IMPORTANCE The ocular status of homeless populations remains largely unknown. Given that visual acuity has been shown to be heavily correlated with reduced well-being and decreased earning potential, findings of poor vision could have important health implications for people experiencing homelessness.

OBJECTIVES To assess the prevalence of visual impairment and to identify unmet eye care needs in an adult homeless population.

DESIGN, SETTING, AND PARTICIPANTS For this cross-sectional study, we recruited 100 homeless persons using a stratified random sampling technique from January to March 2014. Recruitment took place at 10 randomly selected adult shelters in Toronto, Ontario, Canada. All English-speaking persons older than 18 years of age were eligible to participate. Information was obtained on sociodemographic characteristics, ocular history, and subjective visual acuity. A comprehensive vision screening and an undilated retinal examination were performed for each participant.

MAIN OUTCOMES AND MEASURES Rates of functional visual impairment and prevalence of nonrefractive eye pathology.

RESULTS The median age of participants was 48 years (interquartile range, 36-56 years), and 62% were men. The median lifetime duration of homelessness was 12 months (interquartile range, 5-36 months). Based on the participants’ presenting visual acuity, the age-standardized rate of visual impairment was 25.2% (95% CI, 16.7%-33.7%). After pinhole occlusion, this number decreased to 15.2% (95% CI, 7.7%-22.7%). In total, 13.0% (95% CI, 7.8%-20.0%) of participants experienced visual impairment secondary to a correctable refractive error. Although the major problem for this demographic was limited access to refractive correction, a large degree of nonrefractive pathology was also observed. Of all the participants, 34.0% (95% CI, 24.7%-43.3%) had 1 or more abnormal findings during the vision screening, and 8% (95% CI, 2.7%-13.3%) required urgent referral to an ophthalmologist. A large majority of participants (89.0%) indicated interest in accessing free eye examinations.

CONCLUSIONS AND RELEVANCE These data suggest that homeless adults have a high prevalence of visual impairment, even when living within a system of universal health insurance. Given the high level of interest in eye care among homeless persons, ongoing vision-screening programs and readily accessible free eye clinics may help address this need.
Homeless people represent one of the most vulnerable groups within our society. They are at increased risk of a variety of illnesses, including epilepsy, chronic obstructive pulmonary disease, and musculoskeletal disorders. Hypertension, diabetes mellitus, and anemia are often inadequately managed in this population, and rates of substance abuse and mental illness are typically high.

Although an abundance of literature exists on the topic of homelessness and health, the ocular status of homeless populations remains largely unknown. National health surveys, which regularly collect ocular health data, usually target persons living in private dwellings and, therefore, exclude homeless persons. Findings of poor visual health in homeless populations could have important implications because poor visual acuity has already been shown to be heavily correlated with reduced well-being and reduced earning potential. Furthermore, documentation of the rate of visual impairment within this population may facilitate global initiatives, such as the VISION 2020: The Right to Sight, a joint program between the World Health Organization and the International Agency for the Prevention of Blindness that aims to eliminate avoidable blindness (http://www.iapb.org/vision-2020).

Of the little information that exists regarding the ocular health of homeless populations, most has been generated in the United States. Two US studies suggest that homeless persons have poor knowledge of eye care services and are more likely to have uncorrected refractive error, cataracts, and glaucoma. These results are informative but may not be directly applicable to homeless populations living within a system of universal health insurance. For homeless persons within such health systems, even less information is available. A German study surveyed a population of homeless persons and found that they were at increased risk of ocular morbidity and optic nerve atrophy. A Canadian group assessed the vision of 20 participants from a Toronto-based shelter and demonstrated that the majority had poor visual acuity. Although the studies discussed have shed light on the ophthalmic status of this group, only a few have clearly defined their homeless populations, and none used a random sampling technique. To address this gap, we used a stratified random sampling technique in order to establish the prevalence of visual impairment among a representative sample of homeless persons living in Toronto, Ontario, Canada.

