



## **A Cross Sectional Study on the Possible Association between Socioeconomic Status and Unmet Ophthalmic Medical Needs**

**Birgit-Bettina Bestges<sup>1,2</sup>, Cay-Christian Lösche<sup>2</sup> and Frank Krummenauer<sup>1\*</sup>**

<sup>1</sup>Faculty of Health, Institute for Medical Biometry and Epidemiology, Witten/Herdecke University, Witten, Germany.

<sup>2</sup>Muelheim Eye Hospital at the Evangelisches Krankenhaus Muelheim/Ruhr, Muelheim/Ruhr, Germany.

### **Authors' contributions**

*This work was carried out in collaboration between all authors. Author BBB has assisted in designing the investigation and writing the study protocol and corresponding documents concerning the IEC application. She coordinated recruitment, clinical investigation and documentation of all probands and assisted in the exploratory statistical data analysis, furthermore she wrote a preliminary draft of this manuscript. Author CCL designed the investigation from the clinical perspective and revised the manuscript from the clinical perspective. Author FK designed the investigation concerning methodological aspects such as sample size calculation and Statistical Analysis Plan (SAP), programmed major data management steps to derive the clinical endpoints, performed the data analysis as well as the respective result presentations and wrote major parts of the manuscript.*

### **Article Information**

DOI: 10.9734/BJMMR/2016/27096

#### Editor(s):

(1) Crispim Cerutti Junior, Department of Social Medicine, Federal University of Espirito Santo, Brazil.

#### Reviewers:

(1) Nader Hussein Lotfy Bayoumi, Alexandria University, Egypt.

(2) Essam A. El-Moselhy, Al-Azhar University, Egypt.

Complete Peer review History: <http://www.sciencedomain.org/review-history/15579>

**Original Research Article**

**Received 18<sup>th</sup> May 2016**  
**Accepted 22<sup>nd</sup> July 2016**  
**Published 3<sup>rd</sup> August 2016**

### **ABSTRACT**

**Purpose:** Health care research increasingly concentrates on the putative dependence of health care access of socioeconomic determinants. For the particular aspect of ophthalmic health care the intention of this cross sectional study was to assess a possible association between socioeconomic status and lacking ophthalmological health care supplementation.

**Materials and Methods:** Regular visitors to the "Muelheim Tafel" social project were recruited and

\*Corresponding author: E-mail: [Frank.Krummenauer@uni-wh.de](mailto:Frank.Krummenauer@uni-wh.de);

contrasted to administrative hospital staff, both cohorts serving as model cohorts of different socioeconomic status. The cohorts were then compared alongside visual and refractive endpoints based on a total of 110 “Tafel” participants and 68 hospital staff members. The probands’ “presenting” visual acuity was assessed by means of vision charts (in case of probands wearing glasses, the presenting visual acuity was assessed while wearing these glasses, otherwise without glasses to imitate “daily life” vision); furthermore the probands’ “best achievable” corrected visual acuity was assessed by means of an autorefractometer. The primary endpoint was defined by – in at least one eye – a simultaneous presenting visual acuity of less than or equal to 0.5 and a corrected visual acuity of more than 0.5.

**Results:** The primary endpoint had a prevalence of 34% in the “Tafel” cohort and of 10% in the hospital staff cohort; this difference in prevalences was found statistically significant (Fisher  $p < 0.001$ ). This cohort gradient was reproduced for merely all secondary visual and refractive endpoints under consideration.

**Conclusion:** This cross sectional investigation demonstrated a statistically significant association between socioeconomic status and deficits in ophthalmic health care in terms of best achievable visual improvement.

*Keywords: Under-supplementation; socioeconomic status; visual improvement.*

## 1. INTRODUCTION

Bestges et al. [1] implemented a pilot investigation to validate possible clinical – visual and refractive – endpoints with health care research sensitivity, serving as indicators of ophthalmic under-supplementation. Furthermore, this pilot investigation could identify a promising proband pool serving as a cohort model for moderate socioeconomic status: In Germany, between 11 and 13.5 million people are threatened by relative poverty (which means they have less than 50% of the median equivalised net income). Many of them depend on additional social offers like the “Tafel” projects. “Tafel” (“lunch table” in English) stands for social institutions which hand over donated food to people declaring lacking own resources or being homeless. More and more people visit institutions like the “Tafel” as declared by the Bundesverband Deutsche Tafel [2].

