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Vision Screening in Children: The New South Wales Statewide Eyesight Preschooler Screening Program

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Purpose: The aim was to investigate universality of access, screening rate, and outcomes from the New South Wales (NSW) Statewide Eyesight Preschooler Screening (StEPS) over the period of 2009 to 2016.

Design: Cross-sectional, observational study.

Methods: The StEPS program provides vision screening to 4-year-old children residing in NSW and is administered within Local Health Districts (LHDs). Visual acuity (VA) was examined by trained lay and nurse screeners using HOTV logMAR. Children who had VA <6/9^{-2} were referred to local practitioners while those with VA <6/18 were referred to public hospital pediatric ophthalmic outpatient clinics where available. Activity data were collected by NSW Health and screening rates determined from population projections of 4-year-olds per LHD based on adjusted 2014 Census data. To determine factors impacting screening and referral rates, a random effects panel analysis was undertaken.

Results: A total of 719,686 (96.4%) NSW 4-year-old children were offered StEPS vision screening between 2009 and 2016, 84% accepted and 564,825 children (75.6%) were screened. The screening rate increased from 67.3% in 2009 to 74.5% in 2016, with an 80% target reached for 3 consecutive years from 2013 to 2015. Of those screened, 19.2% were referred to an eye health professional or advised to have a vision retest in 12 months. This referral rate remained steady over the period studied, with little variation between metropolitan, and rural and regional LHDs.

Conclusions: StEPS is an ideal service model for preschool vision screening providing coverage that is comparable to school-based screening programs and at an age likely to facilitate optimal treatment outcomes.

Key Words: vision screening, preschoolers, public health

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Screening for reduced vision in a young child enables early detection of visual deficits, which if untreated, may hinder normal visual development.[1] The primary target of childhood vision screening is amblyopia and refractive errors.[2,3] Amblyopia is loss of vision, usually of one eye, due to anisometropia (unequal refractive error between eyes) and/or strabismus (turned eye) or stimulus deprivation due to conditions such as childhood cataract. Amblyopia can be successfully overcome if treated in early childhood, during the period of neural plasticity that progressively declines with age.[4] Early detection and treatment is particularly pertinent if the amblyopia is severe.[5] Treatment of amblyopia by patching the nonamblyopic eye may also be better conducted prior to formal schooling, with some evidence of bullying of school children who received overt vision therapies.[6] Correction of refractive errors prior to school entry may also improve educational outcomes,[7,8] although this remains an area requiring further investigation in cohort studies. However, as such studies could raise ethical concerns, they may be best conducted retrospectively.

The widely recommended age for vision screening for amblyopia and childhood refractive error is between 3 and 5 years.[2,3] The Statewide Eyesight Preschooler Screening (StEPS) service model is a free universal vision screening program for 4-year-old children in New South Wales (NSW), Australia, that commenced in 2008. It is conducted mostly in preschools and childcare centers with some additional clinics provided at other children's services such as community health centers, and child and family health centers. The StEPS program aims to detect vision problems prior to children starting school, at an age when reliable vision testing can be achieved[9] and treatment for amblyopia is effective.[1]

The World Health Organization (WHO) Universal Eye Care Action Plan 2014–2019 states that the provision of universal access to eye care services is necessary, with emphasis on vulnerable groups such as children.[10] The StEPS program meets the WHO criteria for a screening program[11] and is aligned with current recommendations from the United States Preventative Services Task Force (USPSTF).[2] In 2017, the NSW Ministry of Health commissioned an evaluation of the effectiveness and efficiency of StEPS. The current study based on the program evaluation aims to determine access to the StEPS vision screening program and its outcomes over the period from 2009 to 2016.

METHODS

The StEPS program is delivered across the 15 Local Health Districts (LHDs) in NSW, each implementing

the program within the guidelines and procedures stated in the StEPS Program Policy Directive.[12] Children who were eligible to receive vision screening as part of the StEPS program were those who were aged 4 years, typically in the year prior to starting school. Children who were aged 5 years and had not previously been screened by the program and children who were aged 3 years and were eligible to start school in the following year may also have been screened. Families of eligible children attending government and private preschools, private day care centers, or who attend child and family health centers for health checks were invited to participate in the vision screening program. Information regarding the StEPS vision screening was distributed to all parents and carers, and signed consent forms were returned to each center for collection by the screeners when they attended the preschool or childcare center to conduct the screening.

Figure 1 provides an overview of the StEPS screening model and referral pathways. The StEPS vision screening protocol consists of monocular linear visual acuity (VA) testing conducted by trained lay and nurse screeners. Training for screeners includes completion of 2 education modules delivered through the NSW Health Education and Training Institute (HETI) system followed by a minimum of 4 hours of onsite practical vision screening training with a StEPS coordinator or orthoptist. Screeners are assessed for competency following 3 months of screening experience and thereafter are reassessed annually.

