Visual impairment and its correction among Pacific youth in Aotearoa: findings from the Pacific Islands Families Study

Lisa M Hamm, Isabel A Johnson, Robert J Jacobs, Janis E Paterson, El-Shadan Tautolo, Leon Iusitini, Nick Garrett, Suzanne C Purdy

ABSTRACT

AIM: Childhood visual impairment has a life-long impact that, with early access to eyecare, is largely avoidable. We aimed to understand visual impairment and its correction among Pacific youth in Aotearoa New Zealand.

METHOD: The Pacific Islands Families Study is a birth cohort study that tracks an original sample of 1,398 Pacific children born at Middlemore Hospital (Auckland). This analysis focuses on assessed visual acuity (at 9- and 18-years, using 0.3logMAR or 6/12 as the cut-off for visual impairment) and participants' self-reports about accessing eyecare services.

RESULTS: Less than a fifth of children (111/729, 15.2%) and teens (86/457, 18.8%) reported having sought eyecare. The percentage of participants with refractive correction was 3.6% (32/887) at 9-years and 14.3% (66/463) at 18-years. At 9-years, 1.9% of children (16/853) had visual impairment in one eye only, and 0.9% (8/853) had visual impairment impacting both eyes. By 18-years these values increased to 7.9% (36/456) and 4.2% (19/456), respectively. Among those with visual impairment, most children (15/24, 62.5%) and teens (32/55, 58.2%) reported they did not have refractive correction.

CONCLUSION: Although prevalence of visual impairment is relatively low compared to non-Pacific youth, much of the reported impairment appears to be avoidable with improved eyecare.

Pacific people living in Aotearoa New Zealand experience disproportionately poor health outcomes,[1,2] and this extends to eye problems. Despite a relatively low propensity for refractive error during childhood,[3–6] Pacific people experience increased burden from eye problems throughout life.[6–17] There are reports of high rates of eye infections[15] and uncorrected refractive error[5] in Pacific children, high rates of suspected keratoconus in teenagers,[17] more complications from keratoconus in adulthood,[13,14] as well as a more substantial impact of cataracts[11,12] and diabetic retinopathy[7,9,10] later in life.

Many of the poor general health[1,2] and visual[7–14,16] outcomes in Pacific adults are due to socioeconomic deprivation and poor access to assessment and treatment.[1,2,10] This trend appears to extend to children's eye problems. For example, poor housing conditions are thought to be associated with eye infections,[15] and lower attendance at the Ministry of Health's B4 School Check amblyopia screening programme[18] reduces early detection of vision defects and postpones provision of refractive correction and other treatment for Pacific children. The timing of treatment for paediatric eye problems is critical because of the consequences for learning,[19] development of social skills[20] and the risk of amblyopia.[21,22]

A key metric of visual impairment is visual acuity (VA). Although many forms of visual impairment impact daily life, VA results have a key role across the life span, because the results are often used to determine whether children are funded for extra support in school, whether teens can be issued a driver licence and whether certain

ISSN 1175-8716

occupations are available as adults.

There is limited research estimating VA for children living in Pacific Islands, but older studies from Vanuatu,[3,6] and one more recent study in Tonga,[23] suggest less than 1% of school-aged children have visual impairment in both eyes[3,6,23] (using 0.3logMAR or 6/12 as a cut-off). Studies measuring VA in Pacific school children living in Aotearoa New Zealand suggest a similarly low prevalence.[5,24] During childhood, the most common cause of poor VA is uncorrected refractive error; however, not all significant refractive error is captured by the standard distance VA measure.[5] For example, Findlay et al noted that, for a group of 114 predominantly Māori and Pacific children, over 30% had significant refractive error (definitions used were myopia: ≤-0.50DS spherical equivalent, hyperopia: ≥2.00DS spherical equivalent, astigmatism: ≥0.75DC), whereas only 2.6% had distance VA at or worse than 0.3logMAR (6/12) in at least one eye.[5]

The goal of this research was to understand visual impairment and its correction among Pacific youth in Aotearoa New Zealand. We accomplished this through a longitudinal study and analyses of both VA and participants' self-reports about accessing eyecare services.

Methods

This analysis is reported according to relevant STROBE guidelines.[25]

Participants

The Pacific Islands Families Study is a longitudinal study tracking the health and development of a birth cohort of 1,398 Pacific children born at Middlemore Hospital in South Auckland in 2000. The sample size was chosen so findings would be specific to the predominant Pacific ethnic groups residing in Aotearoa New Zealand (Samoan, Tongan and Cook Islands Māori). Parents who consented were interviewed at six weeks postpartum, with follow-up interviews at ages 1-, 2-, 4-, 6-, 9-, 11-, 14-, 17- and 18-years. Children were assessed at all ages, starting at 1 year. At 18-years a subset of participants was invited for further follow-up (a convenience sample, by geographic area, capped by available funding). Further details of recruitment and procedures are available elsewhere.[26] As part of wider data collection, VA tests were also offered at school when the children were 9-years (Northern Y Regional Ethics Committee ref. NTY/08/12/119) and at a study clinic at 18-years (Health and Disability Ethics Committee ref. 17/CEN/262).

Self-reported data

Several interview questions related to participants' ability to access eyecare.

