

ORIGINAL ARTICLE

Trends in low vision service utilisation: A retrospective study based on general population healthcare claims

Miriam L Stolwijk¹  | Ruth M A van Nispen¹  | Ilona W M Verburg² |
 Lieke van Gerwen² | Tim van de Brug³  | Ger H M B van Rens¹

¹Ophthalmology Department, Amsterdam UMC, Vrije Universiteit Amsterdam, Amsterdam Public Health Research Institute, Amsterdam, the Netherlands

²Healthcare Information Center, Vektis CV, Zeist, the Netherlands

³Epidemiology and Data Science Department, Amsterdam UMC, Vrije Universiteit Amsterdam, Amsterdam Public Health Research Institute, Amsterdam, the Netherlands

Correspondence

Miriam L. Stolwijk, Ophthalmology Department, Amsterdam UMC, Vrije Universiteit Amsterdam, Amsterdam Public Health Research Institute, Amsterdam, the Netherlands.
 Email: m.stolwijk@amsterdamumc.nl

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Abstract

Purpose: To identify parameters associated with the downward trend in the uptake of Low Vision Services (LVS) in the Netherlands.

Methods: A retrospective cohort study was conducted based on a Dutch national health insurance claims database (Vektis CV) of all adults (≥ 18 years) who received LVS from 2015 until 2018. Descriptive statistics were used to assess socio-demographic, clinical and contextual characteristics and other healthcare utilisation of the study population. General estimating equations trends in characteristics and healthcare utilisation were determined over time.

Results: A total of 49,726 unique patients received LVS, but between 2015 and 2018, the number of patients decreased by 15%. The majority was aged 65 years or older (53%), female (54%), had a middle (38%) or low (24%) socio-economic status and lived in urban areas (68%). Between 2015–2018, significant downward trends were found for treatment with intravitreal injections and lens-related diseases for LVS patients. For physical comorbidity, utilisation of ophthalmic care, low vision aids and occupational therapy, a significant upward trend was found over time.

Conclusion: The decrease of Dutch LVS patients by 15% between 2015 and 2018 might be explained by a reduced distribution of patients treated with intravitreal injections and patients with lens-related diseases within the LVS. Compared to 2015, patients were more likely to have physical comorbidity, to see an ophthalmologist and to use low vision aids and occupational therapy in 2016, 2017 and 2018. This might indicate enhanced access to LVS when treated by ophthalmologists or within other medical specialties, or the opposite, i.e., less access when not treated within one of these medical specialties. Future research is needed to examine differences in patterns between LVS users and non-users further.

KEYWORDS

healthcare claims, low vision, low vision services, service utilisation, visual impairment

INTRODUCTION

Worldwide, an estimated 590 million people are currently affected by visual impairment, which is defined as low vision or blindness.¹ Leading causes are uncorrected refractive error, age-related macular degeneration, diabetic retinopathy and glaucoma.^{1,2} The majority of the people affected are female and aged 50 or older.^{1,3}

A visual impairment can negatively influence the quality of life (QOL)⁴ and other areas of health and wellbeing.⁵⁻⁷ It may affect an individual's orientation and mobility, which increases the risk of falls,⁸ the ability to participate in daily life activities and also mental health.⁵ It has been repeatedly shown that visual impairment is associated with depression and anxiety.^{6,7} In addition, visual impairment has a large societal and economic burden due to increased healthcare utilisation as well as low work participation and productivity losses.⁹

Low vision services (LVS) are healthcare services that contribute to the QOL and mental health of people with an irreversible visual impairment by teaching them how to make optimal use of their residual functions, helping them to adapt to visual impairment and to participate fully in society.^{10,11} LVS may include, but are not limited to, functional assessments, prescription and training in the use of low-vision aids, occupational therapy, mobility training and mental health treatment. They may be offered by optometrists or multidisciplinary organisations. It has been shown that some of these services, such as prescription of and training in low vision devices, were found to be effective in enhancing QOL¹² and to be potentially cost-effective from a societal perspective.¹³

Despite the benefits of LVS, over the past decade a discrepancy in the need and the actual uptake of these services has been reported internationally.^{11,14} The number of people who utilise LVS seems low compared to the prevalence of people reported to have visual impairment (who should be eligible for LVS). Moreover, in the Netherlands, which has approximately 17 million inhabitants and an estimated 300,000 people with a visual impairment, a downward trend in LVS uptake at multidisciplinary organisations for people with low vision and blindness has been observed in the past few years.^{15,16} The benefit of treatment with vascular endothelial growth factor inhibitors (anti-VEGF) for retinal exudative disease, available since 2005, has been suggested as a first important explanation of a decreased need and hence lower LVS uptake.¹⁷

Secondly, in 2015 a new healthcare policy was introduced in the Netherlands which led to an instant decrease in LVS uptake which progressed in the years thereafter.^{15,16} Sensory disability care was shifted to the Dutch Health Insurance Act, which meant that patients with a visual impairment now had to make a compulsory deductible payment for LVS, which presumably has been a barrier for patients to utilise LVS.¹⁵ Both explanations are plausible, but need to be studied along with other variables. In addition, data on the extent of the decrease in LVS uptake are

Key points

- In the Netherlands, a decline in low vision service utilisation has been observed since 2015.
- The decrease in Dutch patients using low vision services might be explained by a decreased distribution of patients treated with intravitreal injections and patients with lens-related diseases within the services.
- After 2015, patients within low vision services were more likely to have physical comorbidity, to have seen an ophthalmologist and to use low vision aids and occupational therapy.

lacking, although it may be partially deduced from annual patient numbers of LVS institutions.