The StEPS program initially used a Sheridan Gardiner (Snellen) acuity chart with matching card to test vision and after 2017 transitioned to HOTV logMAR charts with matching card. Vision was tested at a distance of 6 meters when convenient, or at 3 meters, using a VA chart specifically calibrated for the distance used. Children who obtained a VA of $<6/9^{-2}$ ($20/30^{-2}$) in either or both eyes were considered a routine referral and were referred to a general medical practitioner or eye care professional, and those with a VA <6/9 (20/30) but $>6/9^{-2}$ ($20/30^{-2}$) were considered a "borderline pass" and advised to be rechecked in 12 months' time either by a general medical practitioner or optometrist. Those that had a VA of $\leq 6/18$ (20/60) were considered a "high-priority" referral and were referred to a metropolitan public hospital pediatric ophthalmic outpatient clinic if available in the area, or alternatively could attend a private ophthalmology or optometry service. In addition to the primary screening, 9 of the LHDs had access to secondary screening conducted by an orthoptist, for children who were unable to be assessed at the initial vision screening or who were deemed "high priority" on initial screening.

StEPS activity data are routinely reported by StEPS coordinators within each of the 15 LHDs to the NSW Ministry of Health and include the number of children offered screening, the number of screening consents received, the number of children screened, and the outcome of

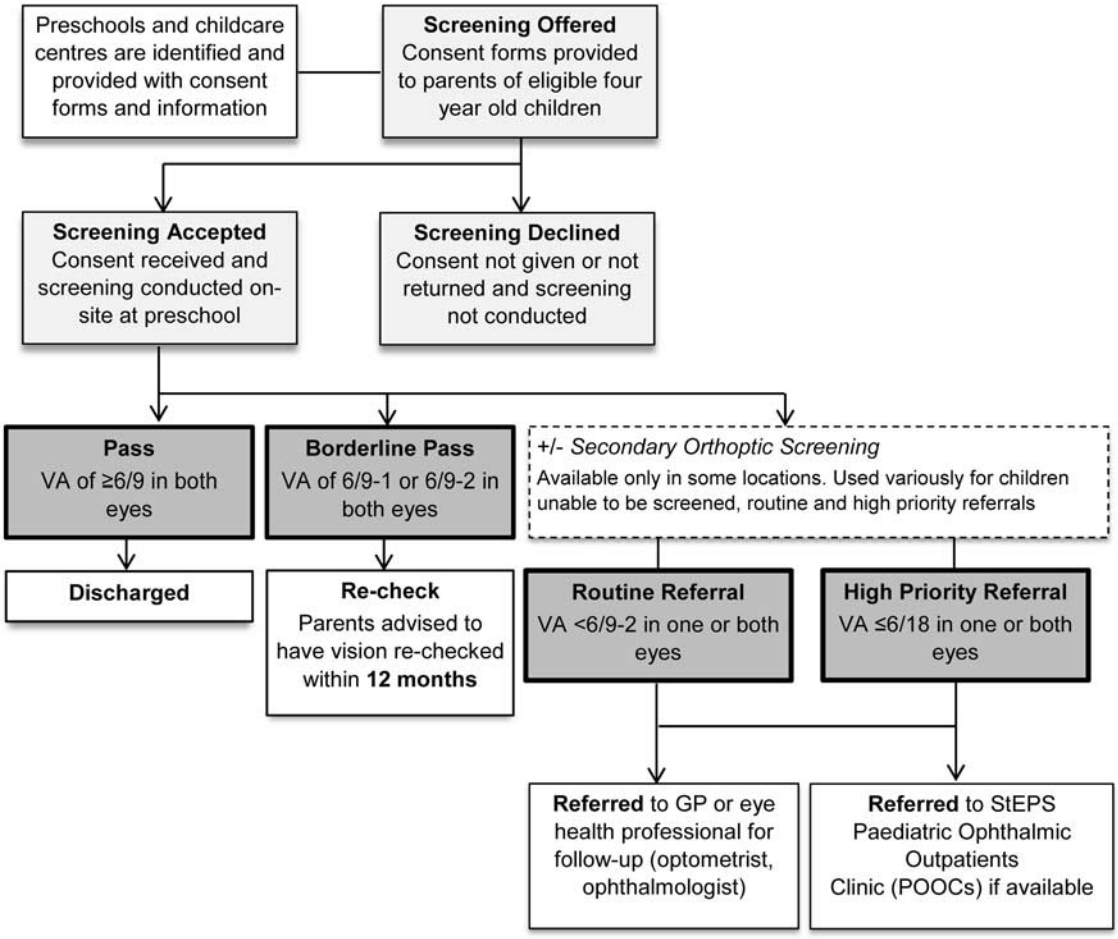

FIGURE 1. Overview of the StEPS screening model and referral pathways. GP indicates general medical practitioner; StEPS, Statewide Eyesight Preschooler Screening; VA, visual acuity.

screening. The deidentified StEPS activity data collected from January 2009 to December 2016, were analyzed for this study. Analysis was performed using Stata version 14. Screening activity rates were determined from projections of the number of 4-year-olds per LHD from 2008 to 2016 based on the Australian Bureau of Statistics 2014 Census population by age data, with adjustments by year calculated by the Centre for Epidemiology and Evidence, Ministry of Health, NSW. Referral rates and proportional classification of referral were also calculated.

