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# The Montreal Cognitive Assessment (MoCA) in a population-based sample of Turkish migrants living in Germany

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**ABSTRACT**

**Objectives:** Data on cognitive testing in migrants in Germany are scarce. We aimed to evaluate the Montreal Cognitive Assessment (MoCA) in Turkish migrants in Berlin and its association with demographics and health-related variables.
**Method:** For this cross-sectional study, a random sample of persons with Turkish names was drawn from the registration-office. Cognitive function was assessed using the MoCA; 0 = worst, 30 = best total score. Multivariable linear regression models were calculated to determine associated factors with the total MoCA-score.
**Results:** In our analyses we included 282 participants (50% female), mean age 42.3 $\pm$ 11.9 years (mean $\pm$ standard deviation (SD)). The mean $\pm$ SD MoCA score was 23.3 $\pm$ 4.3. In the multivariable analysis, higher education ($ß = 2.68$; $p < 0.001$), and chosing the German version of the MoCA ($ß = -1.13$; $p = 0.026$), were associated with higher MoCA-scores, whereas higher age ($ß = -0.08$; $p = 0.002$) was associated with lower MoCA scores.
**Conclusion:** In our study, a higher educational level, lower age, and German as the preferred test language (as compared to Turkish) were positively associated with the cognitive performance of Berliners with Turkish roots. To examine neurocognitive health of migrants, longitudinal population-based and clinical cohort studies that specifically compare migrants and their descendants with the original population of their home countries are required.

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## Introduction

Due to the fact that healthy and younger people migrate rather than the elderly or diseased and have better access to health care in the host country, a healthy migrant effect is not an unusual finding in epidemiological studies (McDonald & Kennedy, 2004). However, a low educational level of many immigrated persons and language barriers negatively influence health literacy, health status and access to health care (Schenk, 2007). A recent study from Germany showed that over the half of Turkish migrants with own migration experience had a low educational level (Wengler, 2011).

Among the population of 3.5 million people living in the German capital Berlin, a proportion of about six percent has roots in Turkey (Amt für Statistik Berlin-brandenburg, 2010). The second generation, born in Germany, tends to be better educated than their parents, but the educational level is still considerably lower than in the native German population (Berlin-Institut, 2009).

A higher risk for mental disorders among migrants compared to the non-migrant German population was found in a re-analysis of the German Federal Health Survey 1998 (Bermejo, Mayninger, Kriston, & Härter, 2010). Lower cognitive function of elderly Turkish migrants in Denmark was strongly linked to low educational status (Nielsen, Vogel, Gade, & Waldemar, 2012), however, comparable German studies regarding prevalence of cognitive impairment and associated factors are lacking. At the same time they are urgently needed, since the migrant population in Germany, like other aging populations, is at increased risk of developing age-related chronic physical and mental diseases (Schouler-Ocak, Aichberger, Penka, Kluge, & Heinz, 2015).

As assessment for impaired cognitive function, Nasreddine et al. developed the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005). It is a brief screening instrument, specifically developed for detecting Mild Cognitive Impairment (MCI) overcoming the limitations of the Mini Mental Status Examination (MMSE) (Folstein, Folstein, & McHugh, 1975). However, since its implementation it also has been increasingly used as an instrument to assess the general cognitive status in population studies (Fujiwara et al., 2010; Lee et al., 2008; Luis, Keegan, & Mullan, 2009; Rossetti, Lacritz, Cullum, & Weiner, 2011).

The current research shows lower cut-offs among Turkish populations for the MoCA than the 26 out of 30 points proposed by Nasreddine et al. (Kaya et al., 2014; Ozdilek & Kenangil, 2014; Selekler, Cangöz, & Uluc, 2010). However, data on the cognitive performance in Turkish migrants are lacking.

The aim of our study was therefore to investigate cognitive performance of MoCA in Turkish migrants and its association with demographics and health related variables.

