Objective: To determine the prevalence, morphologic characteristics, associations, and frequency of features reported to predict growth of choroidal nevi in a large population-based sample.

Methods: A total of 3654 subjects aged 49 to 97 years participating in the Blue Mountains Eye Study had a detailed eye examination, including photography of 6 standard retinal fields. Nevi were graded from photographs.

Results: Nevi were present in 6.5% of the population (n = 232), and were distributed equally between eyes. There was a slight decrease in nevus prevalence with increasing age. Nevus prevalence was higher in women than men, but this difference was not statistically significant. The mean nevus diameter was 1.25 mm (SD, 0.72 mm; range, 0.5 to >4.5 mm). Eighty-seven percent of nevi were blue gray and 6% had a hypomelanotic or amelanotic appearance. There were no significant associations between nevi and iris or skin color or sun-induced skin damage, but nevi were significantly less frequent in persons with blond hair. No nevus associations were found with visual impairment, cataract, or glaucoma. Clearly visible drusen were seen on 42% of nevi and were larger and more centrally distributed as nevus size increased. Features previously identified as predicting nevus growth, such as serous elevation and orange or other pigment, were seen rarely.

Conclusion: Choroidal nevi in the general population are frequent, small, have few features that are commonly reported to indicate potential for growth, and rarely affect visual acuity.


choroidal nevi are a common incidental finding in many fundus examinations. They are seen on ophthalmoscopy as round or oval areas of discrete increased choroidal pigment with detectable but not sharp borders. Nevi are usually described as having a slate-blue or green-gray color and may be slightly raised by 1 to 2 mm.1,2 The clinical significance of choroidal nevi relates to their rare potential for malignant transformation,1,3,4 reported association with visual impairment,5-7 and differential diagnoses, which include choroidal melanoma, choroidal hemangioma, neovascular age-related macular degeneration, and other conditions.8 Reported nevus prevalence rates vary widely: from 0.2% to 30% (Table 1). This wide variation is likely due to different examination methods and inclusion criteria for nevi, as well as differences in study populations, some of which could be susceptible to selection bias. Most studies have been of clinic groups1,4,12,14-16 from autopsy series.9,10 Few population-based studies17 to date have examined the prevalence of choroidal nevi.

Because of the paucity of population-based data, we aimed to describe the prevalence, morphologic characteristics, frequency of features reported to predict growth, and associations with choroidal nevi and overlying drusen in a defined largely white population.

RESULTS

No participants reported a history of diagnosis or treatment for ocular melanoma. None of the larger nevi found had features present at the clinical examination, including elevation, to suggest that they were choroidal melanomas.

PREVALENCE OF CHOROIDAL NEVI AND OCULAR DISTRIBUTION

Seventy-one participants without gradeable photographs of both eyes were excluded. Of 3583 participants with photographs, 232 (6.5%) had 1 or more choroidal nevi. There was a borderline significant trend for nevi to be slightly more prevalent in younger age groups (Table 2). Nevi

From the Department of Ophthalmology, the University of Sydney, Sydney, Australia.
SUBJECTS AND METHODS

Subjects were participants in the Blue Mountains Eye Study, which involves residents aged 49 years or older living in 2 adjacent postcodes in the Blue Mountains area west of Sydney, Australia. Details of the population and study methods have been previously reported. Among the 264 choroidal nevi, 230 (87.1%) were blue, hazel green, tan brown, or dark brown by clinical examination. A total of 264 choroidal nevi were graded in 232 subjects; 215 (92.7%) had a nevus in 1 eye only. The distribution of nevi was equal between the 2 eyes: 109 subjects (47%) had nevi in the right eye, 106 (46%) had nevi in the left eye, and 17 (7%) had nevi in both eyes. Two nevi per eye were seen in 10 subjects (4.3% of subjects with nevi) and more than 2 nevi per eye were found in 3 subjects (1.3% of subjects with nevi).

