| **Study, Year** | **Screening Test (Reference Standard)** | **Sensitivity (95% CI)** | **Specificity (95% CI)** | **Positive Likelihood Ratio (95% CI)** | **Negative Likelihood Ratio (95% CI)** | **Quality** |
| --- | --- | --- | --- | --- | --- | --- |
| ***Retinomax Autorefractors*** |
| Barry et al, 200179 | Retinomax autorefractor (second orthoptic exam [LEA single symbol test, cover-uncover test, eye motility, and abnormal head posture] followed by ophthalmological exam for abnormal, missing, or inconsistent results) | 0.80 (0.44 to 0.98) | 0.58 (0.53 to 0.62) | 1.9 (1.4 to 2.6) | 0.35 (0.10 to 1.2) | Fair |
| Kulp et al, 201494VIP (Phases 1 and 2) | Retinomax (cycloplegic retinoscopy) | Data reported for multiple cutpoints and multiple set specificites (Table S6 of supplement)*Any SREa*A: 0.96B: 0.93C: 0.91D: 0.86E: 0.83F: 0.73Data also reported separately for myopia, hyperopia, astigmatism, and anisometropia for each cutpoint | A: 0.50B: 0.60C: 0.70D: 0.80E: 0.85F: 0.90 | NR | NR | Fair |
| Miller et al, 199997 | Retinomax K-Plus autorefractor(cycloplegic refraction and retinoscopy) | 0.91 (0.82 to 0.96) | 0.86 (0.80 to 0.91) | 6.7 (4.5 to 9.8) | 0.11 (0.05 to 0.22) | Fair |
| Miller et al, 200198 | Retinomax K-Plus autorefractor (cycloplegic refraction) | 0.93 (0.88 to 0.96) | 0.95 (0.91 to 0.98) | 18.0 (10.0 to 34.0) | 0.08 (0.04 to 0.13) | Fair |
| Vision in Preschoolers Study Group(Phase I), 200465 | Retinomax autorefractor (comprehensive eye exam with cycloplegic refraction) | Any conditionA: 0.64 (0.60 to 0.67)B: 0.52 (0.48 to 0.56)b“Very important to detect and treat early” conditionsA: 0.87 (0.84 to 0.91)B: 0.81 (0.77 to 0.85)b | Any conditionA: 0.90 (0.88 to 0.91)B: 0.94 (0.93 to 0.95)b | Any condition A: 6.1 (5.2 to 7.0)B: 8.7 (7.2 to 10)b | Any conditionA: 0.41 (0.37 to 0.45)B: 0.51 (0.47 to 0.55)b | Fair |
| VIP Study Group, 2011106Phase II (Pilot) | Retinomax autorefractor (comprehensive eye exam with cycloplegic refraction) | For 90% specificity, by severity*Overall*0.78 (0.67–0.88)*Group 1*0.93 (0.84–0.94)*Group 2*0.64 (0.41–0.83)*Group 3*0.73 (0.45–0.92)Type of Condition*Amblyopia*0.88 (0.68–0.97)*Strabismus*0.70 (0.35–0.93)*Refractive Error*0.84 (0.71–0.92) *Reduced visual acuity*0.70 (0.35-0.93)For 94% specificity, by severity*Overall*0.66 (0.53–0.77)*Group 1*0.82*Group 2*0.50*Group 3*0.60Type of Condition*Amblyopia*0.83*Strabismus*0.60*Refractive Error*0.75*Reduced visual acuity*0.30 | Specificity set at 90% or 94% for all sensitivities reported; calculated 95% CIs were (0.83–0.95) and (0.88–0.98), respectively | For 90% specificity, by severity*Overall*7.58 (4.37–13.15)*Group 1*9.47 (5.79–15.48) *Group 2*6.32 (3.61–11.09)*Group 3*7.16 (4.16–12.34)Type of