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Abstract: Context: Rurality is associated with a number of direct and indirect causes of eye disease. The direct causes are best described as lifestyle factors, such as exposure to UV light and occupational risks. Indirect factors are those where the occurrence of a predisposition is magnified due to rural population distributions, for example gender and age. Issue: Research into rurality and optical health is limited, so definitive increases in the prevalence of vision disease are difficult to ascertain. Furthermore, establishing the need for additional optometrists in rural areas has been mixed in the literature. The current review addresses the relationship between rurality and optical health and suggests an increase in available optometrists in rural areas. Lessons learned: Age is the single largest correlate of vision disease, with an increase in age over 40 years correlating significantly with a range of vision diseases. Rural New South Wales (NSW) Australian areas contain a higher proportion of 'older' residents than urban equivalents. Gender is also a correlate of vision disease, although the phenomenon is more complex than for age. Rural NSW populations contain a higher ratio of men to women than do urban areas, which is significant. Rural residents are exposed to higher levels of UV radiation than their urban counterparts, increasing the prevalence of pterygium. Rural residents experience higher levels of occupational eye injury and may have less stringent eye safety standards. The interaction between vision and hearing loss can accentuate occupational safety vulnerability and general living difficulties. Rural communities experience higher levels of noise-induced hearing loss. Rural communities experience higher levels of certain eye disease and may be exposed to an increased risk from indirect factors such as age, gender and private health insurance ownership. Rural communities may have lower access to optometrists and this review suggests increasing number of optometrists in rural Australia. The amount of research conducted on factors associated with rurality and optical health should be increased.

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**Impact of Rurality on Optical Health:
Review of the Literature and Relevant ABS Data**

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Abstract

Context: Rurality is associated with a number of direct and indirect causes of eye disease. The direct causes could best be described as lifestyle factors, such as exposure to UV light and occupational risks. Indirect factors are those where a predisposition is magnified due to rural population distributions. Examples are gender and age.

Issue: Research on rurality and optical health is limited, such that definitive increases in prevalence are difficult to ascertain. Furthermore, the need for additional optometrists in rural areas has received mixed calls in the literature. The current review will address the relationship between rurality and optical health and consider the increase in available optometrists in rural areas as a potential solution.

Lessons learned: Age is the single biggest correlate of vision disease, with increase in age over 40 correlating significantly with a range of vision diseases. Rural NSW areas contain a higher proportion of 'older' residents than urban equivalents. Gender is also a correlate of vision disease, though the phenomenon is more complex than for age. Men are more likely to experience ocular trauma and pterygium than women and men are also less likely to seek regular check ups and seek help when experiencing health-related symptoms. Rural New South Wales populations contain a higher ratio of men to women than found in urban areas. Both age and gender may be important indirect causes of higher levels of vision disease in rural areas.

Rural residents are exposed to higher levels of UV radiation than urban counterparts, increasing the prevalence of pterygium. Rural residents experience higher levels of occupational eye injuries and may have less stringent ideals for eye safety. An example of how these factors combine is an eye disease known as Albury-Wodonga syndrome, which is caused by excessive UV exposure, may be exacerbated by not wearing safety gear and is generally experienced only by farmers (hence it is sometimes called Harvester's Eye). Despite being reported in 1995, little subsequent research has been conducted on treatment. This may highlight a lack of eye health research on factors associated with rurality, even where a specific eye disease is discovered.

Rural communities experience higher levels of noise-induced hearing loss and as such would benefit from vision health services more than a community with lower prevalence of hearing loss. The interaction between vision and hearing loss can accentuate occupational safety concerns and general living difficulties.

Rural communities experience higher levels of certain eye disease and may be exposed to increased risk from indirect factors such as age, gender and private health insurance ownership. It is unclear, but rural communities may have less access to optometrists. The current review outlines a moderately strong case for increasing the number of optometrists in rural Australia. Further, a strong case is presented to increase the amount of research conducted on factors associated with rurality and optical health.