To determine factors that impact the StEPS screening and referral rates, regression using random effects panel analyses were undertaken. The data were organized into panel, or cross-sectional time series in each calendar year, for calculation of screening and referral rates for each StEPS service. The random effects model was chosen over a fixed effects model based on the Hausman test[13] and assumes that unobserved factors outside of the model are uncorrelated with the observed variables included in the model. Explanatory variables were obtained through service mapping of each LHD delivering the StEPS program and included: metropolitan or rural and regional location, qualifications of screening staff, permanent or casual employment of screening staff, full-time equivalent screening staff per 10,000 children eligible for screening, availability of catch-up clinics, access to secondary orthoptic screening, and the projected number of eligible 4-year-old children within the LHD.

This study adhered to the tenants of the Declaration of Helsinki and received ethical approval from the University of Technology Sydney's and Northern Sydney Local Health District's Human Research Ethics Committees, and the Aboriginal Health and Medical Research Council (Australia).

RESULTS

Rate of Screening

Overall, 719,686 eligible children (96.4% of the projected population of 4-year-olds) were offered vision screening between 2009 and 2016 by the StEPS program. Of these, 84% accepted, with 564,825 (75.6%) children ultimately screened (Fig. 2). The screening rate increased from 67.3% in 2009 to 74.5% in 2016, representing an increase of 7.2%, although this was not statistically significant ($P = 0.052$). In metropolitan LHDs, screening rates appeared to remain relatively stable over time ($P = 0.638$). However, rural and regional LHDs saw a larger increase in screening rate over the study period, from 56.2% to 84.2%, representing a significant rise of 28% ($P = 0.004$). There was a slight decline in screening rates in 2016 compared to previous years. If 2016 was excluded from the analysis, the increase in screening rate over time was significant across NSW overall ($P = 0.003$) and in rural and regional LHDs ($P = 0.002$) but not in metropolitan LHDs ($P = 0.071$). The target of 80% of the population of 4-year-old children in NSW being vision-screened was reached in 2 years (2013 and 2015) but, the overall screening rate was above 75% for 3 consecutive years (2013–2015) across the state (Fig. 3). In rural and regional LHDs the screening rates were higher than in metropolitan areas overall, with the 80% target met and exceeded since 2012. The 80% target screening rate was met by 40% of LHDs across all years. Two LHDs met the 80% target in at least 90% of the study years, and the remaining 3 metropolitan and 3 rural and regional LHDs met the screening target in at least 50% of the years studied.

For children who were given parental consent to be screened, 6.3% were not screened because they were absent on the day of screening (n = 37,831). A further 0.3% were not screened for other undetermined reasons (n = 2037). The number of children absent increased sharply in 2013 but declined after