Since 2006 the Muelheim Eye Hospital offers annual free (and anonymous) eye examinations to the visitors of the “Tafel” project in the city of Muelheim or near-by cities in the Ruhr area. During such an offer in the city of Oberhausen in 2011, the above mentioned pilot investigation was implemented and could demonstrate the visitors to the “Tafel” as a suitable cohort of probands with moderate socioeconomic status.

In the following independent cross sectional investigation a cohort of attendants of the “Muelheim Tafel” project were recruited in February 2012 and contrasted to a cohort recruited from the administrative staff at a local

hospital (Evangelisches Krankenhaus Muelheim / Ruhr), serving as a model cohort with “better” socioeconomic status than the “Tafel” visitors’. The comparison of these cohorts alongside the endpoints derived from the pilot investigation was then considered as a rationale for the intended association analysis between socioeconomic status and lacking ophthalmologic health care supplementation.

## 2. MATERIALS AND METHODS

This cross sectional investigation intended to contrast two consecutively recruited cohorts representing different levels of socioeconomic status. Visitors to the “Muelheim Tafel” in February 2012 were invited to take part in the investigation as well as members of the non-medical administrative staff at the “Evangelisches Krankenhaus Muelheim” [“EVK”] hospital. All participants were informed verbally and in writing about the intention and content of the investigation. Only probands, who gave their written informed consent, were included in the investigation. Exclusion criteria were lacking written informed consent to participation or data protection, missing comprehension of the study protocol (e.g. because of rudimentary language skills) or a professional MD education. The local Independent Ethics Committee of Witten / Herdecke University approved the study intention and design by January 2012 (application number: 135/2011).

### 2.1 Clinical Examination

A self-reporting questionnaire on previous ocular conditions and surgeries was administered also

including gender, age and self-reported highest achieved level of education. The vertex power of glasses worn by attendants was determined. Intraocular pressure was then measured by means of a non-contact tonometer (NIDEK NT-500) which is non-invasive, painless and does not require the application of anaesthetising eye drops. As soon as the clinical examination revealed any clinically relevant findings, the respective study participants were informed about the nature and impact of these respective findings; recommendations for further handling (medical assistance, delayed or immediately) were made. However, as participants took part in the study on a completely voluntary basis, these recommendations could only be emphasized, but were not followed-up individually.

## 2.2 “Best Achievable” Corrected Visual Acuity Assessment

The objective refractive error was determined by using an autorefractor (NIDEK ARK-560A). The visual acuity was checked after correction of the objective refractive error via letters and numbers projected on the autorefractor’s internal screen. If at least 3 out of 5 items in a vision line were read correctly, this line was considered as positively passed and the next smaller level was checked. The last line successfully passed was then documented and considered as “best achievable” visual acuity under optimal correction.

## 2.3 “Presenting” Visual Acuity Assessment

Persons, who had glasses for distant vision available, took part in an additional assessment of their visual acuity while wearing these glasses and reading letters and numbers from a common visual acuity chart attached to the wall in a 4 meters distance. This assessment was referred to as “presenting” visual acuity and considered to represent “everyday life” visual acuity. For participants not bringing glasses for distant vision, it was assumed that their uncorrected visual acuity corresponded to their everyday vision, irrespective of whether an uncorrected error of refraction existed or not.

## 2.4 Primary Endpoint

A “best achievable” corrected visual acuity of  $> 0.5$  with a “presenting” visual acuity  $\leq 0.5$  in the same eye was defined as primary endpoint of the investigation (thereby parameterising ophthalmological under-supplementation). The

primary endpoint was assessed for each eye, respectively; for every participant it was declared as achieved as soon as it occurred in at least one eye. The underlying cutpoint of 0.5 was motivated by the results of the 2011 pilot investigation [1], where it was proven as a characteristic for a “Tafel” cohort’s visual acuity distribution.

## 2.5 Secondary Endpoints

A key secondary endpoint was the possibility to improve the presenting visual acuity (again in at least one eye) by at least two lines when correcting the objective refractive error. A further endpoint was defined as a presenting visual acuity  $\leq 0.5$  in at least one eye without having distance glasses at one’s disposal. Refractive endpoints were characterized by spherical equivalents of  $> +2$  D or  $< -1$  D (in at least one eye) for probands not having glasses for distant vision at their disposal. A further endpoint was an absolute deviation of at least 1 D in at least one eye between the spherical equivalent measurement of the refractive power of the glasses and the respective autorefractor readings. Again the underlying cutpoints were derived from the 2011 pilot investigation.