Previous international studies have identified several important barriers that have explained low uptake of LVS.¹⁸⁻²⁰ These are related to socio-demographic and clinical patient characteristics, healthcare utilisation and contextual characteristics. Examples of patient characteristics are the presence of comorbidity²¹ and less severe visual acuity and/or field loss.^{20,22}

With regard to barriers related to healthcare utilisation, people who have visual impairment may use other types of healthcare instead of LVS, such as optometry²³ or mental healthcare,²⁴ where their needs may be fully met. Context related barriers that have been reported include lacking referral by eye care professionals,¹⁸ healthcare costs for LVS and lacking service provision due to a widespread LVS patient population and a small distribution or availability of service locations per capita.¹⁹

Although these study outcomes give valuable insights into which barriers may explain the low uptake, little is known about patterns that could explain the observed downward trend in the Netherlands. In addition, previous studies have mainly been based on qualitative designs, surveys or health records and have been limited by relatively small sample sizes. In recent years, there has been a wide interest in research based on healthcare claims to examine patterns in characteristics and healthcare utilisation in patients with various conditions.^{25,26} Healthcare claims data are population-based, eligible to be conducted on a large scale and have the advantage of being generalisable. To our knowledge, there is only one study on LVS provision that was based on healthcare claims, in Canada, which described LVS utilisation patterns over time from both provider and user perspectives.¹⁹ Basiliou et al. found that LVS uptake increased over time, but found disparities in the access to these services based on age, sex and geographic location.

The aim of this paper is to describe the national trends between 2015 and 2018 in LVS utilisation in the Netherlands based on healthcare claims and its associations with socio-demographic, clinical and contextual characteristics of LVS

patients, as well as other healthcare utilisation of patients using LVS. The results of this study may provide policy-makers with suggestions about how to enhance access to LVS in line with the global action plan of the World Health Organisation (WHO).²⁷

METHODS

Design

We conducted a retrospective study based on a Dutch national health insurance claims database retrieved from Vektis CV. We focused on healthcare claims of LVS patients to examine trends in their characteristics and healthcare utilisation.

The Dutch health insurance system

In the Netherlands, curative care is administered by the Dutch Health Insurance Act, which determines that all Dutch citizens are obliged to take out a basic statutory insurance package, including a premium, a compulsory deductible and an income-dependent contribution.²⁸ The premium and the compulsory deductible are directly paid to the health insurers, and the income-dependent contribution is collected by the Dutch tax system. Because of the obligatory basic insurance, almost all (99%) Dutch citizens are covered by health insurance (excluding military personal and convicts). The basic insurance package covers the majority of curative care, including outpatient LVS, inpatient and outpatient (ophthalmic) medical specialist care, mental healthcare and general medical practitioner care (GP care). Medical aids, such as low vision aids, and occupational therapy are partially covered. The average annual premium was 1158 EUR in 2015 and 1308 EUR in 2018. The compulsory deductible in 2015 and 2016 was 375 and 385 EUR, respectively, which applies to all types of curative care, except for GP care, maternity, district nursing and dental care (for children <18 years). The income-dependent contribution was 4.85% of a maximum income of 51,976 EUR in 2015, and 5.65% of a maximum income of 54,614 EUR in 2018.

Moreover, people with low income can receive a monthly contribution towards healthcare costs up to a maximum of 107 EUR. Besides the basic insurance package, citizens can take out other voluntary supplementary insurance packages, which cover extra costs for services such as dental care, physiotherapy, mental healthcare, occupational therapy and low vision aids (e.g., spectacles and lenses). About 85% of Dutch citizens have at least one additional insurance package.²⁹

Healthcare services for patients by all healthcare providers, including prescribed medication, are claimed by health insurers, if patients are covered. When citizens receive care within healthcare services, all health professionals

administer their delivered care with a corresponding digital code to claim healthcare expenses from health insurers. In addition to information about healthcare utilisation, claims include data regarding socio-demographic, clinical and context related characteristics at the patient level.

Data source

Vektis CV continuously collects the healthcare claims of all Dutch insurers to give insights about healthcare utilisation to the Dutch government, health insurers and care providers. Demographic, clinical and context related characteristics at the patient level are also available.

Study population

Low vision services

Within the Dutch Health Insurance Act, LVS belongs to sensory disability care. LVS are provided regionally and, as of 2015, are largely funded by health insurance within the basic statutory insurance package. LVS are offered by specialised, for-profit low vision optometrists who mainly prescribe optical aids, and three non-profit multidisciplinary organisations that offer a whole range of services supporting individuals to gain (back) independence and enhance their QOL. At the multidisciplinary organisations, patients mainly use outpatient LVS, but for some, inpatient LVS is offered, depending on the extent of their needs. The following LVS are offered: advice in disability assistive products (e.g., computer, smartphone, white cane); support in daily activities; occupational therapy; mobility and orientation training; training in braille reading; psychosocial support and psychological therapy.