NEVUS PIGMENTATION, DIMENSIONS, MORPHOLOGY, AND TOPOGRAPHY

Among the 264 choroidal nevi, 230 (87.1%) were blue gray, 12 (4.5%) were graded as having a patchy hypomelanic appearance, 3 (1.1%) were amelanotic with a pigmented halo, 2 (0.7%) were brown, and the appearance was indeterminate in 17 (6.4%). The mean nevus diameter was 1.25 mm (SD, 0.72 mm), with the largest nevus having a diameter larger than 4.5 mm. The distribution of nevus size is shown in Table 3. NEVUS PIGMENTATION, DIMENSIONS, MORPHOLOGY, AND TOPOGRAPHY

The Statistical Analysis System (SAS Institute Inc, Cary, NC) was used. Nevus associations with age, sex, and other variables were assessed using logistic regression. Trends were tested using the Mantel-Haenszel test. Odd ratios and 95% confidence intervals are presented.
...lay within the central grading circle (diameter, 1000 µm), and 38 nevi (14.4%) involved the inner circle (diameter, 3000 µm). Thus, about half of all nevi lay wholly within the posterior pole of the eye. The posterior margin of 6.1% of nevi involved the edge of the optic disc, 42.0% of nevi were within 2 disc diameters of the disc, and 57.6% were beyond 2 disc diameters. Forty percent of all nevi were upper temporal to the disc and 45.1% were lower temporal. Only 6.4% and 7.2% were upper or lower nasal to the disc, respectively. This difference is probably because of the much larger area of temporal field photographed.

**DRUSEN AND OTHER FEATURES**

Accurate grading of the characteristics of drusen overlying nevi was possible for 210 nevi (79.5%). Drusen were seen overlying 98% of nevi, with the majority graded as

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### Table 1. Prevalence Studies of Choroidal Nevi by Sample Type and Study Size

<table>
<thead>
<tr>
<th>Source, y</th>
<th>No. of Subjects</th>
<th>Prevalence, %</th>
<th>Age, y</th>
<th>Comments, Examination Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Autopsy Eyes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Naumann,9 1970</td>
<td>200</td>
<td>11</td>
<td>All ages</td>
<td>Grading of fundus photographs</td>
</tr>
<tr>
<td>Hale et al,10 1965</td>
<td>152</td>
<td>9</td>
<td>&gt;18</td>
<td>Transillumination and light microscopy</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>20</td>
<td>&gt;18</td>
<td>Groups 1 and 2 both included ciliary body nevi</td>
</tr>
<tr>
<td><strong>Clinic Based</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wilder,11 1946</td>
<td>3882</td>
<td>0.2</td>
<td>18-38</td>
<td>Surgical trauma cases</td>
</tr>
<tr>
<td>Lang and Daumann,12 1982</td>
<td>3119</td>
<td>4.2</td>
<td>18-41</td>
<td>Pilots and recruits*</td>
</tr>
<tr>
<td>Albers,13 1940</td>
<td>2300</td>
<td>1.1</td>
<td>. . .†</td>
<td>. . .†</td>
</tr>
<tr>
<td>Albert et al,14 1980</td>
<td>847</td>
<td>6.9</td>
<td>&gt;30</td>
<td>White chemical workers*</td>
</tr>
<tr>
<td></td>
<td>302</td>
<td>10.9</td>
<td>&gt;30</td>
<td>White control group*</td>
</tr>
<tr>
<td>Ganley and Comstock,15 1973</td>
<td>287</td>
<td>3.1 (6.2)‡</td>
<td>&gt;30</td>
<td>Three groups of subjects (office sample, census sample, and subjects with fundus scars)*</td>
</tr>
<tr>
<td>Gass,16 1977</td>
<td>250</td>
<td>30.0</td>
<td>&lt;90</td>
<td>186 of 250 patients aged 50 years or older*</td>
</tr>
<tr>
<td>Albert et al,14 1983</td>
<td>197</td>
<td>4.0</td>
<td>49 (mean)</td>
<td>White patients with cutaneous melanoma*</td>
</tr>
<tr>
<td></td>
<td>147</td>
<td>1.3</td>
<td>47 (mean)</td>
<td>White control patients*</td>
</tr>
<tr>
<td>Rodriguez-Sains,17 1986</td>
<td>92</td>
<td>18.5</td>
<td>8-68</td>
<td>White patients with dysplastic nevus syndrome*</td>
</tr>
<tr>
<td></td>
<td>108</td>
<td>4.6</td>
<td>11-84</td>
<td>White control patients*</td>
</tr>
<tr>
<td><strong>Population Based</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present study</td>
<td>3583</td>
<td>6.5 (8.6)‡</td>
<td>&gt;49</td>
<td>White subjects, grading of fundus photographs covering posterior 70°*</td>
</tr>
<tr>
<td>Smith and Ganley,12 1972</td>
<td>842</td>
<td>1.9</td>
<td>&gt;13</td>
<td>White subjects,* posterior to equator</td>
</tr>
</tbody>
</table>

*Use of indirect ophthalmoscopy stated.
†Information not given.
‡Corrected to represent entire fundus.