## 2.6 Statistical Analysis

Statistical analysis was performed by means of the SPSS® Software (release 19.0 for Windows®). The primary analysis of the investigation comprised both the interval estimation of the primary endpoint’s prevalence in the “Muelheim Tafel” cohort at the nominal 97.5% confidence level as well as the interval estimation of the cohort prevalences’ difference at the nominal 97.5% confidence level (Bonferroni correction for multiplicity in these parallel estimates).

For the secondary binary endpoints, cohort prevalences were described by means of absolute and appropriate relative frequencies; for the cohort prevalences’ difference a 99% confidence interval was estimated; in addition, these prevalences were contrasted by means of a two-sided exact Fisher test at the nominal 1% significance level. Note that the 99% confidence level was chosen to avoid formal correction for multiplicity testing with regards of the above 5 parallel key secondary endpoints. Nevertheless, the results of significance testing in these secondary endpoints should be interpreted as exploratory.

Further exploratory analyses of the cross sectional cohort data were based on medians and interquartile ranges for continuous variables and on absolute and appropriate relative frequencies for binary and categorical data.

In addition, a logistic regression model was fitted to relate the primary endpoint to the cohorts under adjustment for age and gender and ophthalmological self-reported data. These regression models were fitted by means of step-wise forward selection based on Likelihood Ratio tests at the nominal 5% level. Results were summarized in terms of nominal Likelihood Ratio tests for the association between the cohort status with the primary endpoints as well as with the putative cofactors.

## 2.7 Sample Size Calculation

The required number of cases was estimated based on the primary endpoint's prevalence (30%) as found in the independent pilot investigation by Bestges et al. [1]. For the "Muelheim Tafel" attendants we presumed the corresponding prevalence of 30% to be reproduced in this cross sectional study; for its estimation at the nominal 97.5% confidence interval (see above for the Bonferroni correction) with maximum width of +/- 10% around the 30% prevalence estimate, a total number of 106 participants had to be documented. To further enable the contrasting of this cohort to the hospital staff cohort, a prevalence difference in the primary endpoint of 30% ("Tafel") versus 10% (hospital) was presumed; to derive a nominal 97.5% confidence interval for this difference of 30%-10% = 20% with maximum width of +/- 15%, a total number of 68 probands per cohort had to be documented. In summary a total number of 106 "Tafel" attendants and a total number of 68 hospital staff members had to be documented for the overall investigation. Note that the formal Bonferroni correction (97.5% confidence levels) enabled to simultaneously reproduce the primary endpoint's prevalence of the pilot investigation by means of an independent cohort and to estimate its possible association with socioeconomic status as modelled by these two cohorts.

## 2.8 Study Participants

A total of 110 "Tafel" attendants was recruited and documented as well as a total of 68 hospital staff members. Note that the total number of 110 Tafel visitors slightly exceeded the target sample size of 106 participants: as a matter of fact during

the final recruitment schedule an "overrun" of voluntary participants was observed; for ethical reasons we decided not to reject any of these, but still offered participation.

The 110 "Tafel" participants' median age was 53 years (range 21 – 86 years), 54% (59) of them were women. 71% (78) had left secondary school without or had only reached low-level certification, 20% (22) had reached intermediate and 11% (11) had reached high level or university graduation. In the hospital staff ("EVK") cohort the median age was 49 years (range 20 – 63 years), 74% (50) were female. Every member of this cohort had left secondary school with full certification, 13% (9) had reached a low level, 40% (27) an intermediate level and 47% (32) a high level or university graduation (Table 1).

## 3. RESULTS

The "Tafel" participants showed a median "presenting" visual acuity of 0.63 (OD) and 0.8 (OS), furthermore a corrected median visual acuity of 0.8 (OD) and 1.0 (OS). In 20% (22) the presenting visual acuity was  $\leq 0.3$  in at least one eye. The median intraocular pressure (measured with a non-contact tonometer) was 17 mmHg both in the right (range 11 – 26 mmHg) and the left eye (range 10 – 25 mmHg), respectively (Table 1). The last ophthalmological examination was reported 3 years before in median; the reported median age of glasses at hand was 5 years (Table 1).