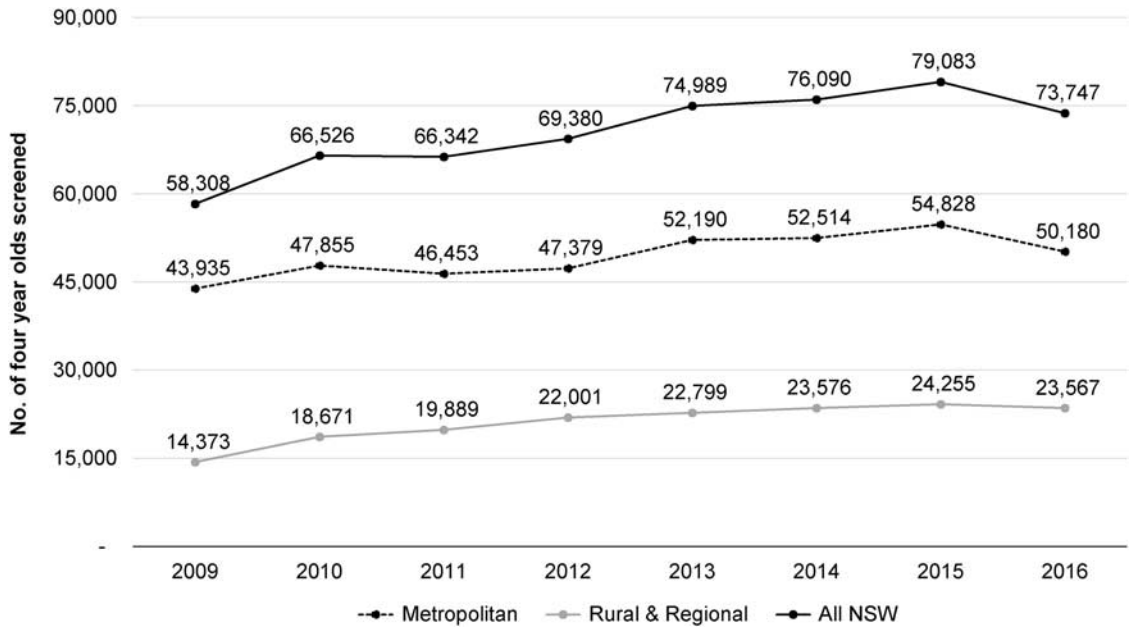

FIGURE 2. The number of children screened between 2009 and 2016 across New South Wales (NSW), metropolitan and rural and regional locations.

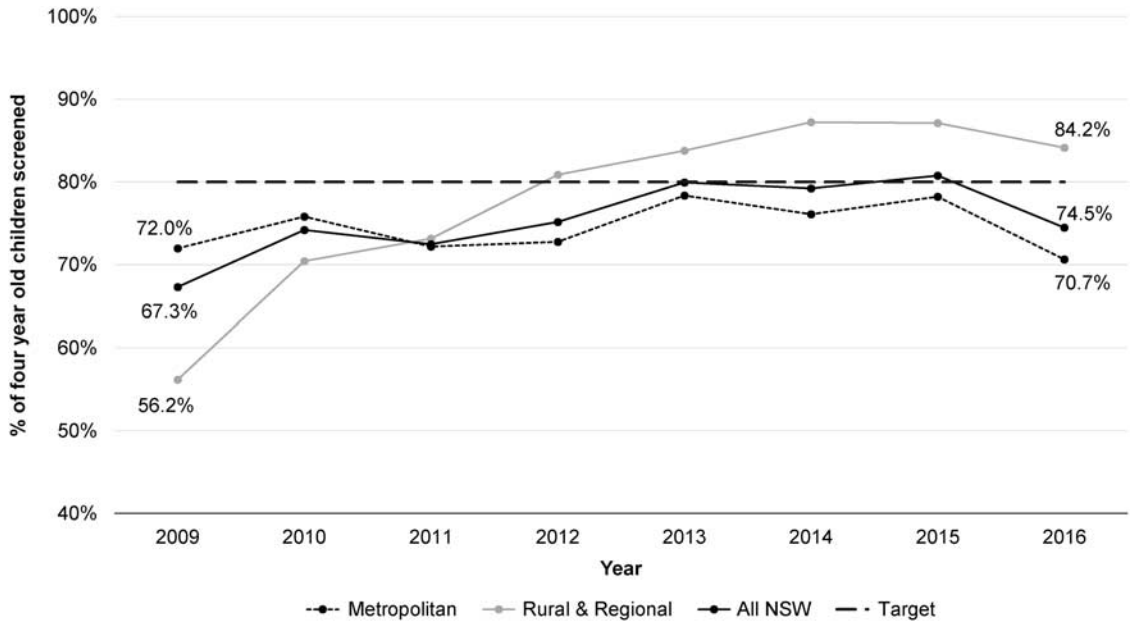

FIGURE 3. The percentage (%) of total predicted 4-year-old children in New South Wales (NSW) who were screened between 2009 and 2016.

2014, and the number of children not screened for other reasons declined after 2012. The number of Aboriginal children screened steadily increased over the study period to be more than doubled in 2016 (n = 4368) compared to 2009 (n = 1908).

Table 1 details the random effects panel analysis to determine factors that may impact screening rates within LHDs. The rate of children completing vision screening was higher where there was a greater proportion of children who received parental consent to be screened (+1.3%, $P = 0.001$) and lower where there were higher rates of absenteeism on the day of screening (–1.3%, $P = 0.007$). There was no significant impact of staffing configuration or location on screening rates, consistent with the high rates of vision screening for those in rural and regional LHDs. However, the screening rate was 19.3% higher in LHDs where catch-up clinics by the StEPS screeners were available to those children who missed initial visits to the preschool or childcare center ($P = 0.047$).

Rate of Referral

Of the children screened, 19.2% (n = 108,419) were referred for further examination. This referral rate remained steady over the 8 years studied (Fig. 4). Of the children referred from the program, 53,169 (49%) were directly referred to an eye care professional with a VA of $<6/9^{-2}$ and the remainder were classified as borderline pass (n = 55,214). Almost a quarter of those referred directly to external services were classified as a high-priority referral (n = 13,246, 24.9%), while more than half (n = 31,015, 58.3%) were routine priority referrals. A further 16.8% (n = 8908) were referred as unable to be screened or who had an incomplete screening.

