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High rate of failed visual-acuity measurements with the Amsterdam Picture Chart in screening at the age of 36 months

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ABSTRACT.

Purpose: **In the Netherlands, youth health care physicians and nurses screen all children for general health disorders at Child Health Care Centers. As part of this, the eyes are screened seven times, with the first visual acuity (VA) measurement at 36 months with the Amsterdam Picture Chart (APK). The suitability of the APK has been questioned.**

Methods: **Children born between July 2011 and June 2012 born in the provinces Drenthe, Gelderland and Flevoland and invited for screening at 36 months were eligible. Parents were sent the APK picture optotypes to practise with their children in advance. Data were collected from electronic screening records. The Dutch vision screening guideline prescribes that children with VA <5/6, or one line interocular difference (not logMAR, however) should be retested or referred.**

Results: **Of 10 809 eligible children, 1546 did not attend and 602 attended but had no VA measurement at age 36 months, 247 of these were under orthoptic treatment. Of the 8448 children examined, VA was sufficient in 5663 (67.0%) and insufficient in 1312 (15.5%). In 1400 (16.6%), the measurement of VA itself failed. In 73 (0.9%), data were missing. Of the 216 children with 2 failed VA measurements, 150 (69%) were not referred, and measurement of VA was deferred to the next general screening examination at 45 months.**

Conclusion: **Although most parents had practised the APK picture optotypes at home with their children, the rate of failed APK measurements plus the measurements with insufficient VA was 32.1% at 36 months. Similar rates have previously been reported for Lea Symbols and HOTV, permitting the conclusion that measurement of VA at the age of 36 months cannot be recommended as a screening test in the general population.**

Key words: amblyopia – optotypes – paediatric vision screening – visual acuity – visual development

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Introduction

In the Netherlands, youth health care (YHC) physicians or nurses screen all children on general health disorders at Child Health Care Centres (CHCC's), where parents are invited to have their child examined. Coverage is between 95% and 100% in the first year, declining thereafter. The eyes of the children are screened seven times, at the ages of 1–2, 3–4, 6–9, 14–24, 36, 45 and 54–60 months. The vision screening programme has been shown to be effective in detecting amblyopia in the Rotterdam Amblyopia Screening Effectiveness prospective birth-cohort Study (RAMSES study) (Groenewoud et al. 2010; de Koning et al. 2013). Eye screening at 0–4 months includes inspection of the anterior segment, Hirschberg test, pupillary reflexes and the fundus red reflex. At 6–24 months, eye screening also comprises cover test, alternating cover test, eye motility and monocular pursuit movements. At 36, 45 and 54–60 months, visual acuity (VA) is measured. At 36 months, the Amsterdam Picture Chart (APK) is used (Coenen-van Vroonhoven et al. 2010). At 45 and at 54–60 months, Landolt-C optotypes are used (Coenen-van Vroonhoven et al. 2010).

The APK was developed in the early 1950s in Amsterdam and has eleven different pictures (**Fig.** 1). These eleven pictures were found recently to have different thresholds (Engin et al. 2014). In contrast with Landolt-C and Snellen's E-optotypes, the width of the lines of the APK optotype is not one-fifth, but one-tenth of the size of the optotype. The width of the lines of the Lea Symbols is one-seventh of the size of the optotype. The APK has been favoured by many Dutch orthoptists