The hospital staff participants (in the following briefly denoted as "EVK" cohort) showed a median "presenting" visual acuity of 1.0 (OD and OS, respectively) and the same corrected median visual acuity (OD and OS). In 7% (5) the presenting visual acuity was  $\leq 0.3$  in at least one eye. The median intraocular pressure (measured with a non-contact tonometer) was 16 mmHg in the right (range 10 – 24 mmHg) and 15 mmHg in the left eye (range 10 – 25 mmHg), respectively (Table 1). The last ophthalmological examination was reported 2 years ago in median; the reported median age of glasses at hand was 2 years.

### 3.1 Primary Endpoint

The primary endpoint (for at least one eye presenting visual acuity  $\leq 0.5$  and a best achievable corrected visual acuity  $> 0.5$  in this eye) had a prevalence of 34% (37) in the "Tafel" cohort and a prevalence of 10% (7) in the "EVK" cohort. This difference in prevalences was found

statistically significant (Fisher  $p < 0.001$ ) with a 97.5% (Bonferroni) confidence interval of 11% to 36% for these prevalences' difference. Furthermore, the pilot investigation's prevalence estimate of 30% [1] for the primary endpoint was confirmed by this independent investigation with the "Muelheim Tafel" cohort's prevalence of 34% (97.5% confidence interval from 24% to 44%).

### 3.2 Secondary Endpoints

A presenting visual acuity  $< 0.5$  in at least one eye without the participant having glasses available was found in 25% (27) of the "Tafel" participants and in 3% (2) of the "EVK" participants. This prevalence's difference was statistically significant at the nominal 1% level (Fisher  $p < 0.001$ ) with a 99% confidence interval from 10% to 34% for the prevalence difference (Table 2).

A visual acuity of  $\leq 0.5$  in at least one eye despite correction of the objective refractive error was found in 18% (20) of the "Tafel" and 6% (4) of the "EVK" participants. This prevalence difference was statistically significant at the nominal 1% level (Fisher  $p = 0.009$ ) with a 99% confidence interval from 0% to 25% for the prevalence difference (Table 2).

The ability of an improvement of at least two lines in visual acuity in at least one eye (comparing presenting and corrected visual acuity) was found in 45% (49) of the "Tafel" and 15% (10) of the "EVK" participants. This difference between prevalences was statistically significant at the 1% level (Fisher  $p < 0.001$ ) with a 99% confidence interval from 13% to 47% for the prevalence difference (Table 2).

After adjustment of the objective refraction via autorefractometer, the spherical equivalent for each eye could be calculated. The latter was found  $< -1$  D or  $> +2$  D in 13% (14) of the "Tafel" and in 3% (2) of the "EVK" participants, who owned glasses. This prevalence difference was not statistically significant at the nominal 1% level (Fisher  $p = 0.024$ ) with a 99% confidence interval from 0% to 20% for the difference of prevalences (Table 2).

When comparing the spherical equivalent assessments of the probands measured by autorefractometer versus their available glasses, a difference of  $< -1$  D or  $> +2$  D – for at least one eye – was found in 20% (6) of the "Tafel" and in 18% (8) of the "EVK" participants. This

difference of prevalences was not statistically significant at the nominal 1% level (Fisher  $p = 1.000$ ) with a 99% confidence interval for the difference of prevalences ranging from -23% to +27% (Table 2).

### 3.3 Association with Educational Level

Table 3 stratifies the above endpoints' prevalences for the study participants' self-reported scholarly education level. Note that in the "Tafel" cohort the fraction of participants showing the above primary endpoint – "presenting" visual acuity  $\leq 0.5$  and "best achievable" corrected visual acuity in this eye  $> 0.5$  for at least one eye – remained merely constant over the three contrasted levels of education, whereas the primary endpoint's prevalence monotonically increased with increasing educational level in the "EVK" cohort. This cohort asymmetry was found for all visual endpoints and implies a negative association between visual impairment as caused by uncorrected refractive errors and self-reported scholarly educational level in the "EVK" cohort, but not in the "Tafel" cohort.