According to the Dutch Society of Ophthalmology guideline, 'Vision disorders: Rehabilitation and referral' (2011–2020), referral to LVS was advised for people with a decimal visual acuity of <0.3 and/or a visual field of <30° around the central point of fixation and/or an evident request for assistance when therapeutic options in regular ophthalmic practice were not sufficient.³⁰ For LVS utilisation, patients need to be referred by an ophthalmologist, or in some cases by another medical specialist, e.g., neurologists or geriatricians. Optometrists or general medical practitioners may refer patients to ophthalmologists in the first place. When the visual functioning can be (partially) improved or compensated with optical low vision aids, referral to a low vision optometrist should be considered. Therefore, ophthalmologists may refer to low vision optometrists before they refer to LVS. If the care of the low vision optometrist is not sufficient to meet the patient's needs, the optometrist can refer to LVS in agreement with the ophthalmologist.

For this study, claims data for the period of 1 January 2015 to 31 December 2018 were examined for all visually

impaired adults, aged 18 or older, who received LVS at least once within the Dutch Health Insurance Act at one of the three Dutch multidisciplinary organisations for people with a visual impairment. Inclusion criteria were being insured with the basic statutory insurance package, whether or not in combination with voluntary supplementary insurance.

Socio-demographic characteristics

The age and sex of LVS patients was retrieved from claims data. Socio-economic status (SES) was retrieved from The Netherlands Institute for Social Research and was linked to the claims data, based on 4-digit postal codes.³¹ For information about SES, The Netherlands Institute for Social Research summarises by factor analysis the average income in a neighbourhood, the percentage of people with a low income, low education and those who do not work. Area of residence was operationalised based on four-digit postal codes within claims data, which was linked to information about the degree of urbanisation of Dutch municipalities from Statistics Netherlands.^{32,33} Statistics Netherlands defines five degrees of urbanisation based on the density of addresses per km²: extremely urbanised (2500 addresses or more), strongly urbanised (1500–2500 addresses), moderately urbanised (1000–1500 addresses), hardly urbanised (500–1000) and not urbanised (less than 500 addresses).

For municipalities, the mean density of all addresses per km² within a municipality compose the degree of urbanisation. For this study, the degree of urbanisation of municipalities was linked to the postal codes within claims data, based on four digits. The five urbanisation levels were then aggregated and recoded into the categories rural and urban area of residence, whereby urban area of residence was based on the three highest degrees of urbanisation and rural area of residence was based on the two lowest degrees of urbanisation.

Clinical characteristics

For clinical characteristics, claims data registered by ophthalmologists were used. Ophthalmic medical specialist care in the Netherlands is offered at general hospitals, university hospitals and independent treatment centres. For reimbursement of medical specialist care, a diagnosis-treatment combination (DTC) is used. It contains information about the total healthcare activities and services that are executed by medical specialists, including information about the medical condition that is treated, type of treatment and type of institution. Ophthalmic medical specialist care includes that provided by ophthalmologists and optometrists. For this study, the claims data of ophthalmologists were collected at the DTC level.

To get information about physical comorbidity, claims data from medical specialist care were used. Data were aggregated at annual level per specialism. The presence of physical comorbidity and the specific comorbidities were examined; the former was defined as having at least one record within one of the corresponding specialisms in a particular year, and the latter as having a record within a certain specialism.

For insights about mental comorbidity, claims data of mental healthcare within the Dutch Health Insurance Act were collected. This comprised basic and specialised mental healthcare, care provided by mental health practice nurses in GP care and other mental healthcare (not specified). Mental healthcare data were aggregated at annual level per type of mental healthcare. Both having mental comorbidity and mental comorbidity at the level of the diagnosis were investigated. Mental comorbidity was defined as having at least one record within one of the corresponding types of mental healthcare per year. Furthermore, information about mental comorbidity at the level of the diagnosis was retrieved from claims data of specialised mental healthcare, whereby the specific mental comorbidity was defined as having a record of a specific diagnosis in a particular year.

Contextual characteristics

Regarding contextual characteristics, we looked at the types of institutions where patients were treated, which were either hospitals or independent treatment centres. Second, distance to LVS was investigated with the Google Maps ruler function based on four-digit postal codes and location of the LVS, assuming that patients would go to the nearest location. Distances were measured in kilometres (km). The ruler function was preferred to the Google Maps route planner, as it was less time consuming and both methods correlated highly ($r = 0.91$).

Other healthcare utilisation

To get insight into other healthcare utilisation of LVS patients, claims data of the ophthalmic medical specialist care, GP care, low vision aids and occupational therapy were examined.

With regard to ophthalmic medical specialist care, overall utilisation of ophthalmic medical specialist care and utilisation of intravitreal anti-VEGF injections was investigated at the DTC level. Utilisation was operationalised as the number of patients that used the healthcare service.

For general practitioner care, low vision aids and occupational therapy, claims data were collected and aggregated at an annual level, whereby utilisation was defined as having at least one record within one of the corresponding types of healthcare per year.