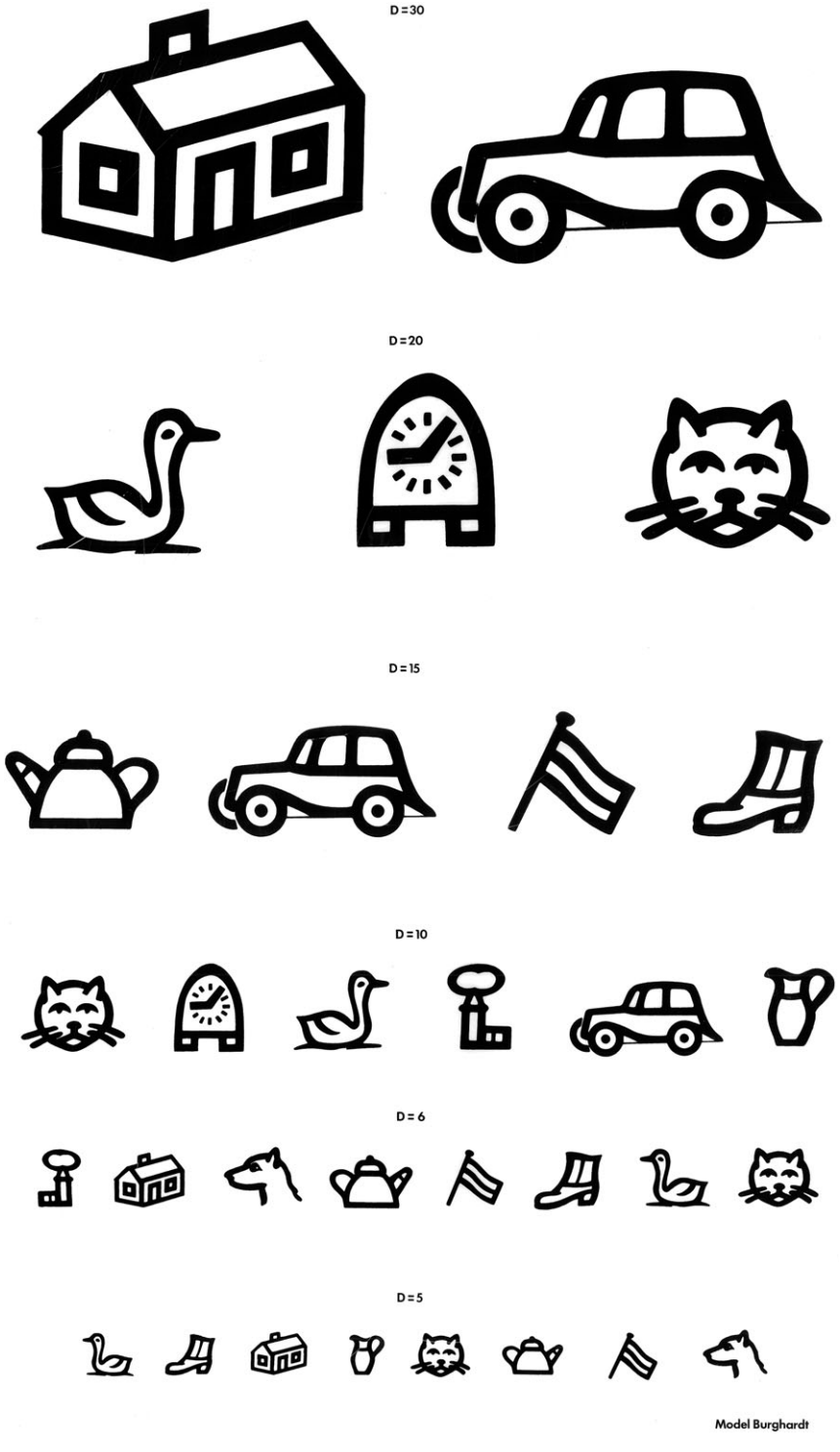

Fig. 1. Amsterdam Picture Chart with eleven different optotypes. When used at 5 m, the measured visual acuity is 5/30, 5/20, 5/15, 5/10, 5/6 or 5/5. The height of the optotypes of D = 5 is approximately 10 min of arc when viewed at 5 m.

over years, because children can be tested at the age of 3 successfully in most cases, provided the measurement of VA is performed by an orthoptist (Becker et al. 2002). However, many of the APK pictures are archaic and may be unfamiliar to modern or non-European children.