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## Methods

### Study design

This cross-sectional study was conducted from November 2011 until May 2012 as part of a feasibility study examining recruitment strategies among Berliners with Turkish roots for The German National Cohort (Linseisen et al., 2014; Wichmann et al., 2012).

### Recruitment strategy and participants

Details of the recruitment strategy are presented by Reiss et al. (Reiss et al., 2014). For the present analyses we included only participants who were recruited via the registration office of Berlin.

Briefly, a random sample of 100,000 persons was drawn from the residents' registration office in Berlin. To identify persons with Turkish origin, an onomastic procedure was applied by the Robert Koch-Institute. Based on first and last names as well as citizenship, 6,000 people with potentially Turkish roots were identified. Out of these, 2987 randomly chosen persons received an invitation letter including study information and a response form in bothGerman and Turkish language. Up to two reminder letters were sent out in case of non-response. If a phone number was available, potential participants were contacted by phone, otherwise bilingual study assistants, mostly medical students, conducted up to three home visits on different days and times. If a potential participant was not at home, an information card with contact details was left at the home address. General practitioners all over Berlin were informed about the study. Inclusion criteria were 20–69 years of age, the ability to understand the aims of the study, and a signed informed consent (in German or Turkish). All participants received a 15€ expense allowance to cover travelling costs and an annotated written report by post.

The study was approved by the ethical review committee of the Charité – Universitätsmedizin Berlin, Germany.

### Data collection

#### Questionnaire

The modified health questionnaire from the German Health Interview and Examination Survey was used (Scheidt-Nave et al., 2012) to assess socioeconomic status, medical history, health behavior, physical and mental diseases and migration background. A participant was defined as having a migration background if (i) he or she was not born in Germany (so called first generation migrant) or (ii) if at least one parent was not born in Germany but moved to Germany after 1949 (so called second generation migrant) (Bundesministerium der Justiz, 2010).

It was used as a self-completed questionnaire and was available in German and Turkish language. The participants could choose their preferred version. Bilingual staff was present in case of difficulties understanding the questionnaires, dyslexia or presbyacusis and conducted the questionnaire as a face to face interview, if necessary.

### Measures

#### Medical examination

The participants were examined by bilingual study physicians and nurses including standardized anthropometric measurements (weight, height, circumference of hip and waist, blood pressure and pulse measurements). We used the age adapted Body-Mass-Index (BMI), proposed by the National Research Council (USA) with an optimal BMI of 19–24 kg/m$^2$ (age group 19–24 years), BMI of 20–25 kg/m$^2$ (age group 25–34 years), BMI 21–26 kg/m$^2$ (age group 35–44 years), BMI 22–27 kg/m$^2$ (age group 45–54 years), BMI 23–28 kg/m$^2$ (age group 55–64 years) and BMI 24–29 kg/m$^2$ (age $\geq$65 years). A blood sample was analyzed for full blood count, liver enzymes, kidney function, cholesterol levels, and blood glucose. Results were sent to the participants together with blood pressure and anthropometric measurements.

#### Application of the MoCA

The MoCA is a 12-item paper and pencil test which assesses six main cognitive domains: attention and concentration, speech, memory, praxis, gnosis, and executive functioning. Average duration of the test is between 10 to 15 minutes with a maximum score of 30 points for best possible cognitive function. A cut-off at 26 is used in clinical practice to differentiate between normal cognitive function and mild cognitive impairment (below 26). To compensate for a lower educational level, 1 point is added for participants with 12 years of education or less. According to a proposition on www.mocatest.org, a further point can be added for participants with 9 years of education or less (Chertkow, Nasreddine, Johns, Phillips, & McHenry, 2011).