### 3.4 Logistic Regression Analysis

The primary endpoint was contrasted between the "Tafel" and the "EVK" cohort under adjustment for putative cofactors such as age, gender and the participants' self-reported level of education as the most promising available proxy of individual socioeconomic status. The univariate statistically significant difference at the nominal 5% level was retained between the two cohorts' primary endpoint prevalences (LR  $p < 0.001$ ) after gender adjustment (LR  $p = 0.140$ ): 41% of the male "Tafel" cohort members and 11% of the male "EVK" cohort members showed the primary endpoint of visual under-supplementation, but it was observed in only 27% versus 11% of the female "Tafel" and "EVK" cohort members, respectively. Age adjustment did not have a significant impact on the overall logistic model (LR  $p = 0.341$ , corresponding to the rather moderate age gradient between the cohorts as already illustrated in Table 1). Furthermore the adjustment for self-reported educational level alone was not statistically significant (LR;  $p = 0.940$  when contrasting "no or moderate" versus "intermediate or higher" self-reported educational level). However, a statistically significant interaction with the primary endpoint's incidence pattern among the cohorts

was found (LR  $p=0.048$ ), according to the stratified description shown in Table 3.

#### 4. DISCUSSION

The aim of the World Health Organisation's (WHO) programme "Vision 2020" is to eliminate avoidable blindness by the year 2020. It is stated that 75% of blindness and visual impairment is caused by five treatable conditions such as uncorrected refractive errors (World Health Organisation, WHO: <http://www.iapb.org/vision-2020>). In highly industrialised countries one may presume that this problem is of negligible order, but as even a "milder" reduction of visual acuity  $< 0.5$  can lead to a significant impairment in activities of daily life and social isolation [3] the

future impact of under-supplementation was demonstrated even for these regions [4]: People with lower vision are more likely to be without work or be paid less. The difference in income between people with good visual acuity and those with lower visual acuity is up to 50%; yet, this relation is not unidirectional as shown by Tielsch et al. [5]. This is compatible with the results of our study: Differences between the "Tafel" and the "EVK" participants were statistically significant in showing a presenting visual acuity  $\leq 0.5$  in at least one eye while the corrected visual acuity was  $> 0.5$ . The attendants of the "Tafel" project represented a cohort with lower income and with lower education (71% without high-school education).

**Table 1. Distribution characteristics (medians and interquartile ranges for continuous variables or absolute and relative frequencies for categorical variables, respectively) for sociodemographic and optometric characteristics in voluntary probands recruited from the "Muelheim Tafel Project" ["Tafel" cohort] and from administrative staff at the "Evangelisches Krankenhaus Muelheim/Ruhr" ["EVK" cohort]**

	"Tafel" cohort	"EVK" cohort
Age (years)	53 (37 – 61)	49 (33 – 52)
Percentage of females	54% (59)	74% (50)
Level of scholarly education	None / Low Intermediate High / University	13% (9) 40% (27) 47% (32)
Reported time since last ophthalmological examination (years)	3 (0 – 6)	2 (0 – 6)
Age of available glasses (years)	5 (3 – 12)	2 (0 – 5)
"Best achievable" visual acuity OD	0.8	1.0
"Best achievable" visual acuity OS	1.0	1.0
"Presenting" visual acuity OD	0.63	1.0
"Presenting" visual acuity OS	0.8	1.0
IOD OD (mmHg)	17 (14 – 21)	16 (14 – 20)
IOD OS (mmHg)	17 (14 – 20)	15 (13 – 21)
Strabism	6% (7)	3% (2)
Ophthalmologic surgery reported	11% (12)	6% (4)
Glasses available	45% (49)	82% (56)
Changes concerning anterior segment in at least one eye	8% (15)	0% (0)
Changes concerning the retina in at least one eye	4% (4)	3% (2)
Changes concerning nervus opticus in at least one eye	10% (2)	0% (0)
Insight to fundus possible	98% (108)	100% (68)

OS = left eye, OD = right eye

**Table 2. Refractive and visual endpoints' prevalences (Absolute and relative frequencies) in voluntary probands recruited from the "Muelheimer Tafel Project" ["Tafel" cohort] and from administrative staff at the "Evangelisches Krankenhaus Muelheim/Ruhr" ["EVK" cohort]; 99% confidence intervals (99% CI) for the cohorts' prevalences difference as well as fisher test p-values (Fisher)**