Keywords

Optical health, rurality, gender, age, UV light, rural lifestyle, rural occupational risk, optometrist, noise-induced hearing loss.

Context

Recent Policy History on Optical Health

This section reviews key work undertaken to develop policy on optical health in Australia. This kind of research falls outside the scientific literature and is therefore not found in academic databases.

The 2001 National Health Survey revealed that 9.7 million Australians or 51% of the population had at least one sight problem¹. The quality of life gains from improving vision in such a large proportion of the population generates a pervasive argument. The cost of such an undertaking is significant and full financial modelling was undertaken as a response to the National Health Survey finding.

Eye Research Australia commissioned two reports. The first estimated the economic impact and cost of vision loss in Australia². Taking into account the direct costs of vision loss as well as indirect factors such as loss of earnings and carer costs, the report estimated that the real financial cost of vision impairment was over \$5.0 billion in Australia in 2004. The report also estimated that the cost of human suffering and premature death was a further \$4.8 billion in 2004. A second report outlined strategies to prevent vision loss in Australia³. The report showed that programs to reduce vision loss could produce significant cost-savings over the longer term. The framework of the program included:

- Regular vision testing particularly for high-risk groups
- Reducing risk factors
- Preventing eye injuries
- Enhancing access to low vision services

Optometrists provide the bulk of the services required to address these issues and are therefore a major component of the framework. It is likely that these reports will garner substantial Government spending on addressing optical health due to the potential to save government spending on health interventions, as well as increase quality of life.

Specific Eye Disease and Treatment Pathways

Optometrists play a role in almost all eye-related injuries, disease and checkups, even if that is only to refer patients to specialty health care providers. It is difficult to determine the exclusive role of an optometrist because their role dovetails several medical specialty areas. The role of optometrists will be considered separately to that of medical doctors, ophthalmologists and other professionals where possible.

There are five eye conditions that account for 75% of vision loss. They are (in order of prevalence)³:

- Refractive error 62%
- Cataract 14%
- Macular degeneration 10%
- Glaucoma 3%
- Diabetic eye disease 2%

Taylor⁴ has made the point that almost 50% of blindness and 70% of vision impairment in Australia is a result of preventable or treatable conditions. A significant proportion of vision loss is caused by uncorrected refractive error. Refractive error is most often treated solely by an optometrist.

An optometrist also plays a role in the other prevalent eye diseases listed above. A cataract is a cloudy area in the eye's lens that causes symptoms of blurred vision and photophobia. Given the symptoms, optometrists are generally the first to treat patients with cataract. Upon diagnosis, patients will be referred to an ophthalmologist who will perform surgery to remove the cataract. Because of the high success rate (1 – 2 % experiencing complications) and the highly procedural nature of the treatment, it has been suggested that optometrists could be up-skilled to perform cataract surgery⁵. Optometrists can diagnose macular degeneration; the disease is incurable although several drugs do offer some relief⁶. Optometrists can be the first to treat patients with glaucoma and diabetic eye disease, although symptoms are usually associated with advanced stages of these diseases, so early detection through regular checkups are the best defence.

The role of ophthalmologists and other medical professionals notwithstanding, the optometrist is the major 'front of house' for most eye-related disorders. Refractive corrections are generally solely performed by the optometrist, whereas other disorders can include co-treatment with other professionals. This report will consider the range of disorders that optometrists treat, including where other professionals are required. The demand for medical practitioners and ophthalmologists will not be reviewed in this report. Ophthalmology is a *medical* specialisation and is not a continuation of the four year degree course in optometry. The number of ophthalmologists therefore is not directly influenced by increases in the number of optometrists trained; there may however be more referrals generated and therefore an increased demand for ophthalmological services.