Executive function is tested using a trail-making task, visuospatial ability is tested using a three-dimensional cube copy and a clock-drawing task. Memory is tested by a short-term memory recall task. In the Turkish version, some unfamiliar, differently syllabled or ambiguous words from the original English version were replaced: 'nose' instead of 'face', 'mosque' instead of 'church', and 'violet' instead of 'red'. In the German version, 'daisy' (from the original English version) was replaced by 'tulip'. Attention, concentration, and working memory is tested using digits forward and backward tasks, a sustained attention task, and a serial subtraction task. Language is tested using a 3-item naming task with low-familiarity animals (lion, camel, rhinoceros), repetition of two complex sentences, and a phonemic fluency test. In the Turkish version, the words that have to be named within one minute must start with the letter 'k' instead of 'f' like in the English and German version. Abstraction is tested with a verbal abstraction test. Orientation is tested asking for time and place.

### Statistical analysis

Our analyses were explorative rather than strictly hypotheses testing. Missing data was not imputed. We computed descriptive statistics for sociodemographic, lifestyle and medical characteristics using mean ± standard deviation (SD), median for continuous variables and absolute and relative frequencies for categorical variables. Potential associations with the total MoCA score were evaluated using univariable and multivariable linear regression models. The multivariable model was adjusted for all exposure variables of interest and was conducted as complete case analysis. All analyses were performed using The SAS System®, Version 9.3 under Windows operating system.

## Results

### *Participant characteristics*

Out of the 2,987 randomly chosen persons (participation quota 10.1% after excluding the 5.2% of neutral non-response), we were able to include 285 registration office-based participants with 282 of them completing the MoCA. Mean age was 42.3 ± 11.9 years, 50% were female. 75.4% of the study participants were born in Turkey and migrated to Germany (first generation migrants), 24.6% were born in Germany and had no migration experience (second generation migrants). 7.8% did not answer the question. There were 12.4% missings regarding educational level. Participants with missing values on educational level were more often women compared to the total sample (77.1% vs. 50%), Turkish language was chosen more often (77.1% vs. 49.6%) and the participants were older (48.7 years vs. 42.3 years). For more details of the study sample see Table 1.

**Table 1.** Sociodemographic, lifestyle and medical characteristics of the study sample (282 Berliners with Turkish roots)

| Characteristics of study participants | Total ($n$ = 282) |
|---|---|
| **Age** (mean ± standard deviation) | 42.3 ± 11.9 |
| | $n$ (%) |
| Sex | |
| Male | 141 (50.0) |
| Female | 141 (50.0) |
| Preferred language for Montreal Cognitive Assessment (MoCA) | |
| German | 142 (50.4) |
| Turkish * | 140 (49.6) |
| Missing | 0 (0) |
| Nationality | |
| German | 115 (40.8) |
| Turkish | 167 (59.2) |
| Missing | 0 (0) |
| Migration generation | |
| First generation | 196 (75.4) |
| Second generation | 64 (24.6) |
| Missing | 22 (7.8) |
| Chronic diseases (diagnosed by physician) | |
| Arterial hypertension | |
| No | 194 (68.8) |
| Yes | 62 (22.0) |
| Missing | 26 (9.2) |
| Diabetes | |
| No | 216 (76.6) |
| Yes | 27 (9.6) |
| Missing | 39 (13.8) |
| Educational level | |
| ≤ 9 years | 101 (35.8) |
| 10–12 years | 93 (33.0) |
| > 12 years | 53 (18.8) |
| Missing | 35 (12.4) |
| Bodyweight classified according to NRC standards (adjusted for sex and age) ** | |
| Underweight | 7 (2.5) |
| Normal | 115 (40.8) |
| Overweight | 101 (35.8) |
| Obese | 53 (18.8) |
| Smoking status | |
| current smoker | 128 (45.4) |
| non- or ex-smoker | 146 (51.8) |
| Missing | 8 (2.8) |
| Work status | |
| currently not employed | 109 (38.7) |
| currently employed | 151 (53.5) |
| Missing | 22 (7.8) |
| Physical activity | |
| <150 min physical activity/week | 207 (73.4) |
| ≥150 min physical activity/week | 36 (12.8) |
| Missing | 39 (13.8) |
| Total | 282 (100) |

*including $n$ = 20 who mixed Turkish and German.
**NRC = National Research Council (USA); optimal BMI of 19–24 kg/m$^2$ (19–24 years), 20–25 kg/m$^2$ (25–34 years), 21–26 kg/m$^2$ (35–44 years), 22–27 kg/m$^2$ (45–54 years), 23–28 kg/m$^2$ (55–64 years) and 24–29 kg/m$^2$ (≥65 years).