### Table 2. Age and Sex Distribution of Choroidal Nevi in the Blue Mountain Eye Study Population

<table>
<thead>
<tr>
<th>No. (%) of Participants With Choroidal Nevus by Age</th>
<th>&lt;60 y</th>
<th>60-69 y</th>
<th>70-79 y</th>
<th>≥80 y</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>42/569 (7.4)</td>
<td>52/707 (7.4)</td>
<td>35/545 (6.4)</td>
<td>7/203 (3.5)</td>
<td>136/2024 (6.7)</td>
</tr>
<tr>
<td>Men</td>
<td>31/438 (7.1)</td>
<td>38/587 (6.5)</td>
<td>17/396 (4.3)</td>
<td>10/138 (7.3)</td>
<td>96/1559 (6.2)</td>
</tr>
<tr>
<td>Both</td>
<td>73/1007 (7.3)</td>
<td>90/1294 (7.0)</td>
<td>52/941 (5.5)</td>
<td>17/341 (5.0)</td>
<td>232/3583 (6.5)</td>
</tr>
</tbody>
</table>

*Mtntel-Haenszel $x^2$ test for trend.

### Table 3. Drusen Characteristics as a Function of Nevus Size

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>&lt;1.0</th>
<th>1.0-1.9</th>
<th>2.0-2.9</th>
<th>3.0-3.9</th>
<th>≥4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. (%)</td>
<td>97 (36.7)</td>
<td>131 (48.9)</td>
<td>29 (11.0)</td>
<td>5 (1.9)</td>
<td>4 (1.5)</td>
</tr>
<tr>
<td>Nesi with centrally placed drusen, %</td>
<td>7.7</td>
<td>13.7</td>
<td>37.5</td>
<td>66.7</td>
<td>50.0</td>
</tr>
<tr>
<td>Mean area of nevus involved by drusen, %</td>
<td>6.4</td>
<td>1.9</td>
<td>2.9</td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Category of largest drusen, No. (%) of cases*</td>
<td>C0 indistinct</td>
<td>59 (78.7)</td>
<td>58 (52.7)</td>
<td>6 (27.2)</td>
<td>1 (25.0)</td>
</tr>
<tr>
<td>C0 distinct</td>
<td>10 (13.3)</td>
<td>35 (31.8)</td>
<td>6 (27.2)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>&gt;C0</td>
<td>3 (4.0)</td>
<td>17 (15.5)</td>
<td>10 (45.5)</td>
<td>3 (75.0)</td>
<td>2 (66.7)</td>
</tr>
</tbody>
</table>

*Includes only nevi able to be graded for drusen size. See “Grading and Definitions” subsection of “Subjects and Methods” section for description of categories.

(1.9%) lay within the central grading circle (diameter, 1000 µm), and 38 nevi (14.4%) involved the inner circle (diameter, 3000 µm). Thus, about half of all nevi lay wholly within the posterior pole of the eye. The posterior margin of 6.1% of nevi involved the edge of the optic disc; 42.0% of nevi were within 2 disc diameters of the disc, and 57.6% were beyond 2 disc diameters. Forty percent of all nevi were upper temporal to the disc and 45.1% were lower temporal. Only 6.4% and 7.2% were upper or lower nasal to the disc, respectively. This difference is probably because of the much larger area of temporal field photographed.
small indistinct C₀ lesions. However, only 40.5% of nevi had overlying drusen that could be readily seen during ophthalmoscopy (distinct C₀ lesions or drusen measuring C₁ or C₂ in size). The distribution of drusen overlying nevi was graded as central on 20.0% of nevi, peripheral on 41.2%, or distributed both centrally and peripherally on 38.8%. Drusen tended to be larger (P < 0.001) and more centrally distributed (P = 0.01) with increasing nevus size (Table 3). There was only 1 nevus (diameter, 2.4 mm) with overlying orange pigment. Two nevi (diameters, 1.9 and 0.6 mm) had pigment clumping unrelated to other abnormality and 2 nevi (diameters, 1.9 and 3.5 mm, respectively) had minor retinal edema overlying the nevus.