Issue

Rurality and Prevalence of Eye Disease

Refractive Error

Refractive error is the most prevalent cause of vision impairment in Australia, so is reviewed specifically. Refractive corrections are made almost exclusively by optometrists. Only one study was found on the rate of refractive error across urban *and* rural population sets in Australia. That study reported no difference in prevalence of undercorrected refractive error across the two populations in a Victorian sample of 40 plus year olds⁷. Further, there were no significant differences in visual acuity improvement between urban and rural participants of the study after corrections had been applied to all participants needing correction. This suggests that the rural sample had received equivalent treatment prior to the study. The authors acknowledge that the results are not generalisable to other states, particularly the more remote, sparsely populated zones. The inclusion of participants less than 40 years of age may have influenced the results since recent studies have shown that up to 10% of 12-year-old children in Australia have uncorrected visual impairment in at least one eye⁸.

Further study is needed before we can be certain that rates of undercorrected refractory error in rural areas are equivalent to that of urban areas. However, no evidence for significant differences between the areas exists in the literature, albeit based on one study described above.

Availability of Services

One study reports that the supply of optometrists is sufficient to meet the needs of the Australian population as a whole, but call for further investigation of needs at local levels⁹. The Australian Institute of Health and Welfare produced a report on the Optometric Labour Force in 1999 (reported in ¹⁰) showing substantial variation in the distribution of the optometric workforce. The number of optometrists (by population number) in large rural centres was equivalent to that found in urban areas. Numbers of optometrists dropped by 2% from large rural centres to small rural centres and by a further 5% in remote centres. The largest disparity was reported for other rural areas (12% less than large rural centres) and other remote areas (over 17% disparity). These data also support the call for investigation at a more local level to determine whether other remote areas have sufficient access to eye care professionals.

Utilisation of Services

There are large differences in the utilisation of health care services between urban and rural populations, even where the overall prevalence of eye disease is similar^{11,12}. One study hypothesises that the difference is related to the availability of health care professionals¹³. Their data strongly support that assertion for ophthalmologists, but is more complex for optometrists. Rural residents are less likely to have ever seen an eye health professional, although this finding is influenced by the fact that ophthalmology services were utilised at significantly lower rates in rural areas.

The same study reported that urban residents (based on 4,744 Victorians) were 17% more likely to have private health insurance and that having private health insurance increased the likelihood of seeing an eye care professional by almost 50%. Studies in other countries have also found that health insurance ownership correlates positively with visits to health professionals¹⁴. This is an intuitive finding as health insurance ownership requires payment, it therefore follows that the owner would intend to utilise the product. The assertion that rural residents have less private health insurance in Australia is more tenable. The Australian study is based on a Victorian sample and results may not be generalisable to the rest of Australia. Further investigation of private health insurance ownership and locality of residence needs to be undertaken as no information on this topic was identified.

Indigenous Population

Rural populations tend to experience higher levels of disease and lower access to health services than metropolitan counterparts. Multiple explanations have been reported, including greater travel distances, cost¹⁵ and attitudes¹⁶.

Australia's Indigenous population continues to experience much poorer health than other Australians¹⁷; rural populations are comprised of 3% indigenous Australians while metropolitan populations include only 1%. This proportional difference is not high enough to impact on differences in health status between people living in metropolitan and rural zones. There may however be differences between metropolitan and remote zones. For people living in non-remote areas, similar proportions of Indigenous (49%) and non-Indigenous people (51%) reported having an eye disorder¹⁸. For the purpose of this report, Indigenous Australia's will not be considered separately, as this is unlikely to influence the conclusions.

Age Factors

Vision impairment is highly age-correlated. It is well known that the need for refractive correction increases with age due to a loss of flexibility in the lens, as well as other factors¹⁹. In fact one study⁶ found that age was the strongest predictor of undercorrected refractive error in a Victorian population. Eye Research Australia³ used ABS data to demonstrate a strong positive correlation between age and prevalence of cataract, glaucoma, age-related macular degeneration, diabetic retinopathy and refractive error. Significant increases can be seen for every decade of life after 40 years of age.