Statistical analyses

Socio-demographic, clinical and contextual characteristics and other healthcare utilisation were expressed as percentages (categorical variables) or mean and standard deviation (continuous variables). For the analysis of trends, we examined associations between time and the different characteristics and other healthcare utilisation in LVS patients. Because LVS patients could have used LVS in more than 1 year, generalised estimating equations (GEE) were used to examine average annual change by calculating regression coefficients and 95% confidence intervals, with 'year' (2015–2018) as an independent, categorical variable, and the different characteristics and other healthcare utilisation in LVS patients as dependent variables. For the continuous variable 'distance to LVS', a linear GEE analysis was performed. Other dependent variables were dichotomised, and logistic GEE analyses were performed. An unstructured working correlation structure was assumed to adjust for the within-subject correlations over subsequent years. The year 2015 was considered as the reference, and annual changes in the dependent variables were reported with respect to that year. Effect sizes were reported in percentage points if there were at least 2 years significantly different from 2015. Since a GEE analysis was performed for each dependent variable separately, a Bonferroni correction for multiple testing was applied by multiplying the p-values by the number of models (21) to control the type I error rate. All analyses were conducted with the GENMOD procedure in SAS Analytics software version 9.4 (SAS Institute, sas.com).

Missing values

There were missing data for some socio-demographic and contextual characteristics at the annual level, specifically for socio-economic status, area of residence and distance to LVS.

In all years, missing data were assumed missing completely at random (MCAR) and were <0.4%. In the analysis, we used only complete data.³⁴

Ethics statement

The study protocol was reviewed and approved by the Medical Ethics Committee (METC) of the Amsterdam University Medical Centers, location VUmc. The processing of data was in line with the European General Data Protection Regulation (EGDPR) and informed consent was not required. For the use of insurance claims data, permission of the Dutch national insurances was requested and provided. To ensure privacy of individual patients and care providers, data for this study were pseudonymised and aggregated to a minimum subgroup level of $n > 10$.

RESULTS

The analyses included 49,726 unique patients who used LVS at least once between 2015 and 2018 (Figure 1). Between 2015 and 2018, the number of LVS patients decreased by 15%, from 19,715 unique patients in 2015 to 16,829 unique patients in 2018.

Trends in socio-demographic characteristics

In the 4 year period, on average LVS patients were mainly 65 years or older (53%), female (54%), had a low (24%) or middle SES (38%) and lived in urban areas (68%) (Table 1). The mean age of people entering LVS services remained stable at 64 years (SD = 20) during the whole study period. Compared to 2015, in 2016, 2017 and 2018, the odds of being older than 65 was significantly higher (Table 2). However, the overall increase in the 4 year period was small at 0.8 percentage points. Although LVS patients had mainly low or middle SES, were female and lived in urban areas, no significant trends were found with respect to SES, sex and area of residence across the different years.

Trends in clinical characteristics

On average, 66% had physical comorbidity, mainly within the cardiovascular system, sensory nervous system and tumours (Table 1). Furthermore, 13% had mental comorbidity, whereby LVS patients who utilised specialised mental healthcare (44%) mainly experienced depressive disorders (20%), anxiety disorders (17%) and/or neurocognitive disorders (8%). Most common ophthalmic conditions for which LVS patients were treated were macular (36%), glaucoma (17%) and lens-related diseases (14%). Compared to 2015, the odds of having physical comorbidity was significantly higher in 2016, 2017 and 2018 (Table 2). Between 2015 and 2018, the relative amount of LVS patients with physical comorbidity increased by 3 percentage points. Compared to 2015, the odds of having a disease of the lens, macula and diabetic retinal disease was significantly lower in 2018 (and in 2017 for lens diseases). For the other diagnosis groups, no significant trends were found.

Trends in context related characteristics

Of the LVS patients who went to an ophthalmologist, 17% were treated with intravitreal injections in the 4 year period and most of them were treated in hospitals (86%) (Table 1). Of all LVS patients, 77% lived within 20 km of an LVS. Compared to 2015, the odds of being treated in hospitals by an ophthalmologist versus receiving eye care from an independent treatment centre was significantly lower in the years after 2015 (1.8 percentage points; Table 2).