There was minimal variation between metropolitan, and rural and regional LHDs in either the rate of referral or proportional types of referrals. From 2009 to 2016, the difference in referral rate ranged between 0.1 and 1.0 percentage points (mean = 0.1) in metropolitan compared to rural and regional locations, and was not consistently higher in any one location. There was also little difference in high-priority (mean = 0.4, range: 0–0.7 percentage points) and routine (mean = 0.6, range: 0.3–1.2 percentage points) referral rates, or referral rate of unable-to-be-screened children (mean = 0.1, range: 0–0.4 percentage points). However, on average 2.7% more children were assessed as a borderline pass in metropolitan LHDs compared to those in rural and regional locations. Correspondingly, on average 2.6% fewer children passed their vision screening in the metropolitan LHDs compared to those in rural and regional locations.

TABLE 1. Random-Effects Panel Model for Factors Impacting Rate of Screening

Explanatory Factor	Coefficient	SE	95% CI		*P*
Rate of acceptance of screening offer	0.08	0.02	0.04	0.13	0.001*
Rate of absenteeism of day of screening	−0.09	0.03	−0.15	−0.02	0.007*
Rate of children not screened for other reasons	−0.26	0.11	−0.47	−0.06	0.012*
Availability of catch-up clinics	1.26	0.03	0.60	1.93	<0.001*
FTE screeners per 10,000 four-year-olds in LHD	0.21	0.35	−0.48	0.90	0.55
Projected no. 4-year-olds in LHD	0	—	—	—	0.84
Metropolitan vs rural and regional	1.07	0.63	−0.18	2.31	0.09
Permanent vs casual screeners	0.25	0.32	−0.39	0.88	0.45
Nurse vs lay screeners	0.21	0.32	−0.36	0.68	0.37
Administrative support for booking preschools	−0.95	0.62	−11.22	−1.90	0.12

CI indicates confidence interval; FTE, full-time equivalent; LHD, local health district.

*Statistically significant.

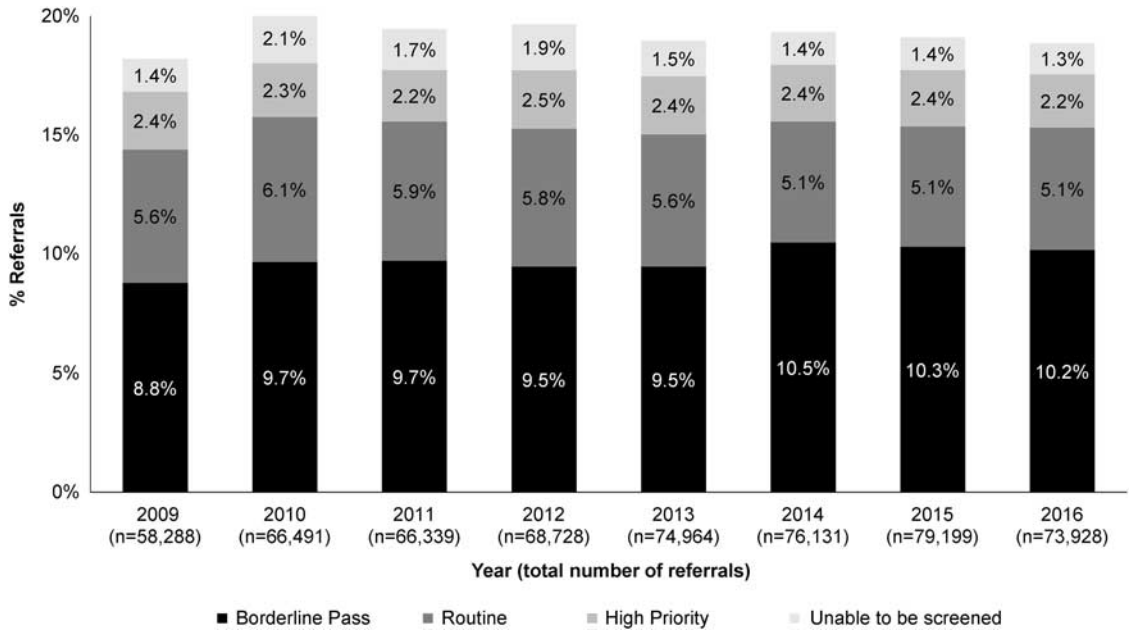

FIGURE 4. The proportion (%) of referrals according to referral classification from the Statewide Eyesight Preschooler Screening program between 2009 and 2016.