Methods

For this cross-sectional study, we recruited participants at homeless shelters for adults in Toronto between January and February 2014. It has been previously shown that Toronto shelter users represent 72.2% of the homeless population. A homeless individual was defined as a person currently residing in a shelter, who self-reported as being homeless for at least the past 7 days. Non-English speakers and persons found to lack decisional capacity were excluded.

A 2-stage sampling technique was used to select 100 participants. All 34 adult homeless shelters in Toronto were identified, of which 10 were randomly selected with probability of selection proportionate to each shelter’s nightly housing capacity. In the second stage, bed numbers within each shelter were randomly selected, and individuals assigned to those beds were invited to participate in our study. We continued using the sampling technique until 10 participants had been recruited at each shelter.

Research ethics approval was obtained from St Michael’s Hospital research ethics board. All participants completed the informed consent process (ie, they provided oral informed consent). Because this is a vulnerable population, someone within their circle of care made the initial approach. Written informed consent was not obtained owing to potential literacy and vision limitations of the participant population; instead, verbal consent was obtained from each participant by one of the study coordinators, and a written statement outlining the information conveyed during the consent process was provided to each participant. The ethics board did not require informed consent to be written because our verbal recruitment approach and consent model was in accordance with the Canadian Tri-Council Policy Statement on Ethical Conduct. Participants received a Can$10 gift card after completion of the study. Data collection consisted of a structured questionnaire, a vision screening, and a retinal examination. Whenever possible, survey questions were derived from validated questionnaires or previously published studies. Data were collected on sociodemographic characteristics, ocular history, subjective visual acuity, and accessibility of eye care services.

Subjective visual acuity was assessed using a series of questions derived from the Canadian Community Health Survey Cycle. Specifically, individuals were asked the following questions: (1) Are you able to see at all? (2) Are you usually able to see well enough to read ordinary newprint without glasses or contact lenses? (3) Are you usually able to see well enough to read ordinary newprint with glasses or contact lenses? (4) Are you able to see well enough to recognize a friend on the other side of the street without glasses or contact lenses? (5) Are you usually able to see well enough to recognize a friend on the other side of the street with glasses or contact lenses? Participant responses were categorized into 5 mutually exclusive groups: (1) no visual problems; (2) problems corrected by lenses (distance, close, or both); (3) problems seeing distance (not corrected); (4) problems seeing close (not corrected); and (5) problems seeing close and distance (not corrected) or no sight at all (blindness). Results were compared with the reported values for the general Canadian population.

The vision screening included an assessment of presenting distance acuity and presenting near visual acuity, pupil reactivity, confrontation fields, extraocular eye movements, intraocular pressure measurements, and an undilated retinal examination via direct fundoscopy. Presenting visual acuity (PVA) was assessed using the participant’s usual distance correction, if any. Visual acuity was recorded as the last line for which 4 or more characters were read correctly. Data on corrected visual acuity (CVA) were also collected using a pinhole occluder. The best PVA and/or CVA of the better-seeing eye was then used to categorize participants into 1 of 3 groups: not im-
paired (better than 20/50), low vision (between 20/50 and 20/200), or blind (20/200 or worse).

Visual acuity data were directly standardized by age to the Canadian population using 2013 Census data, and χ2 analysis was used to access significant differences (P < .01) between our data set and the experiences of the general Canadian population. Confidence intervals for proportions were calculated using the Wilson method. Statistical analyses were conducted using R version 3.0.1.

Results

Of the 110 homeless persons approached, 100 (90.9%) were willing to participate. Two of the homeless persons approached were excluded because one was a non-English speaker and the other was found to lack decisional capacity. The median age was 48 years (interquartile range, 36-56 years) The median life-time duration of homelessness was 12 months (interquartile range, 5-36 months). The demographic characteristics of participants are shown in Table 1.

The 100 homeless persons in our sample had a wide range of medical comorbidities. The most commonly self-reported health issues were depression (42.0%), excessive alcohol use (33.0%), nonintravenous drug use (32.0%), high blood pressure (25.0%), and osteoarthritis (25.0%). With respect to their ocular history, 31.0% reported being previously diagnosed with an eye problem, and 16.0% reported having a prior surgery and/or procedure done on at least 1 of their eyes. A complete list outlining the ocular history of our participants can be found in Table 2. Only 1 participant was taking ocular medication at the time of our study. Of the 16 who had a prior surgery and/or procedure done on their eyes, 2 (12.5%) reported seeing either an optometrist or an ophthalmologist in the past year.