Keeffe and colleagues¹¹ found that utilisation of eye care services increased with age. As with many diseases, age may be the greatest influence on visual impairment. It is therefore important to consider the age distribution of rural compared with urban populations.

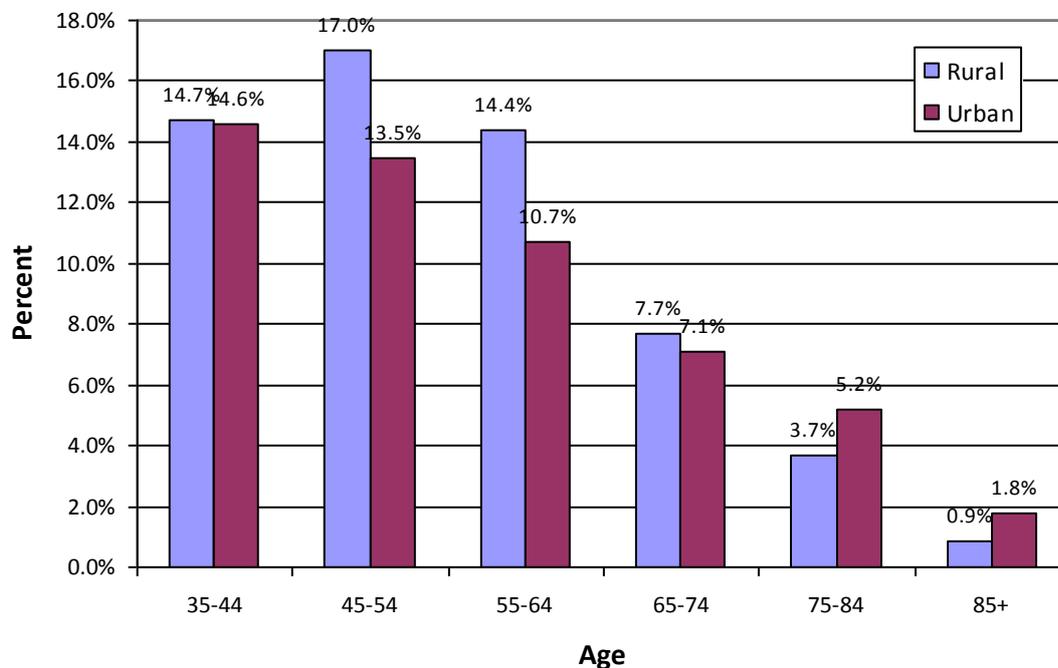


Figure 1: Percentage of population by age for rural and urban areas in NSW. Generated using ABS (2006) data, using ABS definitions of urban and rural.

Figure 1 illustrates the age-disparity between urban and rural populations in NSW. Rural populations have substantially more 45-54 and 55-64 year olds, while urban populations contain more 75-84 and 85+ year olds. Further modelling of ABS data would be required to enable specific claims to be made, but it does appear from Figure 1 that rural populations in NSW contain a greater proportion of older residents. This may predispose rural areas to report more vision impairment and therefore have an increased need for eye care than urban locations.

Influence of Gender

Men utilise health services much less frequently than women²⁰. Men are less likely to arrange regular check-ups¹² and are also less likely to have symptoms checked for fear of wasting the health professional's time²¹. Keeffe and colleagues¹¹ report that men are more likely to never see an eye care professional (at a ratio of 1 woman to 0.77 men).

One study has shown that the effect for rural men may be even more pronounced²². Strodl found that rural men tended to deny symptoms even of a chronic nature, only seeking help when symptoms were regarded as life threatening. This phenomenon has also been demonstrated using a rural NSW sample²³. Buckley and Lower²⁴ have tentatively suggested that work related factors such as shift times may restrict males living in rural areas from utilising

health services. Males who did not have restrictive work requirements were 1.62 times more likely to utilise health services. The authors recognise that their study was limited in size (71 rural males) and the generalisability to the rest of Australia is questionable (sampled from midwest region of Western Australia).