Tables 2 and 3 outline the results of the random effects panel analysis examining factors related to variation in the rate of overall referral, high-priority and routine referrals, and the referral of those unable to be screened. Referral rates were overall lower in LHDs that employed vision screeners on a permanent rather than casual basis (–3.2%, $P = 0.017$), and persisted for both routine referrals (–2.0%, $P < 0.001$) and those unable to be screened (–1.1%, $P < 0.001$). However, the rate of high-priority referral was not significantly impacted by screener employment type. Overall, this equated to permanently employed screeners making 18,130 fewer referrals compared to casual screeners, assuming all else is equal between LHDs. There was no significant impact on any category of referral related to the qualifications of screeners (nurses compared to lay screeners) or the ratio of full-time equivalent screeners to the projected size of the population eligible to be screened.

In those LHDs that had secondary orthoptic screening conducted for children who were unable to be tested at their initial screening, there were significantly lower rates of routine referrals (–0.8%, $P = 0.024$) and borderline pass referrals (–3.9%, $P = 0.03$). However, the availability of the option of sending children to secondary orthoptic screening, probably accounts for a significantly higher rate of children being designated as "unable to be screened" (+1.5%, $P < 0.001$) in these LHDs. This was also coupled with an overall higher rate of referral (+2.0%, $P = 0.033$). Interestingly, in those LHDs who had access to secondary screening for high-priority referrals, there was a significant increase in routine referrals (+1.5%, $P = 0.014$), while in those that had access to orthoptic screening for routine referrals, there was significantly reduced high-priority referral (–1.9%, $P = 0.014$).

Overall referral rate was not significantly different in metropolitan compared to regional or rural location, nor were referrals to an eye care professional (high-priority and routine referral) or unable-to-be-screened referrals. However, metropolitan location remained associated with a significantly higher rate of borderline pass referral (+6.9%, $P = 0.039$) when other explanatory variables were controlled for in this analysis.

DISCUSSION

Overall, the StEPS service model achieved close to universal access to children, with 96% of all NSW 4-year-old children offered vision screening. The program also had a high screening rate that increased over the time period studied, particularly in rural and regional locations, while remaining steady in metropolitan Sydney. In previous reports of childhood vision screening programs, the main determinant of access by children to vision screening has appeared to be where screening is conducted, with considerably higher uptake rates (>90%) from school screening[14,15] than preschool settings (49%–75%).[14–17] As reports of school vision screening programs are generally from countries with comprehensive education, recruitment to vision screening for school-aged children is likely to be more universal. Preschool attendance is frequently not universal and may require specific recruitment strategies to access a high proportion of children of this age. We have found the StEPS program screening rate to be 76% over the 8 years examined, placing StEPS amongst the highest reported screening rates for preschool screening. These findings collectively indicate that the StEPS program is effective in providing a high rate of access to screening for preschool children over an extended period of time.

The StEPS program is unique compared to other programs targeting preschool children[12–15] as it follows a model similar to school screening, with children screened at their preschool or childcare center. Based on our findings and those from school screening programs, it is clear that access to children for screening without the need for specific expenditure of parental time and effort is the most successful approach to recruiting a large proportion of children. It appears that screening in community health centers and cen-

TABLE 2. Random-Effects Panel Model for Factors Impacting Rate of Referral for Total, High-Priority, Routine, and Unable-to-Be-Screened Referral Classification

Explanatory Factor	Coefficient	SE	95% CI		*P*
Total referral					
Metropolitan vs rural and regional	0.09	0.22	−0.33	0.51	0.68
Estimated no. 4-year-olds in LHD	0	—	—	—	0.46
FTE screeners per 10,000 four-year-olds in LHD	0.16	0.01	−0.15	0.47	0.32
Nurse vs lay screeners	−0.17	−0.15	−0.46	0.11	0.23
Permanent vs casual screeners	−0.41	0.18	−0.75	−0.07	0.017*
Catch-up clinics available	0.36	0.26	−0.16	0.88	0.18
Secondary screening for unable-to-be-screened	0.18	0.08	0.02	0.34	0.033*
Secondary screening for high-priority referral	0.28	0.18	−0.07	0.62	0.12
Secondary screening for routine referral	−0.21	0.17	−0.54	0.12	0.22
High-priority referral					
Metropolitan vs rural and regional	−0.38	0.34	−1.04	0.29	0.27
Estimated no. 4-year-olds in LHD	0	—	—	—	0.61
FTE screeners per 10,000 four-year-olds in LHD	0.20	0.23	−0.26	0.65	0.40
Nurse vs lay screeners	−0.20	0.26	−0.71	0.31	0.44
Permanent vs casual screeners	−0.18	0.29	−0.76	0.39	0.53
Catch-up clinics available	0.79	0.51	−0.20	1.78	0.12
Secondary screening for unable-to-be-screened	0.37	0.19	0.01	0.75	0.06
Secondary screening for high-priority referral	0.34	0.29	−0.23	0.91	0.24
Secondary screening for routine referral	−0.78	0.32	−1.40	−0.16	0.014*
Routine referral					
Metropolitan vs rural and regional	0.16	0.15	−0.13	0.46	0.09
Estimated no. 4-year-olds in LHD	0	—	—	—	0.28
FTE screeners per 10,000 four-year-olds in LHD	0.07	0.11	−0.14	0.29	0.50
Nurse vs lay screeners	−0.19	0.07	−0.17	0.13	0.13
Permanent vs casual screeners	−0.37	0.10	−0.16	−0.16	< 0.001*
Catch-up clinics available	0.06	0.17	−0.28	0.40	0.74
Secondary screening for unable-to-be-screened	−0.13	0.59	−0.25	−0.01	0.024*
Secondary screening for high-priority referral	0.26	0.11	0.05	0.47	0.014*
Secondary screening for routine referral	0.09	0.11	−0.12	0.31	0.40