As the quality of the APK as a psychophysical measurement was found to be low in a previous study by Engin et al. (2014), we studied the VA measurement at the age of 36 months in a large birth-cohort study and found high rates of measurements with insufficient VA and of failed measurements.

Materials and Methods

This study is part of the Optimization of Amblyopia Screening study that compares two sequential birth cohorts, with and without eye screening tests between 6 and 24 months of age (Sloot et al. 2015, 2016). In the RAMSES observational birth-cohort study, it had been found that cases of amblyopia detected before age 36 months were not detected by screening and had strabismus in most cases (Groenewoud et al. 2010). Moreover, the quality of the screening examinations between 6 and 24 months of age was shown to be moderate in a semi-structured observational study (Sloot et al. 2017).

Visual acuity (VA) was measured with the APK (**Fig.** 1) in 36-month-old children at CHCC's. Children born between 1st July 2011 and 30th June 2012 in the region with CHCC's of the family health care providers Icare and the Municipal Health Service in the provinces Drenthe, Gelderland and Flevoland, who were invited for screening at 36 months, were eligible. Youth health care (YHC) physicians and nurses of Icare, one of the organizations for preventive health care, screen 8% of the Dutch birth figure. Together with the invitation, parents were sent the APK picture optotypes to practise with their child in advance. Visual acuity (VA) was measured by YHC physicians or nurses. They receive 1 day of eye-examination training by a teaching orthoptist every 5 years. The VA measurement was rated as sufficient VA, insufficient VA or failed measurement (**Table** 1). The VA measurement was rated insufficient when the VA did not reach the threshold. The VA measurement failed when the measurement carried out by a particular YHC physician or nurse failed, when only binocular VA was measured or when only the VA of one eye was measured. If the child already wears glasses and is under treatment of an orthoptist or ophthalmologist, the VA measurement should only be performed if there is a specific reason to do so, according to the Dutch guideline (Coenen-van Vroonhoven et al. 2010). Data were collected from electronic screening records from the CHCC's.

The Dutch vision screening guideline prescribes retesting after 6 weeks in case of failed VA measurement and in case of threshold VA designated as 'doubtful'

Table 1. Criteria for referral or repeat measurement, according to the Dutch national guideline for vision screening, for sufficient, insufficient (including 'doubtful' in case repeat measurement is indicated) or failed measurement at age 36 months (Coenen-van Vroonhoven et al. 2010).

	Visual acuity (VA) measured with Amsterdam Picture Chart
Sufficient	Monocular VA ≥5/6 for both eyes
Insufficient	Monocular VA <5/6 for one or both eyes
	One line interocular difference (not logMAR, however: 5/5, 5/6, 5/10, 5/15, etc.)
Failed measurement	The measurement failed
	Only binocular VA obtained
	VA was measured of one eye only

VA. This is defined as a VA of one eye of 5/10 or when there is one line interocular difference (not logMAR, however: 5/5, 5/6, 5/10, 5/15, etc.). Note that, according to the current Dutch guideline, a VA of 5/6 and 5/5 is designated as 'doubtful'. Note also, that the interval between 5/5 and 5/6 is approximately 1 logMAR line, but the interval between 5/10 and 5/6 is approximately 2 logMAR lines. If the VA at the retest is not better than the first measured VA, the child is referred. Children with a VA lower than 5/10 for one eye or two lines interocular difference at the first measurement are referred directly (Coenen-van Vroonhoven et al. 2010). It must be noted, however, that for this study, the Dutch guideline category 'doubtful', or threshold VA and the Dutch guideline category 'referred directly', are both designated in this study as insufficient VA.