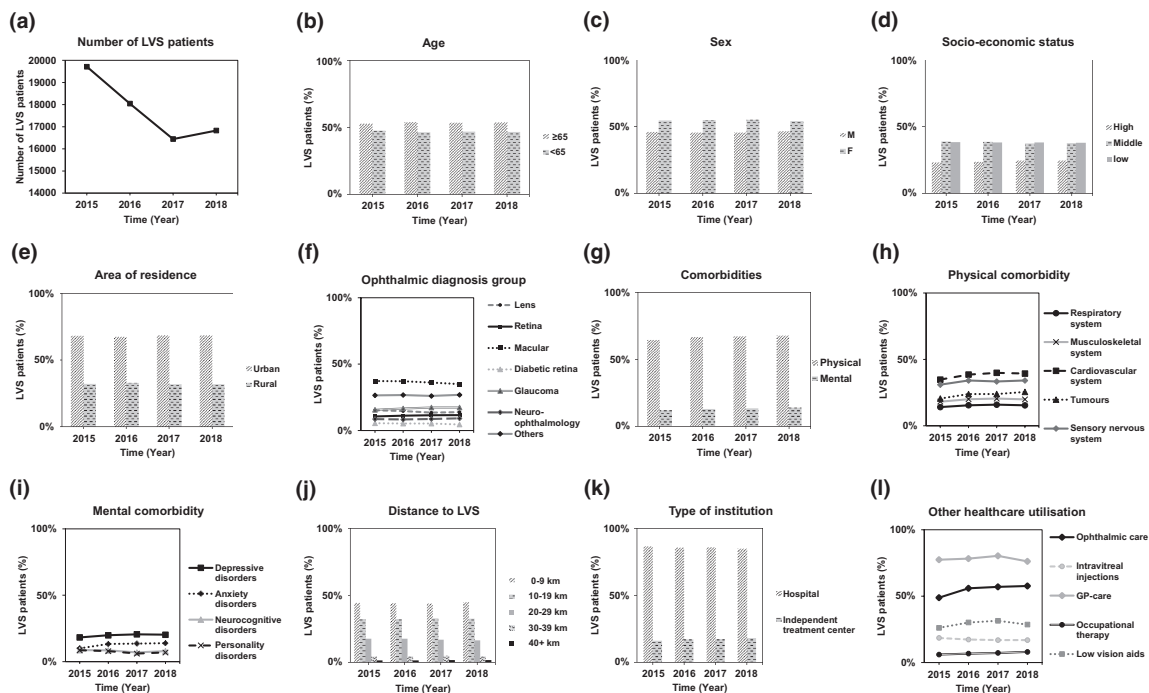


FIGURE 1 Trends in patient characteristics between 2015 and 2018. (a) Number of unique patients per year. *Socio-demographic characteristics:* (b) Age. (c) Sex. (d) Socio-economic status. (e) Area of residence. *Clinical characteristics:* (f) Ophthalmic diagnosis groups within ophthalmic medical specialist care, LVS patients could have been treated for more than one ophthalmic condition across the different diagnosis groups per year. (g) Comorbidities, LVS patients could have been treated for both, mental and physical comorbidity. (h) Physical comorbidities on the diagnosis level, LVS patients could have been treated within more than one of the medical specialisms for comorbid physical disease per year. (i) Mental comorbidity on diagnosis level based on specialised mental healthcare, LVS patients could have been treated for more than one comorbid mental disorder per year. *Contextual characteristics:* (j) Distance to LVS. (k) Type of institution, LVS patients could have been treated in both, hospitals and independent treatment centres for ophthalmic medical specialist care. *Other healthcare utilisation:* (l) Other healthcare utilisation, utilisation of LVS patients of ophthalmic medical specialist care, GP-care, low vision aids and occupational therapy and treatment with intravitreal injections. Intravitreal injections represent the number of LVS patients that were treated with intravitreal injections for ophthalmic medical specialist care

Trends in other healthcare utilisation

Between 2015 and 2018, on average, GP care was utilised by 78% of LVS patients; 55% used ophthalmic care, 29% used low vision aids and 7% used occupational therapy (Table 1). Compared to 2015, the odds of LVS patients utilising ophthalmic care was significantly higher in 2016, 2017 and 2018 (9 percentage points; Table 2). For LVS patients who utilised ophthalmic care, the odds of being treated with intravitreal injections was significantly lower in 2017 and 2018 compared to 2015 (1.7 percentage points). Furthermore, the odds of LVS patients utilising occupational therapy (2 percentage points) and low vision aids (2 percentage points) was significantly higher in 2016, 2017 and 2018, compared to 2015.

DISCUSSION

This study shows a decrease in Dutch LVS patients by 15% between 2015 and 2018, and provides insight into possible explanations for this downward trend. The results demonstrated that LVS patients were less likely to be treated with intravitreal injections over these years, with an overall decrease by 1.7%. As open data of the Dutch Healthcare

Authority about the general population show an increase between 2015 and 2018 of intravitreal injections from 3.9% to 4.9%,¹⁷ this could partly explain the downward trend in the study population, as people who received intravitreal injections utilised LVS less over the years. Patients receiving medical treatment may feel a reduced need for LVS, or might be referred less often by ophthalmologists as intravitreal injections substantially improve the vision of patients and can enhance their QOL.³⁵

Low Vision Services patients were also less likely to have lens related diseases over the study period. This could be due to the rising number of cataract surgeries in Europe, including the Netherlands, as a result of demographic changes, good clinical outcomes, rapid postoperative recovery and a low risk of complications.³⁶ In Europe, cataract surgery is performed with good results in patients with an average preoperative decimal visual acuity of 0.27 (approximately 6/22), a mean age of 73 and in those who have ocular comorbidity such as macular degeneration or glaucoma,³⁶ and can evidently improve their vision related QOL.³⁷ It should be noted that changes for both intravitreal injections and lens related diseases were small, and can therefore only partially explain the downward trend in LVS uptake.