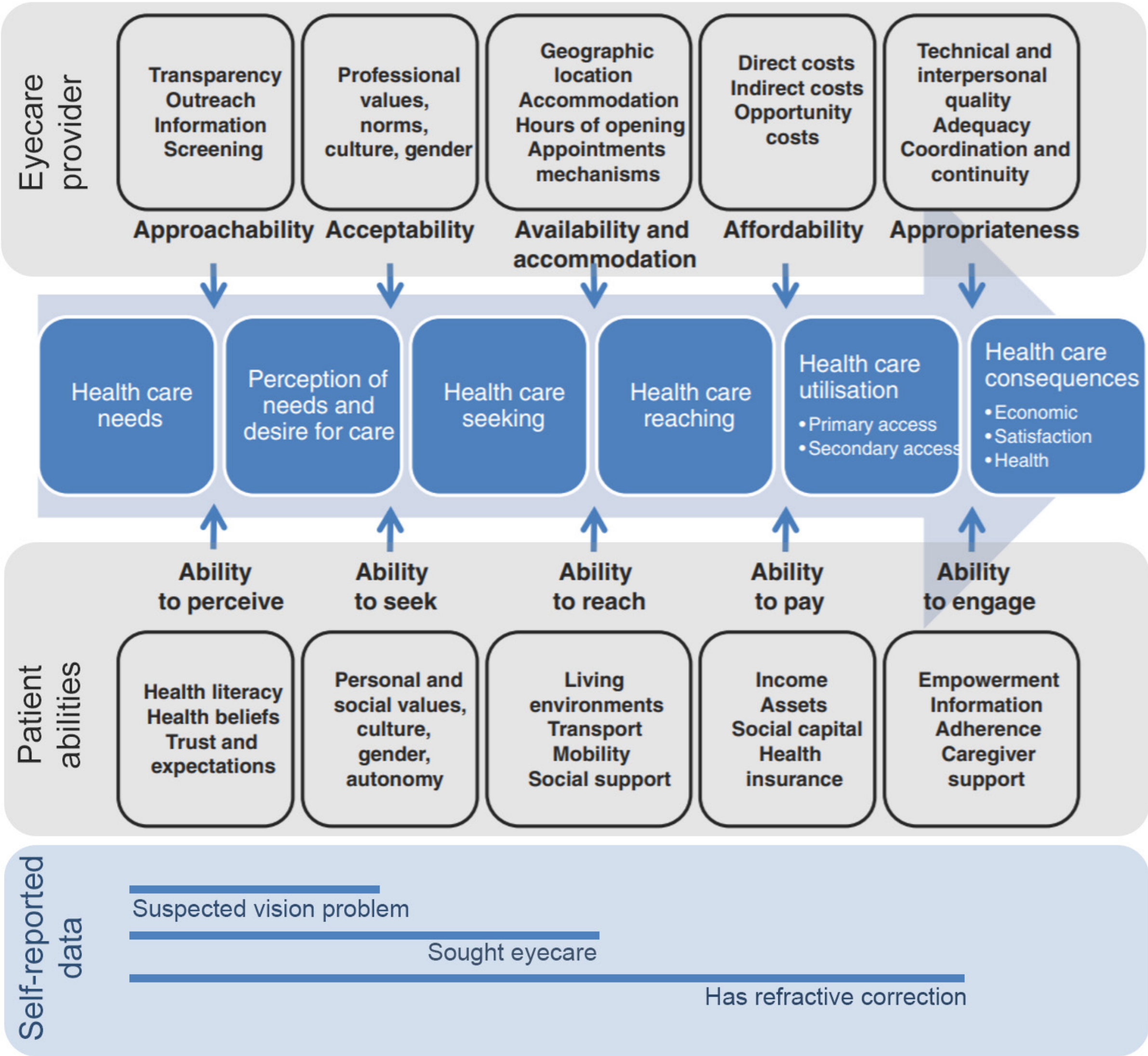
Two sets of relevant questions fell within the general component of the study. At 1-, 2-, 4-, and 6-years, parents were asked about the presence and frequency of vision problems since the last assessment. At 1-, 2-, 4-, 6- and 9-years, parents could note whether they had sought healthcare for their child within the last year for eye problems (an option within a comprehensive list of reasons for seeking healthcare). At 1- and 2-years, options for healthcare providers included healers, general practitioners and hospital/specialist/emergency clinic, whereas at 4-, 6- and 9-years, reasons for seeking healthcare were only queried for hospital/specialist/emergency clinic. We condensed each set of questions down to a single variable for each time point, summarised as "suspected vision problem" and "sought eyecare," respectively.

Additional relevant questions came from vision-specific components of the study at 9- and 18-years. At 9-years, children were asked whether they "normally wear corrective glasses or contact lenses." At 18-years, participants were asked whether they "had refractive correction" and whether they had "seen an eyecare professional (optometrist or ophthalmologist) within the last two years."

Self-reported data, and how that data may fit within a conceptual framework[27] for access, is presented in Figure 1.

Because the early childhood questions about seeking eyecare were not asked directly, we considered a response to be complete if the parent had filled in the relevant section; that is, if a parent did not select "eye problems" to any of the questions about health specialist visits, their response defaulted to a "no." For all other self-reported data, missing data or selection of "unknown" were considered incomplete.