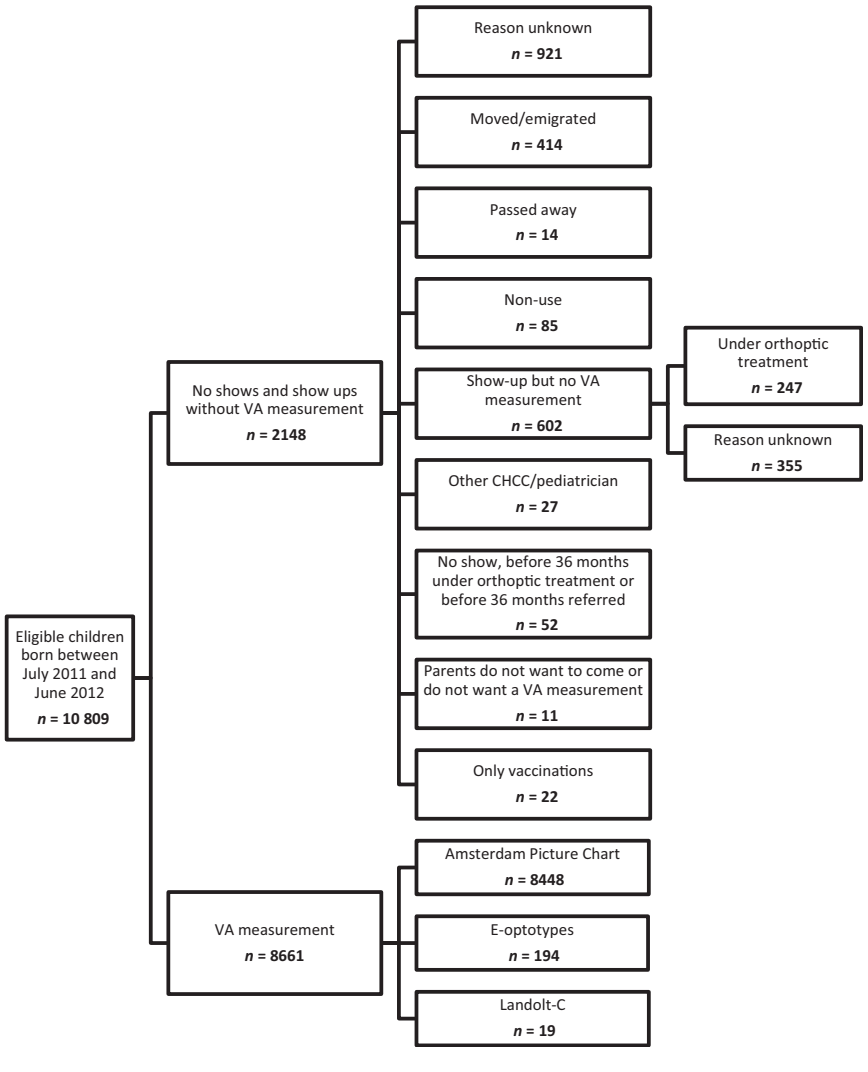

Fig. 2. Flow-chart of the eligible children, the drop-outs and children with and without visual acuity measurement at 36 months.

Results

A flow-chart of the distribution of the eligible children is presented in **Fig.** 2. Of the 10 809 eligible children aged 36 months, 1546 children did not attend, 247 children attended but were not screened as they were already being treated by an orthoptist. Another 355 children attended but had no measurement of VA for unknown reasons. General screening time is limited, and there may have been other priorities. Visual acuity (VA) was measured in 8661 eligible children at 36 months, in 8448 with the APK, in 19 with the Landolt-C and in 194 children with the E-optotypes. Because of the low number in the subsets measured with Landolt-C and with E-optotypes, these were excluded from analysis.