	"Tafel cohort"	"EVK" cohort	99% CI for prevalence difference; p (Fisher)
"Presenting visual acuity < 0.5 in at least one eye and corrected visual acuity $\geq$ 0.5 in this eye"	34% (37)	10% (7)	[0,081; 0,386] p < 0,001
"Presenting visual acuity $\leq$ 0,5 without glasses in at least one eye"	25% (27)	3% (2)	[0,096; 0,336] p < 0,001
"Corrected visual acuity $\leq$ 0.5 in at least one eye"	18% (20)	6% (4)	[0,001; 0,245] p = 0,009
"Increase of at least two lines achievable in at least one eye" (when comparing presenting to corrected visual acuity)	45% (49)	15% (10)	[0,131; 0,466] p < 0,001
"Without glasses spherical equivalent < -1 D or > +2 D" in at least one eye	13% (14)	3% (2)	[-0,001; 0,197] p = 0,024
"Absolute difference < -1 D or > +2 D" in spherical equivalent for at least one eye when comparing autorefractor readings and available glasses	20% (6)	18% (8)	[-0,228; 0,272] p = 1,000

**Table 3. Association of refractive endpoints with self-reported scholarly education (Absolute and relative frequencies of endpoint prevalences, stratified for self-reported educational level) in voluntary probands recruited from the "Muelheim Tafel Project" ["Tafel" cohort] and from administrative staff at the "Evangelisches Krankenhaus Muelheim/Ruhr" ["EVK" cohort]**

Self-reported level of education	Cohort	"Presenting visual acuity < 0.5 in at least one eye and corrected visual acuity $\geq$ 0.5 in this eye"	"Presenting visual acuity $\leq$ 0,5 without glasses in at least one eye"	"Increase of at least two lines achievable in at least one eye" (Presenting vs corrected visual acuity)	"Corrected visual acuity $\leq$ 0.5 in at least one eye"
None	"Tafel"	39% (9)	30% (7)	57% (13)	30% (7)
	"EVK"	0% (0)	0% (0)	0% (0)	0% (0)
Intermediate	"Tafel"	32% (24)	21% (16)	43% (33)	16% (12)
	"EVK"	8% (3)	0% (0)	14% (5)	6% (2)
High	"Tafel"	36% (4)	36% (4)	27% (3)	9% (1)
	"EVK"	13% (4)	6% (2)	16% (5)	6% (2)

In Australia, VanNewkirk et al. [6] found that 50 % of examined persons with a presenting visual acuity < 0.5 could be corrected by providing new glasses. In our examination, participants of the "Tafel" cohort were less likely to bring glasses with them than the "EVK" participants while having a refractive error < -1 D or > +2 D. Even if the "Tafel" visitors had visual aids at their disposal these glasses were in median 2.5 times older than the ones available for the "EVK" staff members. Interestingly, the amount of discrepancy between the spherical equivalent in the objective measurement and the glasses' values was nearly equal in both groups [EVK:

18% (8), Tafel: 20% (6)]. In general, the awareness of the need for regular ophthalmic examinations is rather limited [7].

## 5. METHODOLOGICAL LIMITATIONS

This investigation intended to assess a "real life" health care situation, which meant to compromise design and performance determinants in favour of the research interest under consideration. The examination conditions in the "Tafel" setting, for example, were certainly not comparable to those in standardized clinical trials: we locally installed

the instruments for visual and refractive examinations in a room near the ongoing “Tafel” food supply activities; therefore standardisation of assessments was hardly achievable despite the robustness and principal validity of autorefractor measurements. Furthermore the light conditions during this measurement series were not optimal regarding the improvised room and its surroundings. Nevertheless, this systematic bias should not have caused any liberal cohort contrasts: Note, the primary endpoint was based on the intraindividual comparison of the “presenting” with the “best achievable” corrected visual acuity of the same person under the same circumstances. Therefore their intraindividual difference may be assumed unbiased for any participant.

On the other hand, in both cohorts another kind of measurement bias must be discussed concerning the different means of vision assessment in “presenting” and corrected visual acuity: the presenting visual acuity was assessed by means of vision charts, whereas the “best achievable” corrected one was determined by means of an autorefractor. This difference in assessment methods, however, held for both cohorts and should therefore at least not have lead to an asymmetric bias between the cohorts.