Figure 1: Conceptual framework for access to healthcare.



Levesque et al's framework[27] separates provider and patient factors related to access. The self-reported data that shed light on a patient's ability to access eyecare systems are mapped to the lower part of the figure. Note that discrete questions cannot address the complexity of access; patient abilities are cumulative (someone who has refractive correction would need to have perceived a need, sought and reached eyecare, as well as had an avenue to pay for assessment services and treatment); and barriers and facilitating factors exist on the provider and patient sides. Adapted from Levesque et al (2013)[27].

Assessment of VA

At 9-years, children were invited to complete near and distance VA assessments. At 18-years, teens were invited to complete a distance VA assessment only. In each case, the left and right eyes were tested independently. If participants brought glasses or wore contact lenses, this refractive correction was used during the VA assessment. At 9-years, it was specifically noted whether each participant was using their correction, whereas at 18-years, assessors left a comment if a participant with refractive correction was not wearing it.

For distance VA at 9-years, children were asked to identify letters on a standardised physical chart viewed from four metres (ETDRS design, Sloan font, logarithmic size progression with five letters per line, testable range -0.32 to 1.1logMAR, scored letter by letter). At 18-years, distance VA was measured using an automated electronic VA (EVA[28]) system viewed from three metres (custom algorithm,[28] Sloan font, logarithmic size progression presented one single crowded letter at a time, testable range -0.32 to 1.6logMAR, scored letter by letter). For near VA at 9-years, children viewed a reduced size (1/10th) physical chart from 0.4 meters (ETDRS design, Sloan font, logarithmic size progression with five letters per line, testable range was -0.12 to 1.18logMAR, scored letter by letter).

We use logMAR notation to report VA, where smaller numbers indicate better vision and 0.0logMAR or more negative (Snellen notation 6/6 or better) is considered ostensibly normal. We report visual impairment based on definitions from ICD11 with cut-offs at 0.3logMAR (6/12), 0.5logMAR (6/18) and 1.0logMAR (6/60) for mild, moderate and severe impairment respectively, similar to related studies.[5,24] We use the same cut-offs for visual impairment when reporting near and distance VA.

For all VA assessments, we use the term "attempted" when participants had a recorded score, and "completed" when the recorded score fell within the testable range (defined above for each VA test). If a participant had a complete test result for one eye and did not attempt testing with the other eye, results were considered complete (to not exclude the possibility of monocular enucleation) and recorded as the "better eye."

Data analysis

Only complete data, as defined above, were used for analysis (summarised in Table 1). Data used for cross-sectional and longitudinal analysis were limited to the subset of participants with complete data for each variable in question, so some analyses have a lower "n" than the corresponding cells in Table 1. Data analysis was primarily descriptive and included scatter and Bland–Altman plots. Odds ratios (ORs) and the 95% confidence intervals (95% CI) were used to understand categorical data across time. Chi-squared tests were used to assess whether categorical information varied between groups. Wilcoxon rank-sum tests were used to examine differences in continuous data (neither dataset tested met normality assumptions). When we make comparisons about visual impairment across time, we consider only distance VA and group all visual impairment categories together. Data cleaning and analysis was completed in R studio on R versions 3.6.1 and 3.6.3.

Results

An overview of results, and the number of participants with complete data at each relevant time-point, is summarised in Table 1.

Between birth and 9-years, participation in the project reduced from 1,398 to 1,019 (73% retention). The vision component of the study at 9-years included fewer children than the wider data collection at that time-point; of the 1,016 eligible participants, only 887 answered the question about having refractive correction, 866 completed the distance VA test and 867 completed the near VA test.

At 18-years, 467 teens agreed to the invitation for additional follow-up. The subset of 9-year-olds who went on to participate at 18-years did not differ in terms of ethnic breakdown (χ^2=2.66, df=5, p=0.75) from those who did not participate as teens, but males were less likely to return for this extra follow-up than females (χ^2=5.00, df=1, p=0.03). Importantly, in terms of their 9-year-old distance VA, the subset of participants who returned at 18-years did not differ from the subset who did not return at this age (better eye: W=93081, p=0.87, n=383 vs n=483, worse eye: W=91559, p=0.92, n=383 vs n=480).

Self-reported data

Only 0.5% of parents (6/1,241) reported suspecting a vision problem for their 1-year-old, but this measure increased to about 3% by ages 4- and 6-years (32 and 30/1,064 respectively) as children's behaviour better reflects visual abilities. At 1- and 2-years, about 7% reported seeking some form of eyecare (which could include care for eye and vision concerns, as well as eye or vision check-ups where there were no concerns). This dropped to less than 1% as the questions focused on specialist, hospital and emergency clinic visits. About 15% of parents (111/729, 15.2%) reported seeking eyecare at least once from 1- to 9-years. At 18-years, 18.8% of participants (86/457) reported having seen an eyecare provider in the last two years. Ownership of refractive correction increased from 3.6% (32/887) to 14.3% (66/463) from 9- to 18-years.