**Table 2.** Montreal Cognitive Assessment (MoCA) sum scores with adjustment for educational level.

| MoCA sum scores | Participants $n$ | Mean ± SD | Participants with maximal score $n$ (%) |
|---|---|---|---|
| Raw sum score | 282 | 23.3 ± 4.3 | 6 (2.1) |
| Raw sum score +1 point* | 194 | 24.6 ± 3.6 | 12 (4.3) |
| Raw sum score +2 points** | 93 | 25.0 ± 3.5 | 13 (4.6) |

*education 10–12 years.
**education 9 years or less.

### *MoCA-Scores*

MoCA mean raw score was 23.3 ± 4.3. Only six participants (2.1%) reached the maximal score of 30 points. Language and recall of five words were the domains with the lowest proportions of participants reaching the maximal score (18% and 21%, respectively) whereas orientation seemed to produce a ceiling effect (99.6% reached the maximal score). According to the proposition of the authors of the MoCA, we calculated education adapted MoCA scores by adding one point to the MoCA sum score, if participants had 10–12 years of education and two points, if they had 9 years or less of education. The mean sum score increased from 23.3 ± 4.3 to 24.6 ± 3.6 (one-point-correction) and to 25.0 ± 3.5 (two-point-correction), respectively. The number of participants with maximal sum score increased to 12 persons (4.3%) after one-point-correction, and to 13 (4.6%) after two-point-correction. The results are presented in Table 2. MoCA scores for different educational level categories stratified by age groups are presented in Table 3. The biggest decline of the MoCA score according to higher age was observed in the group with 9 years of education or less. However, the number in the highest age groups were rather low.

### *Multivariable analysis*

In the performed univariable analysis, only sex and the smoking status were not associated with MoCA-Scores. In the multivariable analysis however, only higher age, lower education, and the choice of the Turkish version of the MoCA were associated with a lower MoCA score.

To rule out any association between educational level and the choice of the MoCA language, we investigated the association between these factors and did not find considerable differences among the language groups regarding the education levels. Among the participants who preferred the Turkish version versus those who preferred the German version, 55% vs. 42% had 9 years or less of education, 30% vs. 36% had 10–12 years of education and 15% vs. 23% were in the education group > 12 years. For more details see Table 4.

### *MoCA subtests*

For a better insight into the associations between educational level, language preference, age and the MoCA score, we analysed also the MoCA subtests. Educational level was statistically significantly associated with all subtests except naming and orientation; language preference was associated with visuo-executive functions, naming, attention and recall; age

Table 3. Distribution of Montreal Cognitive Assessment (MoCA) sum scores of 247 participants by educational level and age group.