In total, 68.0% reported having coverage for prescription drugs. Of the 68 participants with coverage, 47 (69.1%) said that eye examinations were covered by their plan, and 43 (63.2%) said that the cost of prescription eyeglasses was at least partially covered. Of the 61 participants who reported using prescription glasses in the past, only 18 (29.5%) reported that they currently had these refractive devices in their possession. Of the 100 participants, 14 reported seeing an optometrist or ophthalmologist in the past year compared with 41% of the general Canadian population (P < .001).

Data from the subjective visual acuity assessment was standardized by age and compared with the general Canadian population (Table 3). Using χ2 tests, we showed that homeless persons were significantly more likely than the general Canadian population to have uncorrected vision issues (P < .001). Specifically, they were 21 times more likely than the general Canadian population to report problems seeing near and/or close. Overall, 70.0% expressed dissatisfaction with their vision.

Based on their PVA, 24.0% (95% CI, 17.0%-33.0%) of participants were classified as either having low vision or being blind (Table 4). When corrected with pinhole occlusion (CVA), the number of participants with low vision or blindness decreased to 11.0% (95% CI, 6.0%-19.0%) (9 participants had impaired vision, and 2 participants were blind). Thus, in total, 13.0% (95% CI, 7.8%-20.0%) of participants experienced visual impairment attributable to a correctable refractive error. A direct age standardization was done in order to accurately compare our population with the general Canadian population. After age standardization, the PVA was adjusted to 25.2% (95% CI, 16.7%-33.7%), and the CVA was adjusted to 15.2% (95% CI, 7.7%-22.7%).

Overall, 34.0% of participants (95% CI, 24.7%-43.3%) had 1 or more abnormal findings on examination, with 16.0% having an abnormal finding on ophthalmoscopic examination, 12.0% having extracocular muscle imbalance, and 8.0% having ocular hypertension (>22 mm Hg). Based on clinical presentation and history, the ophthalmologist who examined each participant (M.L.) made, at the time of the ocular examination, a provisional diagnosis for 18 participants (Table 5).

Table 1. Demographic Characteristics of 100 Homeless Participants Surveyed

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Participants, No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>62</td>
</tr>
<tr>
<td>Female</td>
<td>38</td>
</tr>
<tr>
<td>Age, y</td>
<td></td>
</tr>
<tr>
<td>18-29</td>
<td>9</td>
</tr>
<tr>
<td>30-39</td>
<td>24</td>
</tr>
<tr>
<td>40-49</td>
<td>20</td>
</tr>
<tr>
<td>50-59</td>
<td>30</td>
</tr>
<tr>
<td>≥60</td>
<td>17</td>
</tr>
<tr>
<td>Total length of time spent homeless, y</td>
<td></td>
</tr>
<tr>
<td>&lt;1</td>
<td>41</td>
</tr>
<tr>
<td>1-5</td>
<td>42</td>
</tr>
<tr>
<td>&gt;5</td>
<td>17</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>72</td>
</tr>
<tr>
<td>Black</td>
<td>14</td>
</tr>
<tr>
<td>Aboriginal</td>
<td>6</td>
</tr>
<tr>
<td>East Asian</td>
<td>2</td>
</tr>
<tr>
<td>South Asian</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>63</td>
</tr>
<tr>
<td>Married or common-law marriage</td>
<td>12</td>
</tr>
<tr>
<td>Divorced, separated, or widowed</td>
<td>25</td>
</tr>
<tr>
<td>Highest level of education achieved</td>
<td></td>
</tr>
<tr>
<td>Elementary school</td>
<td>3</td>
</tr>
<tr>
<td>Junior high school</td>
<td>5</td>
</tr>
<tr>
<td>High school (graduated)</td>
<td>26</td>
</tr>
<tr>
<td>High school (did not graduate)</td>
<td>23</td>
</tr>
<tr>
<td>Some college education</td>
<td>43</td>
</tr>
<tr>
<td>Monthly income, Can$</td>
<td></td>
</tr>
<tr>
<td>&lt;500</td>
<td>42</td>
</tr>
<tr>
<td>500-1000</td>
<td>32</td>
</tr>
<tr>
<td>&gt;1000</td>
<td>25</td>
</tr>
<tr>
<td>Refused to provide information</td>
<td>1</td>
</tr>
</tbody>
</table>
both groups could benefit from access to eyeglasses. For the sons, a greater proportion had glasses (15 [23.4%]). Evidently, (70.8%) owning them in the past. For the remaining 76 per-