Parents who reported suspecting a vision problem at some point between 1- and 6-years (n=30) were more likely to seek care for an eye issue (OR=4.8, 95% CI=2.2–10.2) and to have a child who usually wears refractive correction at 9-years (OR=10.6, 95% CI=4.0–28.1) than parents who did not report suspecting their child had problems with their vision. At 18-years, those who reported seeking eyecare in the last two years (n=86) were more likely to report having refractive correction (OR=16.6, 95% CI=9.1–30.4) than those who had not sought eyecare.

Those who reported seeking eyecare at least once between 1- and 9-years (n=97) were not significantly more likely to have refractive correction at 9-years (OR=1.9, 95% CI=0.7–5.0) than those who did not report seeking eyecare. Since there is an elevated odds ratio, it is possible that there were too few children with refractive correction at 9-years (n=24) to show a statistically significant association. Nonetheless, because an eye exam is a prerequisite to acquisition of refractive correction, this counter-intuitive finding suggests children had eye exams not captured by the study questions, possibly because an eye exam between 1- and 9-years was not considered a "specialist visit" by the parent, because eye exams occurred between queried time-points, or because parents reporting seeking eyecare for eye health rather than vision problems.

Assessment of VA

Among those who reported ownership of refractive correction and completed VA tests, only five of 29 children (17.2%) were confirmed to be wearing it at 9-years, compared to just over half at 18-years (36/65, 55.4%).

The VA test results are summarised in Table 2. The percentage of participants with visual impairment in one eye was 1.9% for distance and 2.4% for near at 9-years, and 7.9% for distance at 18-years. Percentage of visual impairment in both eyes was 0.9% for distance and 1.5% for near at 9-years, and 4.2% for distance at 18-years.

The change in distance VA between 9- and 18-years, by eye, is shown in Figure 2.

Overall, there was not a statistically or clinically significant change in mean distance VA from 9- to 18-years (0.02logMAR for each eye, one letter, for each eye). The limits of agreement (±0.42 and ±0.45logMAR for right and left eyes, respectively) are wide because of the variation associated with the deterioration of vision for many participants between 9- and 18-years (red dots above the mean line).

Integration of self-reported data and assessed distance VA

Avoidable visual impairment

Most children with visual impairment in at least one eye at 9-years had neither parental report of seeking eyecare (18/24, 75.0%) nor received refractive correction (15/24, 66.2%), which suggests that opportunities for intervention that could have mitigated or reversed visual impairment were missed. Indeed, of the four children with visual impairment and no refractive correction at 9-years who returned and completed the 18-year VA assessment, three had been prescribed correction by 18-years, and the two who were wearing it had substantial improvements in VA (≥0.20logMAR) compared to their uncorrected VA results at 9-years.

Most 18-year-olds with visual impairment had not seen an eyecare provider in the past two years (31/55, 56.4%) and did not own refractive correction (32/55, 58.2%). Thirty-nine 18-year-olds acquired their visual

Table 1: Overview of results across the longitudinal study.

	Suspected vision problem (same question each year)	Sought eyecare in last year (different wording across years*)	Sought eyecare in last two years (only asked once)	Has refractive correction (different wording across years)	Distance VA (different protocol across years)	Near VA (only assessed once)
	Self-reported data				**Assessed vision data**	
	General component		**Vision Specific component**			
Baseline **1,398 general participants**						
1-year **1,241 general participants**	C=1241 Yes=6 (0.5%)	C=1240 Yes=87 (7.0%)				
2-years **1,162 general participants**	C=1161 Yes=12 (1.0%)	C=1161 Yes=82 (7.1%)				
4-years **1,066 general participants**	C=1064 Yes=32 (3.0%)	C=1066 Yes=3 (0.3%)				
6-years **1,019 general participants**	C=1018 Yes=30 (2.9%)	C=1019 Yes=2 (0.2%)				
9-years **1,016 general participants** **891 vision participants**		C=1012 Yes=10 (1.0%)		C=887 Yes=32 (3.6%)	A=873 C=866 (3OE) VI=24 (2.8%)	A=877 C=867 (1OE) VI=34 (3.9%)
18-years **467 vision participants (only a subset invited to participate)**			C=457 Yes=86 (18.8%)	C=463 Yes=66 (14.3%)	A = 460 C=457 (1OE) VI=55 (12.0%)	
Completed all relevant time points **(Yes=at least once)**	C=847 Yes=45 (5.3%)	C=729 Yes=111 (15.2%)		C=402 Yes=62 (15.5%)	A=389 C=383 (1 OE) VI=50 (13.1%)	