TABLE 1 Characteristics of the study population in 2015–2018 (*n* = 49,726)

	2015 <i>n</i> = 19,715	2016 <i>n</i> = 18,046	2017 <i>n</i> = 16,446	2018 <i>n</i> = 16,829	Mean (4 years)
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	%
Socio-demographic characteristics					
Sex, female, <i>n</i> (%)	10,705 (54.3)	9865 (54.7)	9003 (54.7)	9046 (53.8)	54
Age, y, range 18–106, mean (SD)	64 (20)	64 (20)	64 (20)	64 (20)	
Socio-economic status					
Missing	63 (0.3)	62 (0.3)	67 (0.4)	56 (0.3)	0
Low	7508 (38.1)	6843 (37.9)	6241 (37.9)	6338 (37.7)	38
Middle	7602 (38.6)	6916 (38.3)	6131 (37.3)	6319 (37.5)	38
High	4542(23.0)	4225(23.4)	4007(24.4)	4116 (24.5)	24
Area of residence					
Missing	20 (0.1)	21 (0.1)	13 (0.1)	12 (0.1)	0
Urban	13,392 (67.9)	12,123 (67.2)	11,204 (68.1)	11,476 (68.2)	68
Rural	6303 (32.0)	5902 (32.7)	5229 (31.8)	5341 (31.7)	32
Clinical characteristics					
Ophthalmic diagnosis group[†]					
Lens	1466 (15.2)	1475 (14.6)	1261 (13.5)	1346 (13.9)	14
Retina	1018 (10.6)	1126 (11.2)	1078 (11.5)	1127 (11.6)	11
Macula	3587 (37.2)	3742 (37.1)	3380 (36.1)	3392 (34.9)	36
Diabetic retina	528 (5.5)	528 (5.2)	492 (5.3)	440 (4.5)	5
Glaucoma	1501 (15.6)	1672 (16.6)	1626 (17.4)	1681 (17.3)	17
Neuro-ophthalmology	828 (8.6)	839 (8.3)	816 (8.7)	887 (9.1)	9
Others	2551 (26.5)	2694 (26.7)	2438 (26.0)	2606 (26.8)	26
Physical comorbidity	12,712 (64.5)	12,020 (66.6)	11,021 (67.0)	11,366 (67.5)	66
Mental comorbidity	2376 (12.1)	2338 (13.0)	2223 (13.5)	2336 (13.9)	13
Contextual characteristics					
Type of institution[‡]					
Hospital	8319 (86.3)	8626 (85.5)	8019 (85.6)	8226 (84.7)	86
Independent treatment-centre	1535 (15.9)	1720 (17.1)	1614 (17.2)	1755 (18.1)	17
Distance to LVS (km)					
Missing	20 (0.1)	21 (0.1)	13 (0.1)	12 (0.1)	0
0–9	8720 (44.2)	7922 (43.9)	7205 (43.8)	7535 (44.8)	44
10–19	6385 (32.4)	5833 (32.3)	5403 (32.9)	5491 (32.6)	33
20–29	3455 (17.5)	3190 (17.7)	2780 (16.9)	2739 (16.3)	17
30–39	866 (4.4)	826 (4.6)	770 (4.7)	779 (4.6)	5
40+	269 (1.4)	254 (1.4)	275 (1.7)	273 (1.6)	2
Other healthcare utilisation					
Ophthalmic medical- specialist care	9637 (48.9)	10,084 (55.9)	9371 (57.0)	9710 (57.7)	55
Intravitreal injections [§]	1788 (18.6)	1749 (17.3)	1587 (16.9)	1643 (16.9)	17
GP-care	15,274 (77.5)	14,120 (78.2)	13,222 (80.4)	13,772 (76.2)	78
Occupational therapy	1188 (6.0)	1218 (6.7)	1186 (7.2)	1353 (8.0)	7
Low vision aids	5153 (26.1)	5442 (30.2)	5171 (31.4)	4810 (28.6)	29

Abbreviation: SD, standard deviation.

[†]Within ophthalmic medical specialist care, LVS patients could have been treated for more than one ophthalmic condition per year.[‡]LVS patients could have been treated in both, hospitals and independent treatment centres for ophthalmic medical specialist care.[§]LVS patients that were treated with intravitreal injections within the ophthalmic medical specialist care.

TABLE 2 Results of generalised estimating equations (GEE) analysis: The effects of time (year) on patient characteristics