CI indicates confidence interval; FTE, full-time equivalent; LHD, local health district.

*Statistically significant.

tralized locations poses barriers associated with parents attending with their child, and invitation-based recruitment processes frequently achieve comparatively low rates of response.[14,15] Adding to the success of the StEPS program in accessing children in NSW is the Australian government's commitment to providing universal access to preschool education in the year prior to starting school. This has contributed to high and increasing rates of preschool attendance in Australia, and in NSW by 2016 some 96.1% of children attended preschool.[18] This makes preschool-based screening following the StEPS model particularly viable for accessing the 4-year-old population.

Current recommendations suggest that 4 years of age and prior to school entry, as targeted by StEPS, is the most appropriate age for vision screening in children.[2,3] There are a number of reasons for this recommendation. High testability for VA (95%) can be achieved by this age,[7] while also providing sufficient time for effective amblyopia treatment to be undertaken.[1] Preschool screening also allows for identification and treatment of other visual disorders such as, refractive error, prior to school entry.[7,8] The StEPS testability for gold-standard VA (Sheridan Gardiner and HOTV logMAR) using matching was 98.4%, with only 1.6% of children being unable to be screened. That testability for a gold-standard VA test is high in this age group, supporting recommendations to offer vision screening to preschool children and StEPS as an appropriate model for childhood vision screening.

Worldwide, there is substantial variation in the implementation of pediatric vision screening programs with differences, even within countries, in the age targeted, screening test used, approach to offering screening, and qualifications of those conducting screening.[19–21] A number of reported vision screening programs target children within specific districts, cities or in some cases, individual schools, particularly those in disadvantaged, or low socioeconomic status areas.[22,23]

Despite currently accepted recommendations for universal vision screening of 4-year-old children, these inconsistencies in implementation continue to limit the access of children to vision screening worldwide. A substantial strength of the StEPS program is the scale of screening, with the program providing access to children across the entire state of NSW. The current report is based on systematically collected cross-sectional data from one of the largest vision screening populations and over a long time period. One previous report of a larger population was identified, based on a national vision screening program in Iran that screened 26,574,386 children between the ages of 3 and 6 years over a 14-year period.[24] However, a significant limitation in comparing this program is that it is unclear what proportion of the total population of children were screened and there are limited details provided on how children were accessed for this screening.

TABLE 3. Random-Effects Panel Model for Factors Impacting Rate of Referral for Borderline Pass and Unable-to-Be-Screened Classification

Explanatory Factor	Coefficient	SE	95% CI		*P*
Unable-to-be-screened					
Metropolitan vs rural and regional	0.32	0.29	−0.24	0.89	0.27
Estimated no. 4-year-olds in LHD	0	—	—	—	0.57
FTE screeners per 10,000 four-year-olds in LHD	0.26	0.01	−0.24	0.76	0.40
Nurse vs lay screeners	−0.29	0.26	−0.80	0.22	0.27
Permanent vs casual screeners	−0.72	0.18	−1.07	−0.37	<0.001*
Catch-up clinics available	0.15	0.60	−1.02	1.32	0.80
Secondary screening for unable-to-be-screened	0.85	0.21	0.44	1.27	<0.001*
Borderline pass					
Metropolitan vs rural and regional	0.78	0.28	0.23	1.33	0.039*
Estimated no. 4-year-olds in LHD	0	—	—	—	0.53
FTE screeners per 10,000 four-year-olds in LH	−0.06	0.19	−0.42	0.31	0.61
Nurse vs lay screeners	0.20	0.31	−0.41	0.82	0.52
Permanent vs casual screeners	0.05	0.20	−0.33	0.43	0.79
Catch-up clinics available	−0.21	0.51	−1.27	0.85	0.70
Secondary screening for unable to be screened	−0.45	0.21	−0.86	−0.04	0.030*
Secondary screening for high-priority referral	0.34	0.22	−0.09	0.76	0.12
Secondary screening for routine referral	0.45	0.34	−0.21	1.11	0.19

CI indicates confidence interval; FTE, full-time equivalent; LHD, local health district.

*Statistically significant.