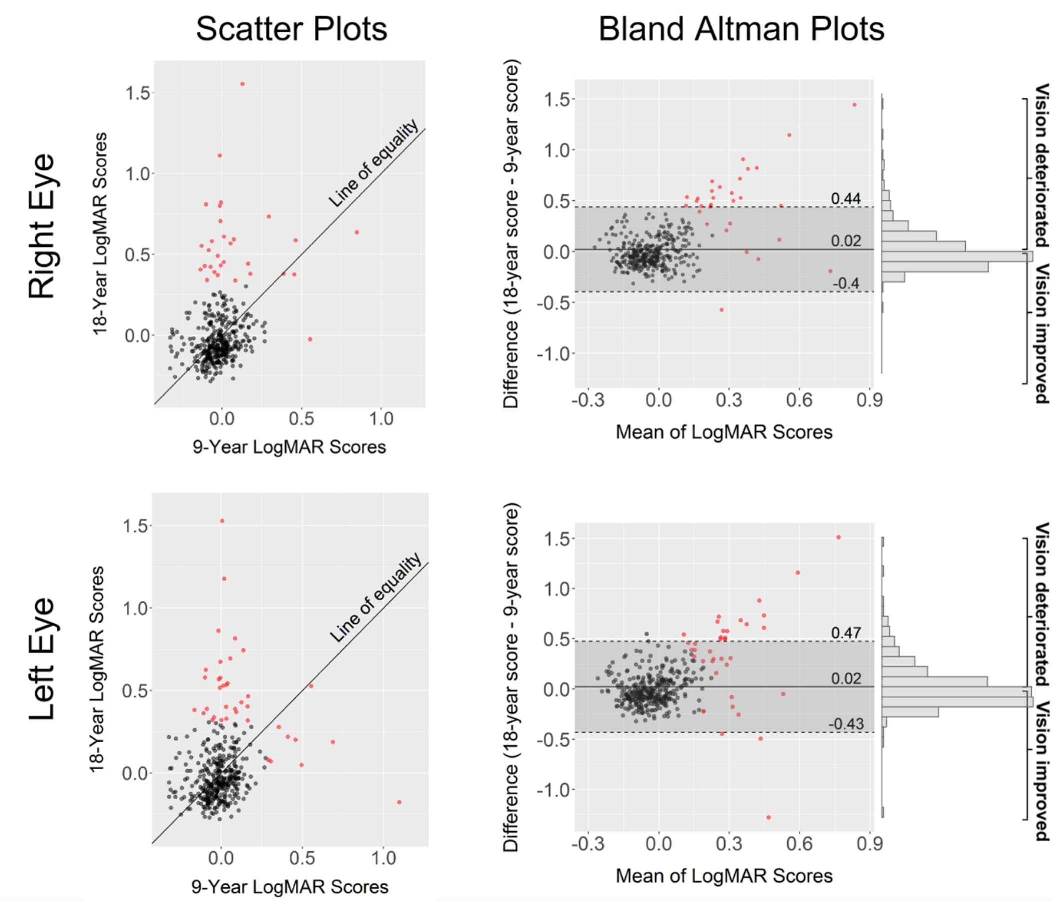
VI = visual impairment, using a cut-off of 0.3logMAR (6/12), including impairment in either one eye or both eyes. *For the questions about seeking eyecare at 1- and 2-years healthcare options included healers, general practitioners and hospital/specialist/emergency clinic, whereas at 4-, 6- and 9-years, reasons for seeking healthcare were only queried for hospital/specialist/emergency clinic. A = assessed, C = complete data, OE = one eye only.

Table 2: Prevalence of visual impairment

	9-year distance VA		9-year near VA		18-year distance VA	
	Count	Percent	Count	Percent	Count	Percent
No visual impairment either eye	839	97.2%	832	96.1%	401	87.9%
Visual impairment in one eye	16	1.9%	21	2.4%	36	7.9%
Visual impairment in both eyes	8	0.9%	13	1.5%	19	4.2%
Visual impairment in both eyes by level						
Mild visual impairment	4	0.5%	9	1.0%	11	2.4%
Moderate visual impairment	4	0.5%	3	0.3%	8	1.8%
Severe visual impairment	0	0.0%	1	0.1%	0	0.0%

Cut-off for visual impairment is >0.3logMAR (6/12), "mild" includes 0.31 to 0.50logMAR (poorer than 6/12 to 6/20), "moderate" includes 0.51 to 1.0logMAR (poorer than 6/18 to 6/60) and "severe" includes 1.1logMAR or greater (poorer than 6/60). This table counts only participants for whom there are completed data for both eyes.

Figure 2: Longitudinal changes in distance VA.



The upper panel shows data from the right eye (n=383) and the lower panel shows data from the left eye (n=382). Participants with vision impairment (VA>0.3logMAR) in either test are shown in red. To better visualise data points, each point is shifted by a randomly generated offset of up to 0.01logMAR (less than one letter on an eye chart), and a small level of transparency was added.

impairment after 9-years (at which age they had good VA and did not report having refractive correction). Most of this likely treatable subgroup had not seen an eyecare provider in the past two years (24/39, 61.5%) and did not own refractive correction (25/39, 64.1%), despite the fact that, for eight of these teens, the level of visual impairment would preclude acquisition of a driver licence.

Ability to access eyecare

Participants whose parents suspected a vision problem had clinically (more than 0.10logMAR, or 1 line) and statistically poorer VA at 9-years (better eye: 0.12logMAR, W=14839, p<0.0001, n=34 vs n=604 worse eye: 0.15logMAR, W=14786, p<0.0001, n=33 vs n=601) and 18-years (better eye: 0.13logMAR, W=6337, p<0.0001, n=28 vs n=320, worse eye: 0.23logMAR, W=6491, p<0.0001, n=28 vs n=319) than participants whose parents had never suspected a vision problem. Parents' ability to perceive a need for eyecare increased the likelihood that their children obtained refractive correction, but barriers remained; only nine of the 38 children whose parents noted concern went on to receive treatment by 9-years (23.7%).