ment was largely a consequence of uncorrected refractive er-

efficiency. Of note is that a disparity exists between these data, an objective acuity assessment, and the homeless population’s subjective assessment. The homeless population was 21 times more likely to report difficulties seeing near and/or far than the general Canadian population, although an objective acuity assessment showed that they were only 4 times more likely to have functional visual impairment. Furthermore, because many of these participants had never owned glasses, they struggled to answer the validated survey questions. If subjective reports of visual acuity are not being analyzed, we suggest that future screenings use solely objective assessments to improve efficiency.

The large degree of objective functional visual impairment was largely a consequence of uncorrected refractive error, highlighting the homeless population’s limited access to refractive eye care. Of the 24 homeless persons identified as having bilateral functional vision impairment, 13 (54.2%) improved with pinhole correction. Of these 24 persons, only 3 (12.5%) owned glasses at the time of our study, despite 17 (70.8%) owning them in the past. For the remaining 76 persons, a greater proportion had glasses (15 [23.4%]). Evidently, both groups could benefit from access to eyeglasses. For the participants without refractive devices, most indicated that their glasses had been lost, stolen, or broken and that they were unable to afford a new pair.

Although a large amount of the functional visual impairment can be explained by uncorrected refractive error, it is important to note there was a very high prevalence of ocular pathology within our sample. In addition to having a high degree of refractive error, 15.2% (95% CI, 7.7%-22.7%) of our study participants also had a CVA that classified them as visually impaired. Interestingly, the median age of this subgroup was similar to that of the entire study population (53 years [interquartile range, 37-64 years]). Given the high sensitivity and specificity of the pinhole occluder (78.8% and 98.1%, respectively), most of these participants likely had an underlying non-refractive pathology. Based on all clinically available information, the ophthalmologist who examined the participants was able to account for the vision loss in 8 of 11 participants: 2 were found to have advanced cataracts, 2 had a longstanding history of poorly managed glaucoma, 2 had optic neuropathy, 1 had advanced bilateral dry age-related macular degeneration, and 1 was experiencing presumed ocular toxicity secondary to prolonged prescription drug use. This rate of non-refractive visual impairment (15.2% [95% CI, 7.7%-22.7%]) stands in stark contrast to the estimated Canadian prevalence rate of 0.39% for nonrefractive visual impairment. This finding echoes the work of Maberley et al,11 who found that a marginalized inner-city population in Vancouver, Canada, was 9 times more likely than the general population to have non-refractive error.

In addition to the 24 individuals with functional visual impair-ment, an additional 8 required urgent referral to an ophthalmologist. Five of these participants were suspected of having glaucoma because their examinations revealed that they had elevated intraocular pressures coupled with either confrontational field deficits or retinal changes. The sixth participant experienced a penetrating keratoplasty graft rejection. The seventh homeless participant had a traumatic cataract. The eighth participant had an idiopathic corneal haze that reduced visual acuity to counting fingers. Of these 8 participants, only 1 had seen either an optometrist or an ophthalmologist in the past year. Given that a large number of participants had ocular diseases that may not be identified from an assessment of visual acuity, we believe that there is a need for an ophthalmologist and/or optometrist to attend these shelter visits.