First measurement

A flow-chart of the results of the first measurement and repeated measurements is presented in **Fig.** 3. In 5663 (67.0%) of the 8448 children, measured VA was sufficient with the APK, in 1312 (15.5%) insufficient. In 1400 (16.6%), the measurement failed and in 73 children (0.9%), data were missing. Of the 1312 children with an insufficient VA, 107 were directly referred to an orthoptist or ophthalmologist. The VA measurement was repeated in 776 children at the CHCC's. The VA measurement was not repeated, nor was the child referred, in the other 429 children, because (i) the VA that was insufficient according to the Dutch guideline was incorrectly rated as sufficient (188 children, many of these had VA 5/6 and 5/5), (ii) the parents or physician decided to measure again at the next general screening examination at age 45 months according to notes in the records (29 children) or (iii) because they did not attend for unknown reason (212 children). Of the 1400 children with a failed measurement, 35 were directly referred to an orthoptist or an ophthalmologist. The VA measurement was repeated in 902 children at the CHCC's. The VA measurement was not repeated, nor was the child referred, in the remaining 463 children because (i) the parents or physician decided to re-measure at the next general screening examination at age 45 months according to notes in the

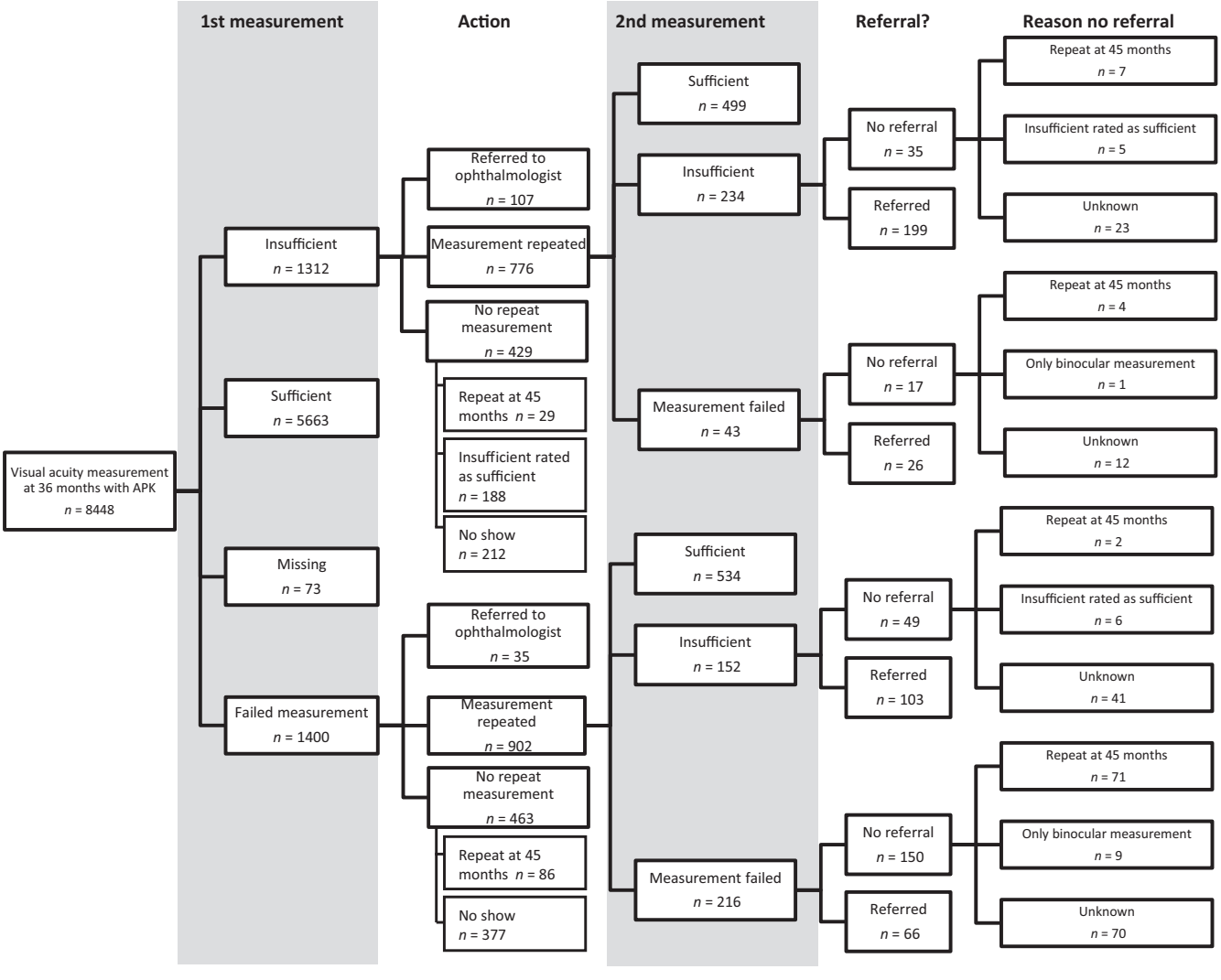

Fig. 3. Flow-chart of visual acuity measurements with the Amsterdam Picture Chart at 36 months, the first measurement, action undertaken after the first measurement, the second measurement, the referral and the reason for no referral after the second measurement.

records (86 children) or because (ii) they did not attended for unknown reason (377 children).

Repeated VA measurement after insufficient first VA measurement

In 776 children with an insufficient VA measured the first time, the measurement was repeated, and in 234 of these, the VA was insufficient, of which 35 children were not referred. In 43 children, the second measurement failed, of which 17 children were not referred. Reasons for non-referral are listed in **Fig.** 3.

Repeated VA measurement after failed first VA measurement

In 902 children with a failed measurement, the measurement was repeated, and in 152 of these, the VA was insufficient, of which 49 were not referred. In 216 children, the second measurement failed, of which 150 (69.4%) children were not referred. In at least half of these children, measurement of VA was deferred to the next general screening examination at 45 months. Reasons for non-referral are listed in **Fig.** 3.

Discussion

In this birth-cohort study, measured VA was insufficient in 15.5% of the children, while the VA measurement failed in another 16.6% of the children, although parents had practised the APK picture optotypes at home with their children in advance.