At 18-years, although few teens (86/457, 18.8%) reported seeking eyecare services, most who did obtained refractive correction (51.2% overall, and 70.8% of those with visual impairment). This suggests Pacific teens were able to engage with treatment options when prescribed; however, barriers existed to reaching eyecare services in a timely matter. When participants reported having but not wearing refractive correction (at 9- and 18-years), lost or broken glasses was often noted as the reason, suggesting replacement was a further barrier (although this was not measured directly).

Discussion

Prevalence of visual impairment

The prevalence of distance-vision impairment at the 9-year assessment (1.9% in one eye only, and 0.9% in both eyes) is similar to the few published reports of visual impairment focused on primary-school aged Pacific children. Available reports include two 1980s publications about 5–19-year-olds in Vanuatu,[3,6] a 2020 report of 5–15-year-olds living in Tonga,[23] as well as recent reports about 5–12-year-olds[24] and 6–7-year-olds[5] in Auckland, all reporting less than 1% of children had visual impairment in both eyes. The higher prevalence of visual impairment at 18-years (7.9% in one eye only, and 4.2% in both eyes) is expected, primarily due to increased rates of myopia (the most common cause of poorer distance VA globally).[29] For example, in Vanuatu, myopia was found in 0.6% of primary school children and in 7.8% of secondary school students.[6] These prevalence rates are low compared to other groups of children. For example, vision impairment in both eyes is estimated to impact 3.7% of 6–7-year-old children in Ireland,[30] 10% of 5–15-year-old children in Southern China[31] and 13% of 6–19-year-olds in Western China.[32]

The prevalence of near-vision impairment at 9-years reported here (2.4% in one eye, and 1.5% in both) is lower than that of a recent study[5] of near vision in 6–7-year-old (predominantly Pacific) children in Auckland (9.7% in one eye, and 12.3% in both). This apparent discrepancy could be related to cognitive development from 6- to 9-years, and the observation that 6-year-olds can find near tests particularly challenging.

Functionally, at least 0.9% of the participants at 9-years would have struggled to see detailed information presented at the front of a classroom, and at least 1.5% would have struggled with their schoolwork at near. By 18-years, not only could untreated visual issues have potentially caused amblyopia[22] and impacted educational[19] and social development,[20] but they may also have begun to impact on teens' transition to independence; 4.2% of the 18-year-old cohort would not have met the vision standards for a driver licence.

Avoidable visual impairment and access to care

Although the prevalence of visual impairment is relatively low, much of it appeared avoidable; most participants with visual impairment had not reported seeking eyecare and did not own refractive correction. These issues reflect available published literature related to access. Pacific families are less likely to participate in the B4 School Check programme;[33] Pacific children are more likely to enter school with uncorrected refractive errors;[5] Pacific and Māori teens are less likely to have refractive correction than their European peers (Owens et al report 10% and 21% ownership, respectively[17]); and Pacific and Māori teens with low VA are reported to have little history of, or plan for, seeking eyecare.[17] Although this analysis of visual impairment and its correction aligns with available literature, the generalisability of these results beyond South Auckland is difficult to ascertain,[26] especially given the paucity of vision data from Aotearoa New Zealand.

This analysis does not address the reasons for these inequities or critique the provider side of access. It highlights patients' abilities (to perceive the need for eyecare, and to engage with treatment options when prescribed) and suggests how Pacific families could be better supported (to reach and pay for services). It is critical to consider the responsibility of the provider to change these negative trends in access. Eyecare is not free in Aotearoa New Zealand, and although subsidies are available, they can be hard to navigate.[5] Re-imagining an eyecare system that is more approachable, acceptable, available, affordable and appropriate[27] could help reduce the impact of avoidable visual impairment for Pacific youth, and should be the focus of further research and policy initiatives.

Strategies for improvement may include incorporating eyecare within primary healthcare; family-centric rather than service-centric models;[34] building trust, perhaps by increasing the number of culturally concordant eyecare providers; extending subsidies for eye-exams and treatment to older teens; and offering affordable and appropriate screening, assessment and treatment options co-located in convenient locations.[2,34,35] Although these broad strategies (and more specific strategies from other contexts[36,37]) may be useful, collaboration with Pacific communities in Aotearoa New Zealand is pivotal to understanding barriers and to developing and implementing appropriate strategies to overcome them.

Support for change in patterns of access is particularly important because Pacific teens are likely to go on to experience disproportionately greater issues associated with keratoconus,[13,14,17] cataracts[11,12] and diabetic retinopathy[7,9,10] later in life, and patterns of access to eyecare from early life may influence future eyecare seeking behaviours.

Limitations

Participant retention reduced between birth and 9-years and only a subset of participants could be invited for the 18-year assessment. These factors together potentially biased the sample towards families with better access to care. Furthermore, without full eye exams, we do not know the cause of visual impairment, and VA alone underestimates significant refractive error[5] and other forms of visual impairment. Thus, the problem of avoidable visual impairment among Pacific youth may well be larger than this analysis suggests.

This analysis does not include barriers to access, and we are limited in our interpretation of eyecare-seeking abilities because questions did not capture eyecare sought between data collection points. Additionally, from 1- to 9-years the question was subject to parent interpretation, and, specifically in years 4, 6 and 9, if a parent did not consider an eyecare provider a "specialist," our reports would underestimate eyecare seeking activity. Further, the wording of questions about having and wearing refractive correction differed slightly across years, which may potentially have affected the longitudinal observations.