Outcome variables	2016 ^a		2017 ^a		2018 ^a	
	OR [95%]	<i>p</i>	OR [95%]	<i>p</i>	OR [95%]	<i>p</i>
Socio-demographic characteristics						
Gender (Female)	1.00 [1.00–1.00]	>0.99	1.00 [1.00–1.00]	>0.99	1.00 [1.00–1.00]	>0.99
Age (≥65)	1.05 [1.03–1.07]	0.002*	1.12 [1.09–1.14]	0.002*	1.21 [1.18–1.23]	0.002*
Socio-economic status (low or middle) ^b	1.00 [0.98–1.02]	>0.99	1.00 [0.98–1.02]	>0.99	0.99 [0.97–1.00]	>0.99
Area of residence (Urban)	1.00 [0.98–1.02]	>0.99	1.00 [0.98–1.02]	>0.99	1.01 [0.99–1.03]	>0.99
Clinical characteristics						
Ophthalmic diagnosis group ^c						
Lens	0.95 [0.88–1.03]	>0.99	0.87 [0.80–0.94]	0.006*	0.88 [0.81–0.95]	0.02*
Retina	0.97 [0.86–1.09]	>0.99	0.95 [0.85–1.07]	>0.99	0.85 [0.70–1.43]	>0.99
Macula	0.98 [0.94–1.02]	>0.99	0.94 [0.90–0.98]	0.06	0.90 [0.87–0.94]	0.02*
Diabetic retina	1.03 [0.95–1.12]	>0.99	0.95 [0.86–1.05]	>0.99	0.89 [0.80–0.98]	0.04*
Glaucoma	1.02 [0.89–1.17]	>0.99	1.00 [0.88–1.12]	>0.99	0.93 [0.75–1.16]	>0.99
Neuro-ophthalmology	0.98 [0.92–1.04]	>0.99	1.00 [0.92–1.07]	>0.99	0.99 [0.92–1.07]	>0.99
Others	1.00 [0.94–1.06]	>0.99	0.96 [0.91–1.02]	>0.99	0.98 [0.92–1.04]	>0.99
Physical comorbidity ^c	1.21 [1.16–1.26]	0.002*	1.21 [1.16–1.26]	0.002*	1.25 [1.20–1.30]	0.002*
Mental comorbidity ^c	1.04 [0.98–1.04]	>0.99	1.07 [1.01–1.14]	0.59	1.09 [1.03–1.16]	0.11
Contextual characteristics						
Type of institution (Hospital) ^d	0.92 [0.87–0.97]	0.02*	0.91 [0.86–0.97]	0.04*	0.86 [0.81–0.91]	0.002*
Distance to LVS [†]	−0.04 [−0.43–0.35]	0.82	−0.01 [−0.07–0.05]	>0.99	−0.05 [−0.11–0.01]	>0.99
Other healthcare utilisation ^c						
Ophthalmic medical specialist care	1.23 [1.19–1.28]	0.002*	1.25 [1.10–1.30]	0.02*	1.23 [1.19–1.28]	0.002*
Intravitreal injections	0.92 [0.87–0.98]	0.15	0.83 [0.77–0.88]	0.002*	0.78 [0.72–0.84]	0.002*
GP-care	0.97 [0.93–1.01]	>0.99	1.04 [1.00–1.08]	>0.99	0.89 [0.85–0.92]	0.002*
Occupational therapy	1.13 [1.04–1.22]	0.04*	1.22 [1.13–1.32]	0.002*	1.36 [1.26–1.48]	0.002*
Low vision aids	1.20 [1.16–1.26]	0.002*	1.26 [1.21–1.31]	0.002*	1.09 [1.05–1.14]	0.002*

Reference group: ^a2015; ^bhigh; ^cno utilisation; ^dindependent treatment centre.

*Reported *p*-values are corrected. Bold is significant at *p* < 0.05 (i.e. after Bonferroni correction).

[†]Regression coefficients obtained from the linear GEE analysis.

In addition, findings revealed interesting trends in characteristics in the LVS user population. LVS patients were more likely to have physical comorbidity over the years, possibly reflecting the increasing prevalence of multimorbidity in the general population due to demographic aging, as reported by other studies.^{38,39} This implication is supported by the slight increase in LVS patients who were 65 years or older across the years in the study population. On the other hand, higher rates of physical comorbidity in LVS patients could also indicate greater access to and/or utilisation of LVS for people with more physical comorbidity. This is not in line with other studies that found major concurrent health problems to be a barrier for LVS utilisation.²¹ However, a possible explanation could be that the perceived need for LVS by patients with comorbidity is higher as it may exacerbate the impact of vision loss.³⁸ In turn, being treated for other physical conditions might increase the chance of being referred. Another explanation could be the compulsory deductible payment that might

already be paid for other medical specialist care, which means that LVS will be reimbursed by health insurance, hence lowering the barrier for LVS access.⁴⁰

Low Vision Services patients were more likely to be treated by an ophthalmologist over the years, which might reflect an increased knowledge of the referral guidelines and extensive implementation programmes of the past 20 years. This finding is not consistent with other studies, in which the lack of referral to LVS by eye care professionals was found to be a major barrier to LVS access.^{18,41} In turn, it might also indicate a barrier to access LVS when a patient is not receiving treatment from an ophthalmologist or other medical specialist.

Interestingly, LVS patients were more likely to utilise low vision aids, which may indicate better access to specialised, for-profit, low vision optometrists and other non-profit LVS that also prescribe low vision aids, or, increasing collaboration between these companies and LVS. This differs from previous studies that suggested LVS patients experience a

barrier to obtaining low vision aids.⁴² However, this referral pathway is in complete agreement with the Dutch referral guidelines.

Moreover, LVS patients were mainly older adults over 65 years of age, female, had low or middle SES, macular related diseases and lived in urban areas within 20 km of LVS locations.

Findings with respect to age, sex, ophthalmic condition and area of residence were also reported by other investigations,^{19,41,43} and most can be explained by the epidemiological distribution of ophthalmic conditions and the Dutch population structure. As widely reported, the prevalence of visual impairment is increasing with age, with people above 50 years of age being particularly affected. Also, women are more likely to have visual impairment, and age-related macular degeneration has been reported as one of the leading causes of severe vision loss. Further, in the Netherlands around 70% of the population lives in cities, and approximately 30% lives in villages.⁴⁴ A discrepancy can be found with respect to SES. In contrast to LVS patients in the study population of the present study who had mainly low or middle SES, the general Dutch population predominately has a middle or high SES.⁴⁵ There is some evidence that SES is associated with visual impairment, as in people with low education, employment and/or income are at higher risk of developing visual impairment, even in developed countries.⁴⁶ This could be a plausible explanation for the SES distribution in the study population. On the other hand, visual impairment is associated with adverse outcomes for employment⁹ and economic status.⁴⁷ Given this background, the present SES distribution in our study population might indicate a barrier to receive LVS for visually impaired people with fewer resources, with regard to the SES indicators education, income and occupation. Although studies on barriers to LVS did not focus on SES, low income¹⁸ and low education⁴¹ were found to be prohibitive factors for utilising or having access to LVS in countries where LVS are not or are only partially paid for by the public health system. More research on the role of SES with regard to the access to and/or utilisation of LVS is needed.