Condition*Amblyopia*8.59 (5.27–13.99)*Strabismus*7.04 (3.84–12.92)*Refractive Error*8.11 (4.78–13.74)*Reduced visual acuity*7.04 (3.84–12.92)For 94% specificity, by severity*Overall*10.96 (5.24–22.95) | For 90% specificity, by severity*Overall*0.24 (0.15–0.38)*Group 1*0.08 (0.02–0.30)*Group 2*0.40 (0.23–0.70)*Group 3*0.30 (0.13–0.69)Type of Condition*Amblyopia*0.14 (0.05–0.40)*Strabismus*0.33 (0.13–0.86)*Refractive Error*0.18 (0.10–0.33)*Reduced visual acuity*0.33 (0.13–0.86)For 94% specificity, by severity*Overall*0.36 (0.26–0.51) | Fair |
| VIP Study Group, 2005108 Phase II | Retinomax autorefractor | By severity, screener tool*Any condition**Nurse*0.68 (0.64–0.72)*Lay Screener*0.62 (0.57–0.66)*Group1**Nurse*0.88 (0.83–0.92)*Lay Screener*0.85 (0.79–0.89)*Group 2**Nurse*0.59 (0.51–0.67)*Lay Screener*0.49 (0.41–0.58)*Group 3**Nurse*0.39 (0.30–0.49)*Lay Screener*0.36 (0.27–0.46) | By severity, screener tool*Any condition**Nurse*0.90 (0.88–0.92)*Lay Screener*0.90 (0.88–0.92)*Group1**Nurse*0.90 (0.88–0.92)*Lay Screener*0.90 (0.88–0.92)*Group 2**Nurse*0.90 (0.88–0.92)*Lay Screener*0.90 (0.88–0.92)*Group 3**Nurse*0.90 (0.88–0.92)*Lay Screener*0.90 (0.88–0.92) | By severity, screener tool*Any condition**Nurse*6.8 (5.6–8.3)*Lay Screener*6.2 (5.1–7.6)*Group1**Nurse*8.8 (7.3–10.7)*Lay Screener*8.5 (7.0–10.3)*Group 2**Nurse*5.9 (4.7–7.4)*Lay Screener*4.9 (3.8–6.3)*Group 3**Nurse*3.9 (2.9–5.3)*Lay Screener*3.6 (2.6–4.9) | By severity, screener tool*Any condition**Nurse*0.36 (0.31–0.41)*Lay Screener*0.42 (0.38–0.48)*Group1**Nurse*0.13 (0.09–0.19)*Lay Screener*0.17 (0.12–0.23)*Group 2**Nurse*0.46 (0.37–0.55)*Lay Screener*0.56 (0.48–0.66)*Group 3**Nurse*0.68 (0.58–0.79)*Lay Screener*0.71 (0.62–0.82) | Fair |
| Ying et al, 2011111VIP (Phases 1 and 2) | Retinomax autorefractor | Sensitivity dependent upon specificity for any targeted condition and given for Group 1 and any targeted conditioncSpecificity 0.50*Group 1 Conditions*0.96*Any Targeted Condition*0.90Specificity 0.60*Group 1 Conditions*0.96*Any Targeted Condition*0.88Specificity 0.70*Group 1 Conditions*0.95*Any Targeted Condition*0.83Specificity 0.80*Group 1 Conditions*0.92*Any Targeted Condition*0.77Specificity 0.85*Group 1 Conditions*0.91*Any Targeted Condition*0.73Specificity 0.90*Group 1 Conditions*0.87*Any Targeted Condition*0.68Specificity 0.95*Group 1 Conditions*0.83*Any Targeted Condition*0.58 | Fixed at 0.50, 0.60, 0.70, 0.80, 0.85, 0.90, or 0.95 | NR | NR | Fair |
| ***SureSight Autorefractors*** |
| Jost, 201589 | SureSight autorefractor (comprehensive eye exam with cycloplegic retinoscopy) | 1.00 (0.02 to 1.0) | 0.87 (0.79 to 0.93) | 7.9 (4.7 to 13.4) | 0.0 | Fair |