Table 2. Ocular History of Homeless Participants Surveyed

<table>
<thead>
<tr>
<th>Ocular History</th>
<th>Participants, No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previously diagnosed eye problem (n = 31)</td>
<td></td>
</tr>
<tr>
<td>Trauma to globe, orbit, or skull</td>
<td>9</td>
</tr>
<tr>
<td>Strabismus</td>
<td>7</td>
</tr>
<tr>
<td>Cataracts</td>
<td>6</td>
</tr>
<tr>
<td>Chalazion</td>
<td>2</td>
</tr>
<tr>
<td>Corneal infiltrate or ulcer</td>
<td>2</td>
</tr>
<tr>
<td>Other*</td>
<td>5</td>
</tr>
<tr>
<td>Previous eye surgery or procedure (n = 16)</td>
<td></td>
</tr>
<tr>
<td>Cataract surgery</td>
<td>2</td>
</tr>
<tr>
<td>Chalazion surgery</td>
<td>2</td>
</tr>
<tr>
<td>Foreign object excision</td>
<td>2</td>
</tr>
<tr>
<td>Orbital reconstruction</td>
<td>2</td>
</tr>
<tr>
<td>Globe rupture repair</td>
<td>1</td>
</tr>
<tr>
<td>Penetrating keratoplasty</td>
<td>1</td>
</tr>
<tr>
<td>Peripheral iridotomy</td>
<td>1</td>
</tr>
<tr>
<td>Retinal detachment repair</td>
<td>1</td>
</tr>
<tr>
<td>Strabismus surgery</td>
<td>1</td>
</tr>
<tr>
<td>Vitrectomy with silicone oil</td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>2</td>
</tr>
</tbody>
</table>

* Included the following conditions: age-related macular degeneration, glaucoma, parietal lobe stroke, retinal detachment, and retinal tear.

Table 3. Subjective Visual Acuity

<table>
<thead>
<tr>
<th>Visual Acuity</th>
<th>% of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vision problems</td>
<td>Homeless Adults</td>
</tr>
<tr>
<td>None</td>
<td>37.5</td>
</tr>
<tr>
<td>Corrected</td>
<td>39.5</td>
</tr>
<tr>
<td>Problems seeing</td>
<td></td>
</tr>
<tr>
<td>Distances</td>
<td>5.0</td>
</tr>
<tr>
<td>Close</td>
<td>7.8</td>
</tr>
<tr>
<td>Close and distance/no sight</td>
<td>10.3</td>
</tr>
</tbody>
</table>
In total, approximately 34.0% (95% CI, 24.7%-43.3%) of our study participants had 1 or more abnormal findings during the vision screening. Our study finding of a large amount of extraocular muscle imbalance (12.0% of cases) is consistent with previous reports that suggest there is a higher incidence of this pathology among homeless populations.7 Like other groups, we did not find an increased incidence of age-related macular degeneration or diabetic retinopathy.7,11 We suspect that there is a higher incidence of glaucoma among this demographic; however, because comprehensive eye examinations were not performed, we are unable to draw any definitive conclusions. We believe that a lack of utilization of eye care services accounts for the increased prevalence of visual disability within our study population. This is because only 14.0% of the participants, as opposed to 41.0% of the general Canadian population, reported visiting an optometrist or an ophthalmologist in the past year.17 Because 89.0% of participants in our study expressed an interest in receiving free examinations, the low utilization rate arguably does not reflect this group’s disinterest in eye care services. Rather, we believe the low utilization rate to be a direct result of the extreme poverty faced by homeless persons and, more specifically, their inability to afford eye care, which is not routinely covered by the provincial government for those between 20 and 65 years of age. Although free primary eye care is accessible in Ontario through social assistance programs, a majority of participants were unaware of these benefits.29 In addition to affordability and awareness, other possible factors contributing to this lack of utilization may be logistical and mental barriers to accessing eye care services that are available. With this in mind, bringing medical services to homeless populations may be important in providing care to this group.

Future directions involve addressing the identified ocular needs of homeless and marginalized populations. If the global initiative VISION 2020: The Right to Sight is to succeed in eliminating preventable blindness, it is imperative that we remember to address the needs of these communities.