ASSOCIATIONS INVESTIGATED

No statistically significant associations were found between choroidal nevi and iris color, skin color, or examiner-assessed sun-related skin damage. However, nevi were significantly less frequent in people with blond hair (36/763; 4.7%) compared with other hair colors (196/2791; 7.0%) (odds ratio, 0.66; 95% confidence interval, 0.46-0.95). No associations were found between
accepted that malignant melanomas of the choroid may rarely arise de novo and induce a nevus-like structure within the malignant lesion because of some shared oncogenic potential and it ceases to be classed as a nevus. There is, therefore, great clinical interest in the follow-up of patients with choroidal nevi, and efforts continue to assess reliable indicators of likely growth and malignant potential.1,30 The present population-based survey of nevi provides useful baseline information to interpret follow-up studies of choroidal nevi.

To highlight the low probability of melanomas developing from existing choroidal nevi, Ganley and Comstock4 used a mixed clinical and population sample. They estimated that 1 choroidal melanoma would result from 100 nevi per year for both women and men could be expected in a population sample. Unfortunately, we do not have data on nevus height, although we can anecdotal report that the lesions we studied gave an impression of being quite flat in almost all cases.

**COMMENT**

Choroidal nevi were first described by Fuchs in 1882.2 In 1905, de Schweinitz and Shumway26 proposed that these lesions could give rise to malignant melanomas. It is now accepted that malignant melanomas of the choroid may rarely develop from choroidal nevi.1,3-11,27 However, it remains controversial whether the malignant cells arise from neoplastic transformation of preexisting nevus cells or whether melanomas arise de novo and induce a nevus-like structure within the malignant lesion because of some shared oncogenic stimulus to both nevocellular nevi and melanocarcinoma.28,29

Despite the histogenesis controversy, it seems likely that at some stage in its development, a choroidal melanoma will potentially resemble a choroidal nevus and be harbored within the “nevus” population until its ophthalmoscopic features give warning of its malignant potential and it ceases to be classed as a nevus. There is, therefore, great clinical interest in the follow-up of patients with choroidal nevi, and efforts continue to assess reliable indicators of likely growth and malignant potential.1,30 The present population-based survey of nevi provides useful baseline information to interpret follow-up studies of choroidal nevi.

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The significance of drusen overlying nevi is equivocal, but the sign is thought to indicate low growth potential. One difficulty when interpreting drusen data between studies is that drusen descriptions have not been standardized and drusen detection methods have varied. Although Naumann et al found that 26% of nevi had overlying drusen histologically, they conceded that ophthalmoscopy was more reliable for drusen detection and later reported drusen in 51% of cases using ophthalmoscopy. Hale et al found drusen over 80% of nevi using transillumination on postmortem eyes. To standardize the grading of overlying drusen, we used the WARMGS and our grading identified different prevalence rates for drusen differing in size and type. Indistinct C0 drusen were seen overlying 98% of nevi, yet ophthalmoscopically visible distinct C0 or larger drusen were found on only 42% of nevi. Our finding of larger drusen overlying larger nevi supports the concept that this sign reflects chronicity of the nevus.

Several series have suggested an association between nevus growth and proximity of its posterior edge to the optic disc. However, of 264 nevi in our study, 42% of nevi were within 2 disc diameter of the disc, suggesting that this is a relatively common feature. Although several articles have reported a relatively common reduction in visual acuity from choroidal nevi, we found no cases with nevi involving the macular area in which reduced vision could be attributed to the nevus. After excluding subjects with a demonstrable cause of reduced vision, the remainder had a median refracted visual acuity of 20/20. Gonder et al noted reduced acuity in 11% of 206 patients referred to an oncology clinic for assessment of pigmented choroidal tumors. These posterior lesions averaged 4.3 mm in basal diameter and 0.7 mm in thickness, which was much larger than those in our study. The authors attributed the visual impairment to serous foveal detachment (50%), photoreceptor degeneration (42%), and subtretinal choroidal neovascularization (8%).

In conclusion, our study has documented prevalence and characteristics of choroidal nevi in a large, representative, older population. Most nevi found were relatively small, without features predictive of growth or malignant transformation. Visual acuity was not affected by these small nevi. Characteristics of drusen overlying choroidal nevi were also documented.

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