A second methodological limitation arises from the underlying “cohort models” used in this investigation to represent cohorts of “moderate” versus “normal” socioeconomic status: it appears plausible, that “Tafel” project probands represent moderate socioeconomic status, so that we decided not to interrogate the “Tafel” participants concerning their financial and social situation directly. A severe reduction in cooperation and participation agreement might have been the consequence of such questions, thereby introducing a severe selection bias into this cohort. For the same reason we did not interview the “EVK” staff members on socioeconomic characteristics; nevertheless, administrative hospital staff can be assumed to represent a cohort or “normal” – maybe even “higher” – socioeconomic status. On the other hand, it must be admitted, that even administrative hospital staff does not necessarily provide a representative cohort in terms of sampling from a Western European population, when health care access and standards are addressed. Although the “EVK” cohort primarily concentrated on administrative staff, the probands in this cohort have more direct access to ophthalmic health care

offers than others just because of its local availability. Communication with other hospital staff furthermore might have improved awareness of the advantages and the offers of regular ophthalmic health care. However, bearing this potential recruitment bias in mind, it is remarkable, that despite the “EVK” participants’ direct access to the eye hospital (as both departments are run by the same holding in a joint building) we found administrative staff members with a visual acuity of  $\leq 0.5$  in at least one eye that could be corrected by glasses (Table 2) – even though the absolute number was negligible. Whether this finding rather indicates lacking awareness of the need for regular ophthalmic examination [8] or the ability to adjust “daily (work) life” for moderate visual impairment remains open for discussion.

## 6. CONCLUSION

In summary, socioeconomic status was found significantly associated with notable deficits in ophthalmic care. Whether the association observed is causal or rather intermediate cannot be decided by means of the non-interventional investigation design used here. Nevertheless, the strength and consistency of the observed association over nearly all considered refractive and visual endpoints encourages the formulation of a causal hypothesis – and perhaps thereby political discussions on lowering access barriers to regular ophthalmic screening.

## FUNDING

No industrial funding was received for this investigation. The foundation “Leonhard-Stinnes Stiftung” provided a one year research grant for Mrs Bestges to enable the implementation of this investigation held at the joint Research Unit “Patient-related Research in Ophthalmology” of the Augenlinik Muelheim/Ruhr and the Institute for Medical Biometry and Epidemiology at Witten / Herdecke University.

## DECLARATION

The data presented in this manuscript have been presented at the 2012 and 2013 annual meetings of the Association of German Ophthalmic Surgeons (DOC congress) as well as at the 2012 annual meeting of the German Health Care Research Network (DNVF), and are part of the Doctoral Thesis of Mrs Bestges submitted to Witten / Herdecke University, Faculty of Health.



## ACKNOWLEDGEMENTS

The authors are grateful for Dr. Wolfgang Strunk, MD, and Mrs. Cornelia Lenze for their assistance in assessment of the clinical data presented here. Furthermore the authors gratefully thank the foundation "Leonhard-Stinnes Stiftung" for providing the research grant for Mrs. Birgit-Bettina Bestges. Furthermore the authors are grateful to two anonymous reviewers and an BJMMR editor, whose comments helped to improve this presentation.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Bestges BB, Lösche CC, Krummenauer F. Worin manifestiert sich eine eventuelle augenärztliche unterversorgung sozial schlechter gestellter menschen – ergebnisse einer pilot-querschnittstudie zur wahl versorgungswissenschaftlicher endpunkte im rahmen der "Oberhausener Tafel". Klin Monatsbl Augenheilkd. 2013; 230:721-6. German.
2. Bundesverband Deutsche Tafel e.V. (editors). Gemeinsam Wachsen, Bundesverband Deutsche Tafel e.V., Jahresbericht 2011. German; 2012.
3. Taylor HR. Eye care for the future: The weisenfeld lecture. Invest Ophthalmol Vis Sci. 2003;44:1413-8.
4. Taylor HR. Fred hollows lecture. Eye care for the community. Clin Experiment Ophthalmol. 2002;30:151-4.
5. Tielsch JM, Sommer A, Katz J, et al. Socioeconomic status and visual impairment among Urban Americans. Arch Ophthalmol. 1991;109:637-41.
6. VanNewkirk MR, Weih L, McCarty CA, et al. Cause-specific prevalence of bilateral visual impairment in Victoria, Australia: The visual impairment project. Ophthalmology. 2001;108:960-7.
7. Alexander RL, Miller NA, Cotch MF, et al. Factors that influence the receipt of eye care. Am J Health Behav. 2008;32:547-56.
8. Younan C, Mitchell P, Cumming R, et al. Socioeconomic status and incident cataract surgery: The blue mountains eye study. Clin Experiment Ophthalmol. 2002; 30:163-7.

© 2016 Bestges et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*  
*The peer review history for this paper can be accessed here:*  
<http://sciedomain.org/review-history/15579>