the enlarged blind spot being partly due to hypermetropia induced by the elevation of the retina surrounding the swollen optic disc. This alerts clinicians to the need of using a strict prescription correction protocol that ensure that unwanted manipulation of the blind spot size does not occur.

The reviewed studies appeared to focus on a predominantly Caucasian sample; it is now known that anatomically there is variation in the size of the optic disc dependant on ethnicity. Mansour [27] found that white – Americans had smaller optic discs than other Americans from differing ethnic backgrounds, this was later confirmed by Seider [28] in a larger population who found that the mean optic disc size of white-Americans (2.15mm²) was significantly smaller than that of African (2.55mm²), Asian (2.38mm²), Filipino (2.48mm²) and Hispanic-Americans (2.57mm²) (P≤0.0007), no differences were found between age and sex. As the blind spot correlates with the size of the disc, future studies should correlate the size of the blind spot with variables of optic disc.

6. CONCLUSION

Six of the seven articles included in this literature review were published between the years 1931–1976, one was published recently in 2006 however this study utilized the TCC an instrument not commonly found in ophthalmic practice. This review found that the size of the blind spot scotoma to be dependent on the methods used to measure it.

The Goldmann perimeter is considered the 'gold standard' for visual field testing [21] however its production ceased in 2008, Armaly's [17] data showing the blind spot measurement on the Goldmann cannot be equated to those found on modern instruments such as it's official successor the Octopus 900. The Octopus 900 is theoretically more accurate as it allows clinicians to move the kinetic stimulus at a constant speed and account for the patient's reaction time via software adjustment. It is on the Octopus 900 that we are lacking data and this review calls for further research.

It appears that clinicians accept the older literature as definitive and may not be aware of the need for further research. In today's world of evidence-based medicine it can never be assumed that our knowledge is complete. Does this literature review provide an example of mythology and tradition surviving from a pre-evidence based past? Further research using this latest and most accurate equipment must be conducted.

7. LIMITATIONS

Certain limitations can be associated with this literature review. A single author conducted all search components including the search, data extraction and quality assessment; this gives rise to the possibility of observer bias. Due to limited resources and funding the literature review was limited to articles published in the English language. Only published data was reviewed, many authors being unavailable to comment due to the age of the publications. This review was not funded and there are no competing interests to disclose.

GLOSSARY

Idiopathic Intracranial Hypertension (IIH)

Also known as Benign Intracranial Hypertension or Pseudotumor Cerebri, IIH is a neurological condition defined as an increase in the intracranial pressure (ICP) around the brain, without the presence of a tumour or disease. Its cause is unknown.

Papilloedema

Swelling of the first part of the optic nerve (the optic disc or the optic papilla) [1]

Perimetry

The process of using an instrument to map the extent of a persons visual field [1].

Presbyopia

An age-related loss of lens accommodation that results in an inability to focus at near distances. It is the most common physiological change occurring in the adult eye and is thought to cause universal near vision impairment with advancing age [29]

Scotoma

A small area of abnormally less sensitive or absent vision in the visual field, surrounded by normal sight [1].

CONSENT

Not applicable.

ETHICAL APPROVAL

Not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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APPENDIX - I

PROTOCOL

1. Title of Review

What is the normative size of the visual blind spot in adults and how much do these measurements vary?

2. Background

As in Article

3. Focused Review Question

<p>Question:</p> <p>What is the normative size of the visual blind spot in adults and how much do these measurements vary?</p> <p>Population</p> <p>Human Adults without neurological conditions that may effect the size of the physiological blind spot</p> <p>Objective (s)</p> <p>To determine the size of the Blind spot size,</p> <p>Outcomes</p> <p>Blind spot area/measurement/size</p>
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4. Search Strategy

4.1 Search Terms

Terms	Key search terms
Population	Adults (MeSH 18 years and over) Humans Male & Female
Objective (s)	Blind Spot (MeSH Optic Nerve Head, Optic Papilla)
Outcomes	Blind spot: size, area measurements.

4.2 Search Limits

Study designs	All study designs will be considered but prioritised according to Greenhalgh's (1997) hierarchy of evidence as listed below: Systematic reviews and meta-analyses Randomised controlled trials
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	Cohort studies Case-control studies Cross sectional surveys Case reports
Publication types	Journals, Grey/fugative literature, Dissertation/Thesis
Date of publication	The full extent of listed databases, no time frames imposed.
Language	Any language that can be translated using available resources
Other limits	Human subjects only

4.3 Sources to be searched

Databases	Ovid Medline, Ovid SP, EMBASE, CINAHL, Google Scholar, Cochrane Central Library, Individual Journal Searches: British Medical Journal, British Journal of Ophthalmology, Journal of Neurology, European Journal of Neurology, Archives of Ophthalmology, American Academy of Ophthalmology, Ophthalmology, Brain (a journal of neurology), Eye (The Royal College of Ophthalmologists)
Grey literature	Conference proceedings, abstracts and presentations. Lectures, seminars and tutorials. Internal and technical reports. Research - completed and in progress. Unpublished dissertations and thesis. Networked Digital Library of Theses and Dissertations.
Other sources	Tracing references from relevant articles

5. Study Selection

Inclusion and exclusion criteria

Selection Criteria	Inclusion	Exclusion
Population	Male, Female, Adults, Humans	Animals,
Equipment used to measure the blindspot	Octopus Tubingen computer campimeter (TCC) Goldmann Tangent screen Humphery	Confrontational visual fields
Outcomes	Blind spot: area, size, height, width	
Study type	All	-
Language	All that I can translate with available resources	-

6. Quality Assessment Strategy

A Centre of Evidence Based Medicine (CASP) score will be allocated to each study using the appropriate tools from the CASP website. If possible a risk of bias table highlighting each studies strengths and weaknesses will be made following the examples set by 'The Cochrane Collaboration's tool for assessing risk of bias'.

7. Data Extraction

The University of York's 'Guidance for undertaking reviews in Health Care' was used to create a data extraction form, having piloted the form certain aspects were adapted to better extract the relevant data.

8. Proposed Data Synthesis

As the size of the visual blind spot is continuous data any common effect may be measured using a meta-analysis. If a great deal of heterogeneity is found within the studies methodology a narrative synthesis may have to be considered instead.

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