A point of interest is the regional distribution of LVS patients. It is expected that in the Netherlands by 2035, the number of people aged 65 or older will increase, particularly in rural areas due to demographic aging and younger people moving to urban areas.⁴⁸ Policymakers should be aware of this population shift and possible emerging disparities in access to LVS based on area of residence as most LVS patients currently live in urban areas. The fact that most LVS patients in the study population lived within 20 km of LVS can be explained by the high population density and the good geographical coverage of LVS in the Netherlands.

This study has some limitations. First, this study reflects the Dutch situation and the way LVS are offered, whereas the method whereby patients are referred to LVS varies across countries. LVS may be offered by multidisciplinary practitioners or in a single service, as part of an ophthalmology department in hospitals, and may be reimbursed

by health insurance or not. Furthermore, there is a difference in how LVS are defined and whether or not low vision aids and optometry are included in the definition. Because of this country specific LVS care delivery system and definitions, one-to-one comparisons should be made with caution. Nevertheless, the results of the present study regarding the downward trend in LVS patients and characteristics can be considered as informative for other countries.

Second, in contrast to other countries, the DTC diagnosis codes are not in accordance with the International Classification of Diseases (ICD-10). Although DTC diagnoses are based on the ICD-10 structure for their classification, ICD-10 diagnoses themselves are not used within DTC, which has different diagnoses options. Therefore, the present findings regarding ophthalmic diagnoses and physical comorbidity in LVS patients cannot be compared directly with the results from international studies.

Third, study results could include coding errors or misdiagnosis, which can be a flaw in any study based on healthcare insurance claims.⁴⁹ However, a recent validation study in a cardiac population indicated that Dutch healthcare claims data are highly accurate.⁵⁰ Fourth, in view of international studies where the severity of the visual impairment was found to be strongly related to the likelihood of patients receiving LVS,^{20,22} the role of visual acuity and the severity of the visual impairment in the downward trend in LVS patients could not be assessed, as these data were not available. Fifth, this study only included care that was covered by health insurance, and therefore these results might not represent accurately the actual healthcare utilisation and characteristics of the study population. Sixth, as this study only includes healthcare claims data of LVS within the Dutch Health Insurance Act, which was introduced in 2015, the impact of the shift to this new healthcare policy could not be observed here. A major strength of this study was the use of a large population-based dataset, which includes the claims data of all Dutch insurers covering almost all LVS delivered within the Dutch Health Insurance Act, and thus enhances generalisability to the Dutch LVS population.

CONCLUSION

Between 2015 and 2018, the number of Dutch LVS patients decreased by 15%. This decrease might, at least partially, be explained by a decreased distribution of patients treated with intravitreal injections and patients with lens related diseases within LVS. In 2016, 2017 and 2018, LVS patients were more likely to have physical comorbidity and to utilise ophthalmic care, low vision aids and occupational therapy compared to 2015. This might indicate enhanced access to LVS when treated by ophthalmologists or other medical specialties, or the opposite, i.e., less access to LVS when not treated within one of these medical specialties. In addition, LVS patients with multimorbidity might have experienced fewer barriers to LVS because of the compulsory deductible payment that

had already been made. Policymakers should pay attention to possible emerging regional disparities in access to and/or utilisation of LVS. Given these current results, future studies should investigate further these differences in characteristics between LVS users and non-users.

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AUTHOR CONTRIBUTIONS

Miriam L Stolwijk: Conceptualization (equal); data curation (equal); formal analysis (equal); methodology (equal); project administration (equal); visualization (lead); writing – original draft (equal). **Ruth MA van Nispen:** Conceptualization (equal); formal analysis (equal); methodology (equal); project administration (equal); supervision (equal); writing – original draft (equal). **Ilona WM Verburg:** Data curation (equal); methodology (equal); resources (equal); writing – review and editing (equal). **Lieke van Gerwen:** Data curation (equal); resources (equal); writing – review and editing (equal). **Tim van de Brug:** Formal analysis (equal); methodology (equal); writing – review and editing (equal). **Ger HMB van Rens:** Funding acquisition (lead); supervision (equal); writing – review and editing (equal).

COMMERCIAL RELATIONSHIPS AND DISCLOSURES

ML Stolwijk, RMA van Nispen, IWM Verburg, L van Gerwen, T van de Brug, GHMB van Rens: No Commercial Relationship.

ORCID

Miriam L Stolwijk  <https://orcid.org/0000-0003-2816-0156>
 Ruth M A van Nispen  <https://orcid.org/0000-0003-1227-1177>
 Tim van de Brug  <https://orcid.org/0000-0003-3541-9111>

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