Since men do not utilise health care as much as women, it is not surprising that men in the US are less likely to have private health insurance¹². No Australian based study could be found on gender and private health insurance ownership.

Urban men are three times more likely to experience ocular trauma than women. For rural men, the ratio increases to more than four times²⁵. It has been hypothesised that the higher rate of ocular trauma for rural men is due to the comparatively higher rates of eye injuries reported in the mining and agricultural industries⁸.

Men are also approximately two times more likely to experience pterygium²⁶, a condition that is treated by an optometrist except in serious cases where the patient is referred to an eye surgeon. The major cause of pterygium is thought to be UV radiation²⁷. The prevalence of pterygium increases sharply in rural populations at approximately equal rates for males and females²³. A possible explanation is that rural residents are exposed to greater amounts of UV radiation as a general lifestyle factor, which will be discussed further in the next section.

In summary, men are more likely to experience ocular trauma and the magnitude of risk increases for rural men. Men are more likely to experience pterygium. Men are less likely to utilise health services and less likely to have symptoms checked; this effect may be more pronounced for rural men. These combined findings suggest that men are at greater risk of experiencing vision disease. Further, men and particularly rural men may benefit from targeted campaigns to promote health checks and other safety related behaviours. It is likely that optometrists practicing in rural areas could perform part of this role.

Table 1 shows the ratio of males to females in rural and urban NSW populations (ABS, 2006). It is noteworthy that NSW rural populations have a greater ratio of men to women (1.07 : 1) than urban populations (0.96 : 1). This magnitude could partly explain why rural populations experience greater levels of vision disease.

Table 1: Distribution of males and females across rural and urban locations in NSW, using the ABS defined rural/urban localities (ABS, 2006).

Group	Total_Pop	Total MF	Overall %
maleRural	571255	295445	51.72
femaleRural	571255	275810	48.28
maleUrban	5967593	2926920	49.05
femaleUrban	5967593	3040673	50.95

Lifestyle Factors

There is clearly a gender effect for ocular trauma, with men more likely to experience injury than women. The effect of rurality on ocular trauma is less clear. One study has shown that metropolitan women are significantly less likely to experience ocular trauma than their rural counterparts, but that the magnitude of difference is only 0.3% in prevalence²³. It is questionable whether this difference relates to a differing lifestyle between the areas of residence. The prevalence rate for men however, increases from 30.5% to 42.1% for rural residents, a significant change that is likely to be related to inherent lifestyle factors. A study in the LaTrobe valley, a rural region of Victoria, found that eye injuries accounted for 12% of all presenting injuries at the local hospital, whereas the rate reported at Melbourne based hospitals was only 5%. Occupational activities accounted for over one-third of eye injuries and 40% of the non-occupational eye injuries occurred while performing maintenance-related activities²⁸.

It is likely that rural residents are exposed to more UV radiation than their urban counterparts. UV radiation is a major cause of cataract and pterygium. The prevalence of pterygium in rural adults is more than five times that reported in urban based adults²³. In fact, the prevalence increases from a relatively small 1.2% to a more concerning 6.7% for rural residents. McCarthy and colleagues show that sunlight was the biggest attributable risk, further supporting the hypothesis that rural lifestyle introduces greater levels of UV exposure²³.

The interplay between UV exposure, occupational risk and attitudes toward safety is complex, but a specific eye condition known as Albury-Wodonga syndrome provides evidence of their combined importance^{29,30}. Also known as Harvester's eye or Christmas eye, the condition occurs in summer and is caused by 4 – 5 days of severe corneal sunburn. The prevalence of this condition is unknown and further research is required to understand the ideal treatment regime. No research has followed Howsam's pilot²⁷ on the use of drops and subsequent call for further research. The existence of a rural-based research group in the area of eye health may provide resources to conduct research such as that called for by Howsam in 1995. One study claims that the cost to treat preventable vision loss is less than would be required to deal with the consequences of the vision impairment³¹. Further, that a strong case exists for research into vision loss that can be neither prevented nor treated.