Although the differences between the 9-year and 18-year VA protocols may have impacted reported thresholds, the effect is likely small. A recent study[38] found that results from the electronic format were only slightly improved compared to physical charts (range of 1–3 letters or 0.02–0.06logMAR[38]).

Conclusion

Although the prevalence of visual impairment was relatively low, most participants who had visual impairment did not report having refractive correction, and few reported regular eye exams. These findings suggest that much of the visual impairment would be avoidable with improved access to eyecare services. Because untreated childhood visual impairment may have life-long impact, establishing equitable access to eyecare could substantially improve outcomes for Pacific communities throughout the lifespan.

Competing interests:
Dr Tautolo, Dr Purdy, Dr Johnson, Dr Garrett and Dr Iusitini report grants from Health Research Council of New Zealand during the conduct of the study. Dr Tautolo and Dr Iusitini report grants from the Foundation for Research, Science and Technology during the conduct of the study. Dr Purdy reports other grants from University of Auckland during the conduct of the study.

Acknowledgements:
The authors would like to thank the families participating in the Pacific Islands Families Study, the researchers and assessors who collected the data at 9-years (Fa'asisila Savila, Jessica Scott) and 18-years (Daniela Estay, Julie Hill, Nidhi Aggarwal, Peter Stubbing, Oscar Cañete), the field staff who recruited participants at 18-years (David Qaranivalu, Natasha Pati, Metu Tariau) and Ben Elliot for his data support, as well as Joanna Black, Rebecca Findlay and Edda Thiels for providing helpful feedback on a draft of the manuscript. The authors also want to acknowledge the support of our funders, the Foundation for Research, Science, and Technology, the Health Research Council of New Zealand, and the Royal Society of New Zealand who funded Lisa M Hamm, through a Rutherford Postdoctoral Fellowship.

Author information:
Lisa M Hamm: Postdoctoral Research Fellow, School of Optometry and Vision Science, University of Auckland, Auckland, New Zealand.
Isabel A Johnson: Research Officer, Department of Biostatistics and Epidemiology, Faculty of Health, Auckland University of Technology, Auckland, New Zealand.
Robert J Jacobs: Associate Professor, School of Optometry and Vision Science, University of Auckland, Auckland, New Zealand.
Janis E Paterson: Professor, AUT Pacific Health Research Centre, Auckland University of Technology, Auckland, New Zealand.
El-Shadan Tautolo: Associate Professor, AUT Pacific Health Research Centre, Auckland University of Technology, Auckland, New Zealand.
Leon Iusitini: Senior Research Officer, AUT Pacific Health Research Centre, Auckland University of Technology, Auckland, New Zealand.
Nick Garrett: Associate Professor, Department of Biostatistics and Epidemiology, Faculty of Health, Auckland University of Technology, Auckland, New Zealand.
Suzanne C Purdy: Professor, School of Psychology, Eisdell Moore Centre, University of Auckland, Auckland, New Zealand

Corresponding author:
Suzanne C Purdy, School of Psychology, Faculty of Science, The University of Auckland, Building 302, 23 Symonds Street, Auckland Central 1010, 021 524 933
sc.purdy@auckland.ac.nz

URL:
www.nzma.org.nz/journal-articles/visual-impairment-and-its-correction-among-pacific-youth-in-aotearoa-findings-from-the-pacific-islands-families-study

REFERENCES

1. Ryan D, Grey C, Mischewksi B. Tofa Saili: A review of evidence about health equity for Pacific Peoples in New Zealand. 2019, Pacific Perspectives: Wellington.
2. Southwick M, Kenealy T, Ryan D. Primary Care for Pacific People: A Pacific and Health Systems Approach. 2012, Pacific Perspectives: Wellington.
3. Garner LF, Kinnear RF, McKellar M, et al. Refraction and its components in Melanesian schoolchildren in Vanuatu. Am J Optom Physiol Opt. 1988;65:182-9.
4. Newland HS, Harris MF, Walland M, et al. Epidemiology of blindness and visual impairment in Vanuatu. Bull World Health Organ. 1992;70:369-72.
5. Findlay R, Black J, Anstice N, et al. The prevalence of refractive error and visual impairment among New Zealand children in a community with significant socioeconomic disadvantage: is current preschool vision screening effective? N Z Med J. 2020;133:33-41.
6. Grosvenor T. Myopia in Melanesian school children in Vanuatu. Acta Ophthalmol Suppl. 1988;185:24-8.
7. Chang LY, Lee AC, Sue W. Prevalence of diabetic retinopathy at first presentation to the retinal

screening service in the greater Wellington region of New Zealand 2006-2015, and implications for models of retinal screening. N Z Med J. 2017;130:78-88.