While the majority of children were offered screening by StEPS, there were some children who were not screened. Factors that were found to influence screening rates, including rate of absenteeism and lack of parental consent, were not unexpected and are likely to impact uptake rates in all vision screening programs. The gradual improvement in consent to screening rates over time suggests that increasing familiarization with the StEPS program, both by preschools and parents, may be an important factor that could be enhanced by increased public health promotion of the benefits of participation in StEPS.

Interestingly, availability of catch-up clinics was found to be an important aspect of increasing completion of screening rates in StEPS, and these should perhaps be a standard feature of preschool vision screening programs. These clinics were predominantly community health-based appointments offered to children who were absent on the scheduled screening day. At the time of data collection, catch-up clinics were available in a majority but not all LHDs, however, this has since been consistently implemented across the StEPS program. In addition to offering catch-up clinics and additional screening opportunities to increase uptake, parental education on the importance of vision screening could be beneficial in increasing rates of consent for screening.

Urban-rural differences in the preschool vision screening rates were anticipated due to the well-known health inequities across these geographical locations in Australia.[25] While the expectation may be that rates of screening would be less in rural LHDs, after an initial slower progress in the establishment phase, the rates of screening after 2012 were higher in rural LHDs than metropolitan areas, whose screening rates remained largely unchanged over time. While this may be counterintuitive, it is to be noted that rural areas have been shown to display greater social cohesion than urban areas, through high levels of networking and community participation,[26] which may enhance the reach and acceptance in rural locations of a community-based program, such as StEPS. It also reflects that the greater socioeconomic disadvantage seen outside metropolitan Sydney[27] may not play a significant role, as was seen in a preschool vision screening program in New Zealand.[28] The metropolitan and rural differences in screening rates seen in this study are likely to have multifactorial foundations, one of which may be that easily accessible health screening has greater value in a community with generally poorer access to health services.

Of those children screened by StEPS, 19.2% were referred into care as they did not meet the VA criteria or were unable to be screened. If referral for unable-to-be-screened (1.6%) and borderline pass are excluded, the referral rate was 8% (5.5% routine and 2.3% high-priority referral). There is substantial variation reported in the literature regarding rates of referral from mass vision screening programs that makes meaningful comparison between reports challenging. Sources of variation are likely to be based on differences in location and population prevalence of ocular conditions, the age group screened, referral criteria, and VA test used, as well as the accuracy of screening itself. Orthoptic screening has been demonstrated to be highly accurate, with referral rates ranging from 7.2% to 19%.[29–31] The referral rate from the StEPS program is broadly aligned with the rates from orthoptic screening and suggests that StEPS screening is likely to have reasonable accuracy. In addition, the referral rate in the current analysis was similar across locations and over time, suggesting consistency in the proportion of children failing vision screening. Our data are limited in determining the sensitivity and specificity of screening from StEPS. Calculation of these values would require a comprehensive ophthalmic assessment of a subsample of children who passed screening compared to those who were referred. This would be a valuable direction for further research into the validity of the StEPS program.

Screener's qualifications, whether nurse or lay screeners, did not impact the rate of referral. This is consistent with previous reports of no significant difference in accuracy of nurse compared to lay screeners when similar levels of training are provided,[32] although both professions have been shown to

have lower accuracy compared with trained eye health care professionals (orthoptists, optometrists, and ophthalmologists).[17,33] Some studies have shown that appropriate training can increase accuracy of noneye care professional screeners.[34,35] Screeners in the StEPS program are provided with orthoptic-led training, and both lay and nurse screeners often have prior experience in working with children. However, it was found that referral rates were significantly reduced when permanent screening staff were employed compared to casual screeners. This reduction in referral rates where permanent staff were employed, suggests a potentially lower false-positive rate and indicates that access to training, coupled with ongoing experience in the field, may be important for increasing accuracy of vision screeners.

Previous research has shown that secondary screening by orthoptists can reduce false positives, particularly for children who are unable or difficult to screen.[35,36] A limited number of StEPS LHDs had access to secondary orthoptic screening, and there was variation in whether this was offered for high-priority referrals and/or children who were unable to be screened. We found that access to secondary orthoptic screening for children who were unable to be screened reduced both borderline pass and routine referrals, although the rate of unable-to-be-screened referral increased. The reasons for this are unclear and require further systematic investigation. However, this may indicate that in the presence of secondary orthoptic screening, those children who were difficult to assess were more frequently referred through this pathway. Nonetheless, the reduction in borderline pass and routine referral may suggest improved accuracy of initial screening.

In conclusion, the StEPS vision screening program is a highly successful health service model in both widespread recruitment and screening of NSW preschool children across all locations. It provides an important service in both metropolitan, regional, and rural areas, with a pathway for the referral of young children with vision deficits to appropriate care in a manner that facilitates timely intervention before school entry.

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