Madden and colleagues⁸ claim that rural lifestyle factors such as diet, smoking, exposure to UV radiation, occupational hazards and attitudes to work safety may all play a role in increasing the prevalence of vision impairment. No supporting evidence is provided and a full review of Australian population data available on these known risk factors and their prevalence in rural areas needs to be undertaken before definitive claims can be made. This relational approach is necessary as there is a paucity of causal data on rural lifestyle and risk of vision disease.

Interaction with Hearing Loss

There is evidence that rural populations in New South Wales experience higher levels of noise-induced hearing loss than urban counterparts³². Safety equipment is available to help prevent such hearing loss during the use of loud and very loud machinery³³ but it is likely that attitudes towards safety hinder the benefits that such equipment can offer. In fact, research has shown that around two-thirds of farmers have a measurable hearing loss, or have on average, hearing levels 10 to 15 years worse than that of the rest of the population³⁴.

Research has demonstrated the important role that visual cues play in human sound localisation³⁵ and speech intelligibility³⁶. In populations with a high prevalence of hearing loss, it becomes even more important to identify vision deficits and to treat or educate clients on the interaction between their vision and hearing loss. Poor sound localisation ability can increase the likelihood of accident while poorer speech intelligibility can manifest in a range of difficulties. The higher prevalence of hearing loss reported in rural communities increases the importance of delivering vision health services to this community.

Lessons Learned

The current report has reviewed the major policy research and all scientific research that could be found on rurality and optical health. There is a general paucity of research in this area and further scientific research should be encouraged. Six recommendations are generated below.

Recommendation 1: Refractive error in rural areas.

The current review found only one study on the prevalence of refractive error in rural compared with urban populations. That study⁶ showed no difference in uncorrected refractive error but was based on a Victorian sample. Further work should examine other sources of information (e.g. ABS, Medicare) to provide a current picture for all of Australia.

Recommendation 2: Up-skilling optometrists.

The treatment of some diseases has become so procedural and routine that they could be treated by an optometrist rather than specialist. Claims about which diseases may be suitable candidates can only be made through discussion with Optometrists Association Australia and with reference to future plans. The Universities teaching optometry will also be a key component of any long-term strategy to treat a greater range of disease through optometric services.

Recommendation 3: Number of optometrists in rural areas.

Rural residents appear to utilise health services at lower rates than their urban counterparts and some hypothesise that this may be due to inequity of access¹¹. There is evidence that the availability of optometrists in rural areas (by some definitions) may be below that in urban areas. There is a case for increasing the number of optometrists practicing in rural areas.

Recommendation 4: Private health insurance and rurality.

Private health insurance ownership promotes good health practices such as seeking regular checkups. A Victorian based study has shown that rural residents are less likely to have private health insurance¹¹. Further investigations should be made as to the prevalence of private health insurance ownership in rural Australia and potentially, rural Australian's should be encouraged to uptake private health insurance.

Recommendation 5: Age distribution in rural and urban areas.

It has been established that age is a strong correlate of vision disease. ABS data was used to show that there is more 'older' residents in rural NSW than found in urban areas. The age disparity between rural and urban areas may be one of the most important factors associated with rurality and optical health. The age disparity should be considered when developing solutions to rural optical health issues, as well as generic health phenomena related to rurality.

Recommendation 6: Gender distribution in rural and urban areas.

It has been established that males may be at greater risk of vision disease than females, and a higher proportion of males were reported living in rural NSW areas. Specific campaigns should target men based in rural areas, as this segment of the population are naturally predisposed to higher incidence of vision disease and are also less likely to seek treatment.

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