8. Court JH, Lu LM, Wang N, McGhee CNJ. Visual and ocular morbidity in severe open-globe injuries presenting to a regional eye centre in New Zealand. Clin Exp Ophthalmol. 2019;47:469-77.
9. Simmons D. The epidemiology of diabetes and its complications in New Zealand. Diabet Med. 1996;13:371-75.
10. Simmons D, Gatland BA, Leakehe L, Fleming C. Ethnic differences in diabetes care in a multiethnic community in New Zealand. Diabetes Res Clin Pract. 1996;34:89-93.
11. Yoon JJ, Misra SL, McGhee CNJ, Patel DV. Demographics and ocular biometric characteristics of patients undergoing cataract surgery in Auckland, New Zealand. Clin Exp Ophthalmol. 2016;44:106-13.
12. McGhee CNJ, Zhang J, Patel DV. A perspective of contemporary cataract surgery: the most common surgical procedure in the world. J R Soc N Z. 2020;50:245-62.
13. Crawford AZ, McKelvie J, Craig JP, et al. Corneal transplantation in Auckland, New Zealand, 1999-2009: Indications, patient characteristics, ethnicity, social deprivation, and access to services. Cornea. 2017;36:546-52.
14. Fan Gaskin JC, Good WR, Jordan CA, et al. The Auckland keratoconus study: Identifying predictors of acute corneal hydrops in keratoconus. Clin Exp Optom. 2013;96:208-13.
15. Johnston NR, Sanderson G. Orbital infection in New Zealand: Increased incidence due to socioeconomic deprivation and ethnicity. N Z Med J. 2010;123:50-7.
16. Bhikoo R, Murray N, Sikivou B, et al. Demographic features and visual outcomes of patients presenting to diabetic photo-screening and treated for sight threatening retinopathy in Fiji. Int J Ophthalmol. 2017;10:790-5.
17. Owens H, Gamble GD, Bjornholdt MC, Boyce NK, Keung L, Topographic indications of emerging keratoconus in teenage New Zealanders. Cornea. 2007;26:312-8.
18. Hamm L, Findlay R, Black J. Vision Screening in infancy and childhood. In: Brief Evidence Reviews for the Well Child Tamariki Ora Programme. 2019, Ministry of Health: Auckland.
19. Hopkins S, Narayanasamy S, Vincent SJ, et al. Do reduced visual acuity and refractive error affect classroom performance? Clin Exp Optom. 2020;103:278-89.
20. Runjić T, Prcić AB, Alimović S. The relationship between social skills and behavioral problems in children with visual impairment. Hrvat. Rev. Za Rehabil. Istraz. 2015;51:64-76.
21. Holmes JM, Clarke MP. Amblyopia. Lancet. 2006;367:1343-51.
22. Levi DM, Rethinking amblyopia 2020. Vision Res. 2020;176:118-29.
23. Hamm LM, Langridge F, Black JM, et al. Evaluation of vision screening of 5–15-year-old children in three Tongan schools: comparison of The Auckland Optotypes and Lea symbols. Clin Exp Optom. 2020;103:353-60.
24. Hamm LM, Anstice NS, Black JM, Dakin SC. Recognition acuity in children measured using The Auckland Optotypes. Ophthalmic Physiol Opt. 2018;38:596-608.
25. Von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. The Lancet. 2007;370,1453–1457.
26. Paterson J, Percival T, Schluter P, et al. Cohort Profile: The Pacific Islands Families (PIF) Study. Int J Epidemiol. 2008;37:273-9.
27. Levesque JF, Harris MF, Russell G. Patient-centred access to health care: Conceptualising access at the interface of health systems and populations. Int J Equity Health. 2013;12:18.
28. Beck RW, Moke PS, Turpin AH, et al. A computerized method of visual acuity testing: Adaptation of the early treatment of diabetic retinopathy study testing protocol. Am J Ophthalmol. 2003;135:194-205.
29. Holden BA, Fricke TR, Wilson DA, et al. Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. Ophthalmology. 2016;123:1036-42.
30. Harrington SC, Stack J, Saunders K, O'Dwyer V. Refractive error and visual impairment in Ireland schoolchildren. Br J Ophthalmol. 2019;103:1112-8.
31. He M, Zeng J, Liu Y, et al. Refractive error and visual impairment in urban children in southern China. Invest Ophthalmol Vis Sci. 2004;45:793-9.
32. Chin MP, Siong KH, Chan

KH et al. Prevalence of visual impairment and refractive errors among different ethnic groups in schoolchildren in Turpan, China. Ophthalmic Physiol Opt 2015;35:263-70.

33. Gibb S, Milne B, Shackleton N, et al. How universal are universal preschool health checks? An observational study using routine data from New Zealand's B4 School Check. BMJ Open. 2019;9:e025535.
34. Premium Research Limited. Before School Checks Consumer Research. 2014, Health Promotion Agency: Wellington.
35. Teevale T, Denny S, Percival T, Fleming T. Pacific secondary school students' access to primary health care in New Zealand. N Z Med J. 2013;126:58-68.
36. Frazier M, De La Cruz N, Garcés IC. Development of Educational Materials to Improve Rates of Early Eyecare for Hispanic Children. J Immigr Minor Health. 2012;14:608-16.
37. Rodriguez E, Srivastava A, Landau M. Increasing Screening Follow-Up for Vulnerable Children: A Partnership with School Nurses. Int J Environ Res Public Health. 2018;15:1572.
38. Jolly JK, Juenemann K, Boagey H, et al. Validation of electronic visual acuity (EVA) measurement against standardised ETDRS charts in patients with visual field loss from inherited retinal degenerations. Br J Ophthalmol. 2020;104:924-31.