One could argue that the rate of failed VA measurements would have been lower when using the Lea symbols, but in a systematic study by Becker et al. (2002), it was shown that the failure rate using Lea symbols in general population screening was even higher than in our study: 44% at the age of 31–36 months and 24% at the age of 37–48 months. In that study, the failure rates were much lower for VA measurements when carried out by orthoptists (Becker et al. 2002). To have VA measured in all children in the Netherlands by orthoptists would be prohibitively expensive, however. In a Swedish study, measurement of VA using both HOTV and Lea symbols at 36 months and 48 months was evaluated. For both charts, at the age of 36 months, the test failed in 20% of the children, apart from the children who did not reach the VA threshold, as compared to around 10% at the age of 48 months (Kvarnström & Jakobsson 2005).

As compared with the Lea Symbols and HOTV, the failure rate of the APK

in our study at the age of 36 months is only slightly better, but still too high for it to be used to measure VA in general screening at 36 months. If 16.6% of the VA measurements fails and another 15.5% of the children does not reach the VA threshold, 32.1% should either be retested after 6 weeks or referred according to the Dutch guideline. For screening in the general population, this becomes prohibitively expensive.

In addition, it seems possible that the large number of failed measurements and of measurements with insufficient VA may have kept YHC physicians and nurses from referring children in accordance with the Dutch vision screening guideline at the age of 36 months. It has been found previously by Tjiam et al. (2011) that, in some cases, YHC physicians or nurses deviate from the Dutch guideline when they consider a repeat measurement as unlikely to be successful, for instance when caused by a language barrier.

Accordingly, YHC physicians and nurses were more inclined to refer a child when the measurement of VA was insufficient as compared to a failed measurement of VA. This is evident from the number of children who were not referred after two failed measurements, 150 (69.4%) of 216 children. According to notes in the records, in at least half of the children with two failed measurements, instead of referral, the decision was taken to repeat the measurement at the next general screening examination 9 months later, at age 45 months.

In conclusion, measurement of VA at the age of 36 months cannot be recommended as a screening test in the general population, considering the high rate of failed VA measurements for the APK and the previously reported failure rates for the Lea Symbols and HOTV.

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