| Kemper et al, 200590 | SureSight autorefractor (comprehensive eye exam with cycloplegic refraction) | Overall: 0.85 (0.69–0.95)Age <3 years (n=80): 0.80(0.44–0.97)Age 3 to 5 years (n=90): 0.88(0.68–0.97) | Overall: 0.52 (0.40–0.63)Age <3 years: 0.41(0.24–0.61)Age 3 to 5 years: 0.58(0.42–0.71) | Overall: 1.8dAge <3 years: 1.4d Age 3 to 5 years: 2.1d | Overall: 0.29dAge <3 years: 0.49d Age 3 to 5 years: 0.21d | Fair |
| Kulp et al, 201494VIP (Phases 1 and 2) | SureSight Vision Screener used in Phase 1, year 1(cycloplegic retinoscopy) | Data reported for multiple cutpoints and multiple set specificites (Table S6 of supplement)*Any SRE* eA: 0.94B: 0.91C: 0.88D: 0.83E: 0.77F: 0.68Data also reported separately for myopia, hyperopia, astigmatism, and anisometropia for each cutpoint | A: 0.50B: 0.60C: 0.70D: 0.80E: 0.85F: 0.90 | NR | NR | Fair |
| Rogers et al, 2008102 | SureSight autorefractor(comprehensive eye exam with cycloplegic refraction) | A (manufacturer criteria): 0.97 (0.88–1.0)B (VIP 90% specificity criteria): 0.79 (0.67–0.89) C (VIP 94% specificity criteria): 0.67 (0.54–0.79)D (Rowatt et al criteria): 0.62 (0.4–0.74) | A: 0.38 (0.24 to 0.54)B: 0.64 (0.48 to 0.78)C: 0.69 (0.53 to 0.82)D: 0.74 (0.58 to 0.86) | A: 1.6 (1.2 to 2.0)B: 2.2 (1.4 to 3.4)C: 2.2 (1.3 to 3.5)D: 2.4 (1.4 to 4.1) | A: 0.09 (0.02 to 0.37)B: 0.32 (0.18 to 0.56)C: 0.47 (0.31 to 0.72)D: 0.51 (0.35 to 0.75) | Fair |
| Vision in Preschoolers Study Group(Phase I), 200465 | SureSight autorefractor (comprehensive eye exam with cycloplegic refraction) | Any conditionA1 (manufacturer criteria): 0.85 (0.81–0.88)A2 (VIP criteria): 0.63 (0.59–0.65)B (VIP criteria): 0.51 (0.46–0.56)b“Very important to detect and treat early” conditionsA1: 0.96 (0.93–0.99)A2: 0.81 (0.75–0.87)B: 0.75 (0.69–0.81)b  | Any conditionA1: 0.62 (0.59 to 0.65)A2: 0.90 (0.88 to 0.92)B: 0.94 (0.92 to 0.95)b | Any condition A1: 2.2 (2.0 to 2.4)A2: 6.3 (5.2 to 7.7)B: 8.6 (6.6 to 11)b | Any conditionA1: 0.24 (0.19 to 0.30)A2: 0.41 (0.36 to 0.47)B: 0.52 (0.47 to 0.58)b | Fair |
| VIP Study Group, 2005108Phase II | SureSight(comprehensive eye exam including monocular distance visual acuity, cover testing, cycloplegic retinoscopy) | By severity*Any condition**Nurse*0.64 (0.60–0.68)*Lay Screener*0.61 (0.56–0.66)*Group1**Nurse*0.83 (0.77-0.88)*Lay Screener*0.82 (0.76–0.87)*Group 2**Nurse*0.57 (0.48-0.65)*Lay Screener*0.51 (0.42–0.59)*Group 3**Nurse*0.34 (0.25–0.44)*Lay Screener*0.34 (0.25–0.44) | By severity*Any condition**Nurse*0.90 (0.88–0.92)*Lay Screener*0.90 (0.88–0.92)*Group1**Nurse*0.90 (0.88–0.92)*Lay Screener*0.90 (0.88–0.92)*Group 2**Nurse*0.90 (0.88–0.92)*Lay Screener*0.90 (0.88–0.92)*Group 3**Nurse*0.90 (0.88–0.92)*Lay Screener*0.90 (0.88–0.92) | By severity*Any condition**Nurse*6.4 (5.3–7.8)*Lay Screener*6.1 (5.0–7.5)*Group1**Nurse*8.3 (6.8–10.1)*Lay Screener*8.2 (6.7–10.0)*Group 2**Nurse*5.7 (4.5–7.2)*Lay Screener*5.1 (4.0–6.5)*Group 3**Nurse*3.4 (2.5–4.7)*Lay Screener*3.4 (2.5–4.7) | By severity*Any condition**Nurse*0.40 (0.35–0.45)*Lay Screener*0.43 (0.39–0.49)*Group1**Nurse*0.19 (0.14–0.26)*Lay Screener*0.20 (0.15–0.27)*Group 2**Nurse*0.48 (0.40–0.58)*Lay Screener*0.55 (0.46–0.65)*Group 3**Nurse*0.73 (0.64–0.84)*Lay Screener*0.73 (0.64–0.84) | Fair |
| Ying et al, 2011111VIP (Phases 1 and 2) | SureSight(comprehensive eye exam including monocular threshold visual acuity, cover testing, stereopsis, and cycloplegic retinoscopy) | Sensitivity dependent on specificity for any targeted condition and given for group 1 and any targeted conditionfSpecificity 0.50*Group 1 Conditions*0.98*Any Targeted Condition*0.91Specificity 0.60*Group 1 Conditions*0.95*Any Targeted Condition*0.88Specificity 0.70*Group 1 Conditions*0.95*Any Targeted Condition*0.83Specificity 0.80*Group 1 Conditions*0.90*Any Targeted Condition*0.77Specificity 0.85*Group 1 Conditions*0.87*Any Targeted Condition*0.72Specificity 0.90*Group 1 Conditions*0.82*Any Targeted Condition*0.65Specificity 0.95*Group 1 Conditions*0.77*Any Targeted Condition*0.55 | Fixed at 0.50, 0.60, 0.70, 0.80, 0.85, 0.90, or 0.95 | NR | NR | Fair |
| ***Plusoptix Autorefractors*** |
| Arthur et al, 200978 | Plusoptix/Power Refractor autorefractor (comprehensive eye exam with cycloplegic refraction) | 0.83 (0.67 to 0.93) | 0.95 (0.92 to 0.98) | 18 (10 to 33) | 0.17 (0.08 to 0.36) | Fair |
| Dahlmann- Noor et al, 2009a84 | Plusoptix/Power Refractor autorefractor (comprehensive eye exam with cycloplegic refraction) | Myopia: 0.88 (0.30 to 1.0)Hyperopia: 0.20 (0.10 to 0.35)Astigmatism: 0.75 (0.36 to 0.96)Anisometropia: 0.50 (0.31 to 0.69) | Myopia: 0.96 (0.89 to 0.99)Hyperopia: 0.99(0.92 to 1.0)Astigmatism: 0.93(0.86 to 0.97)Anisometropia: 0.87(0.77 to 0.93) | Myopia: 21 (7.8 to 55)Hyperopia: 26(1.6 to 450)Astigmatism: 11(4.7 to 24)Anisometropia: 3.7 (1.9 to 7.1) | Myopia: 0.13 (0.01 to 1.7)Hyperopia: 0.81(0.70 to 0.94)Astigmatism: 0.27(0.08 to 0.89)Anisometropia: 0.58(0.40 to 0.84) | Fair |
| Dahlmann- Noor et al, 2009b85 | Plusoptix/Power Refractor autorefractor (orthoptist screening with distance acuity testing, cover test, extraocular movements, prism test, and Lang stereotest; comprehensive eye exam with cycloplegic refraction for abnormal autorefractor or orthoptist screening results) | 0.45 (0.29 to 0.62) | 1.0 (0.98 to 1.0) | 230 (14 to 3680) | 0.56 (0.42 to 0.74) | Fair |
| Matta et al, 200896 | Plusoptix/Power Refractor autorefractor (comprehensive eye exam with cycloplegic refraction) | A (manufacturer criteria): 0.98 (0.85 to 1.0)B (revised criteria): 0.98 (0.85 to 1.0) | A: 0.68 (0.51 to 0.81)B: 0.88 (0.74 to 0.96) | A: 3.0 (1.9 to 4.7)B: 8.4 (3.7 to 19) | A: 0.04 (0.01 to 0.26)B: 0.03 (0.00 to 0.20) | Fair |