While documenting the size and scope of this problem lays a productive foundation, our hope is that this work will eventually lead to the establishment of an ongoing vision-screening program within shelter systems. Mobile eye screenings have already been demonstrated to be an effective delivery model for ophthalmology care in South Africa, Costa Rica, the United States, and the United Kingdom.26-29 For those found to have poor visual acuity or ocular pathology, the idea would be to refer them to a designated eye clinic in order to obtain a comprehensive ocular examination, as well as free eyewear. A similar clinic in Vancouver has already been shown to be an effective resource for certain marginalized populations.11

Additional investigations are still needed regarding the ocular status of this population. An important limitation of our mobile screening study was that we were unable to perform complete ophthalmic examinations. Furthermore, while our study’s stratified random sampling technique was fairly robust, the time of day and/or season that the sampling took place may also have affected our results. An additional limitation of our study was that it was only conducted in 1 city. The differences between cities (eg, their infrastructures to support homelessness and their general access to primary eye care) can be quite profound. Thus, although our degree of unmet eye care needs may be applicable to other cities, generalizing our findings, particularly outside of Canada and/or the United States, requires a consideration of these factors. Nevertheless, our data are congruent with data from other cities such as Vancouver, Los Angeles, and Baltimore.7,11,22 Consequently, our findings may apply to other large metropolitan cities. Future research will be needed to test whether our proposed strategies indeed reduce ocular health inequities, as well as to see whether they constitute an effective use of scarce hospital resources.

### Conclusions

This work represents an important step in reducing the dearth of knowledge regarding the ocular health status of vulnerable homeless populations. To our knowledge, this is the first study to use a random sampling technique to estimate the prevalence of visual impairment within a homeless population. This is also one of the first data sources to be generated concerning vision health in a Canadian homeless population. The data demonstrate a major unmet need and highlight the strong link between homelessness and poor ocular health. Although these findings are worrisome, targeting interventions to mitigate these issues presents an opportunity to improve the ocular health of this vulnerable population. We believe that further community outreach will be required to address these inequities.

| Table 4. Visual Acuity in Better Seeing Eye of 100 Homeless Participants Surveyed |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| **Visual Acuity**               | **Participants, No.** |
|                                 | **Presenting Visual Acuity** | **After Pinhole Correction** |
| Not impaired                    | 20/20 or better       | 35               | 44               |
|                                 | 20/25-20/30           | 29               | 34               |
|                                 | 20/40                | 12               | 11               |
| Low vision                      | 20/50-20/100         | 21               | 9                |
| Blind                           | 20/200 or worse       | 3                | 2                |

<table>
<thead>
<tr>
<th>Table 5. Suspected Causes of Abnormal Findings in Vision Screening</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cause</strong></td>
</tr>
<tr>
<td>Suspected glaucoma</td>
</tr>
<tr>
<td>Cataract</td>
</tr>
<tr>
<td>Blocked nasolacrimal duct</td>
</tr>
<tr>
<td>Dry age-related macular degeneration</td>
</tr>
<tr>
<td>Fourth nerve palsy</td>
</tr>
<tr>
<td>Homonymous hemianopsia secondary to stroke</td>
</tr>
<tr>
<td>Nonproliferative diabetic retinopathy</td>
</tr>
<tr>
<td>Penetrating keratoplasty graft rejection</td>
</tr>
<tr>
<td>Traumatic cataract</td>
</tr>
<tr>
<td>Idiopathic corneal opacity</td>
</tr>
</tbody>
</table>
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responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Noel, Fung, Hwang, Berger, Lichter.
Acquisition, analysis, or interpretation of data: Noel, Fung, Srivastava, Lebovic, Hwang, Lichter.
Drafting of the manuscript: Noel, Fung, Srivastava, Berger, Lichter.
Critical revision of the manuscript for important intellectual content: Noel, Fung, Srivastava, Lebovic, Hwang, Lichter.
Statistical analysis: Noel, Srivastava, Lebovic.
Obtained funding: Lichter.
Study supervision: Fung, Hwang, Berger, Lichter.
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