| ***Other Autorefractors*** |
| Vision in Preschoolers Study Group (Phase I),200465 | Power Refractor autorefractor (now called the Plusoptix) (comprehensive eye exam with cycloplegic refraction) | Any conditionA: 0.54 (0.49 to 0.59)B: 0.36 (0.31 to 0.41)b“Very important to detect and treat early” conditionsA: 0.72 (0.65 to 0.79)B: 0.56 (0.48 to 0.63)b | Any conditionA: 0.90 (0.88 to 0.92)B: 0.94 (0.92 to 0.95)b | Any condition A: 5.4 (4.4 to 6.6)B: 6.0 (4.6 to 7.9)b | Any conditionA: 0.51 (0.46 to 0.57)B: 0.68 (0.63 to 0.73)b | Fair |
| VIP Study Group, 2011106Phase II (Pilot) | Palm-Automatic refractometer(comprehensive eye exam including cycloplegic retinoscopy, distance and near cover test, and monocular threshold vision acuity using crowded HOTV optotypes | For 90% Specificity, by severity*Overall*0.74 (0.61–0.84)*Group 1*0.79 (0.59–0.92)*Group 2*0.77 (0.55–0.92)*Group 3*0.60 (0.32–0.84)Type of Condition*Amblyopia*0.75 (0.53–0.90)*Strabismus*0.70 (0.35–0.93)*Refractive Error*0.84 (0.71–0.92) *Reduced visual acuity*0.30 (0.06–0.65)For 94% Specificity, by severity*Overall*0.66 (0.53–0.77)*Group 1*0.71*Group 2*0.64*Group 3*0.60Type of Condition*Amblyopia*0.67*Strabismus*0.60*Refractive Error*0.76*Reduced visual acuity*0.30 | Specificity set at 90% or 94% for all sensitivities reported; calculated 95% Cis were (0.83–0.95) and (0.88–0.98), respectively.  | For 90% Specificity, by severity*Overall*7.14 (4.10–12.43)*Group 1*8.01 (4.77–13.45)*Group 2*7.68 (4.58–12.88)*Group 3*5.86 (3.18–10.80)Type of Condition*Amblyopia*7.36 (4.38–12.36)*Strabismus*7.04 (3.84–12.92)*Refractive Error*8.11 (4.78–13.74)*Reduced visual acuity*3.02 (1.06–8.61)For 94% Specificity, by severity*Overall*10.96 (5.24–22.95) | For 90% Specificity, by severity*Overall*0.29 (0.19–0.44)*Group 1*0.24 (0.12–0.48)*Group 2*0.25 (0.12–0.55)*Group 3*0.45 (0.24–0.83)Type of Condition*Amblyopia*0.28 (0.14–0.56)*Strabismus*0.33 (0.13–0.86)*Refractive Error*0.18 (0.10–0.33)*Reduced visual acuity*0.78 (0.52–1.17)For 94% Specificity, by severity*Overall*0.36 (0.26–0.51) | Fair |
| Williams et al, 2000110 | Topcon PR2000 autorefractor (comprehensive eye examination with cycloplegic refraction) | Spherical error: 0.50 (0.33 to 0.67)gAnisometropia: 0.74 (0.52 to 0.90)gAstigmatism: 0.47 (0.28 to 0.66)g | Spherical error: 0.95 (0.90 to 0.98)gAnisometropia: 0.95 (0.91 to 0.98)gAstigmatism: 0.96 (0.92 to 0.99)g | Spherical error: 9.6 (4.5 to 20)gAnisometropia: 15 (7.5 to 32)gAstigmatism: 12 (5.2 to 30)g | Spherical error: 0.53 (0.38 to 0.73)gAnisometropia: 0.27 (0.14 to 0.55)gAstigmatism: 0.55 (0.40 to 0.78)g | Fair |

a Data in main paper focused on area under the curve (AUC). For detection of each type of SRE, AUC of each test was high; AUC was better for detecting the most severe levels of SRE than for all Res considered important to detect (AUC 0.97 to 1.00 vs. 0.92 to 0.93). The AUC of each screening test was high for myopia (AUC 0.97 to 0.99). Noncycloplegic retinoscopy and Retinomax performed better than SureSight for hyperopia (AUC 0.92 to 0.99 and 0.90 to 0.98 vs. 0.85 to 0.94, P ≤ 0.02), Retinomax performed better than NCR for astigmatism greater than 1.50 D (AUC 0.95 vs.0.90, P0.01), and SureSight performed better than Retinomax for anisometropia (AUC 0.85 to 1.00 vs. 0.76 to 0.96, P ≤ 0.07). Performance was similar for nurse and lay screeners in detecting any SRE (AUC 0.92 to 1.00 vs. 0.92 to 0.99).

b Results based on cutoffs to obtain specificity of 94%.

c Data in main paper focused on AUC. The AUC for detecting any VIP-targeted condition was 0.83 for NCR, 0.83 (phase I) to 0.88 (phase II) for Retinomax, and 0.86 (phase I) to 0.87 (phase II) for SureSight. The AUC was 0.93 to 0.95 for detecting group 1 (most severe) conditions and did not differ between instruments or screeners or by age of the child.

d Unable to calculate confidence intervals, raw data not provided.

e Data in main paper focused on AUC. For detection of each type of SRE, AUC of each test was high; AUC was better for detecting the most severe levels of SRE than for all Res considered important to detect (AUC 0.97 to 1.00 vs. 0.92 to 0.93). The AUC of each screening test was high for myopia (AUC 0.97 to 0.99). Noncycloplegic retinoscopy and Retinomax performed better than SureSight for hyperopia (AUC 0.92 to 0.99 and 0.90 to 0.98 vs. 0.85 to 0.94, P ≤ 0.02), Retinomax performed better than NCR for astigmatism greater than 1.50 D (AUC 0.95 vs.0.90, P0.01), and SureSight performed better than Retinomax for anisometropia (AUC 0.85 to 1.00 vs. 0.76 to 0.96, P ≤ 0.07). Performance was similar for nurse and lay screeners in detecting any SRE (AUC 0.92 to 1.00 vs. 0.92 to 0.99).

f Data in main paper focused on area AUC. The AUC for detecting any VIP-targeted condition was 0.83 for NCR, 0.83 (phase I) to 0.88 (phase II) for Retinomax, and 0.86 (phase I) to 0.87 (phase II) for SureSight. The AUC was 0.93 to 0.95 for detecting group 1 (most severe) conditions and did not differ between instruments or screeners or by age of the child.

g Results based on cutoffs to obtain specificity of at least 95%.

Abbreviations:AUC=area under the curve; CI=confidence interval; NCR=noncycloplegic refraction; NR=not reported; SRE=significant refractive error; VIP=Vision In Preschoolers.