| | MoCA sum score | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Educational level | | | | | | | |
| | ≤ 9 years | | 10–12 years | | > 12 years | | Total | |
| Age in years | Mean ± SD (participants) | Median | Mean ± SD (participants) | Median | Mean ± SD (participants) | Median | Mean ± SD (participants) | Median |
| 20–25 | 24.0 ± 2.8 (*n* = 6) | 24.5 | 25.0 ± 2.1 (*n* = 6) | 24.5 | 27.4 ± 1.7 (*n* = 13) | 28.0 | 26.0 ± 2.4 (*n* = 25) | 26.0 |
| 26–30 | 24.7 ± 5.2 (*n* = 6) | 25.0 | 25.3 ± 3.0 (*n* = 6) | 25.5 | 26.4 ± 1.8 (*n* = 11) | 27.0 | 25.6 ± 3.1 (*n* = 23) | 26.0 |
| 31–35 | 23.8 ± 2.7 (*n* = 11) | 25.0 | 25.2 ± 2.8 (*n* = 13) | 25.0 | 27.3 ± 2.2 (*n* = 4) | 28.0 | 24.5 ± 3.2 (*n* = 28) | 25.0 |
| 36–40 | 23.7 ± 2.9 (*n* = 16) | 24.0 | 24.1 ± 3.2 (*n* = 21) | 24.0 | 27.3 ± 1.3 (*n* = 4) | 27.0 | 23.7 ± 4.4 (*n* = 41) | 24.0 |
| 41–45 | 23.7 ± 2.8 (*n* = 12) | 23.5 | 25.8 ± 2.4 (*n* = 16) | 26.0 | 25.8 ± 2.9 (*n* = 9) | 26.0 | 24.6 ± 3.0 (*n* = 37) | 25.0 |
| 46–50 | 21.7 ± 3.5 (*n* = 27) | 21.0 | 22.8 ± 4.6 (*n* = 14) | 23.5 | 20.0 ± 5.7 (*n* = 2) | 20.0 | 22.2 ± 4.0 (*n* = 43) | 22.0 |
| 51–55 | 19.2 ± 5.6 (*n* = 9) | 21.0 | 23.3 ± 2.1 (*n* = 7) | 23.0 | 24.2 ± 1.5 (*n* = 5) | 24.0 | 21.4 ± 5.0 (*n* = 21) | 22.0 |
| 56–60 | 19.2 ± 5.4 (*n* = 5) | 21.0 | 22.0 ± 3.4 (*n* = 5) | 21.0 | 23.3 ± 1.5 (*n* = 3) | 23.0 | 21.3 ± 4.4 (*n* = 13) | 22.0 |
| 61–65 | 21.4 ± 5.0 (*n* = 7) | 23.0 | 21.0 ± 1.4 (*n* = 2) | 21.0 | 24.5 ± 0.7 (*n* = 2) | 24.5 | 19.1 ± 5.5 (*n* = 11) | 20.0 |
| 66–69 | 19.0 ± 4.2 (*n* = 2) | 19.0 | 23.0 ± 3.6 (*n* = 3) | 24.0 | – (*n* = 0) | – | 18.9 ± 5.0 (*n* = 5) | 18.5 |
| Total [20–69] | 22.3 ± 4.0 (*n* = 101) | 23.0 | 24.2 ± 3.2 (*n* = 93) | 24.0 | 26.0 ± 2.6 (*n* = 53) | 26.0 | 23.3 ± 4.3 (*n* = 247) | 24.0 |

Table 4. Factors associated with Montreal Cognitive Assessment (MoCA) scores in persons with Turkish roots living in Berlin (univariable and multivariable regression model; dependent variable: continuous MoCA score).

| | Univariable | | Multivariable, *n* = 204 | |
|---|---|---|---|---|
| | $\beta$-estimate | *p*-value | $\beta$-estimate | *p*-value |
| Female vs. male | −0.81 | 0. 105 | −0.27 | 0.723 |
| Age (in years) | −0.16 | <0.001 | −0.08 | 0.002 |
| Hypertension vs. none | −3.78 | <0.001 | −0.96 | 0.157 |
| Diabetes vs. none | −3.67 | <0.001 | −0.35 | 0.721 |
| Obese vs. normal body-mass-index* | −1.89 | 0.004 | 0.41 | 0.523 |
| Overweight vs. normal body-mass-index * | −0.96 | 0.093 | 0.17 | 0.760 |
| Education >12 years vs. <10 years | 3.58 | <.001 | 2.68 | <0.001 |
| Education 10–12 years vs. <10 years | 1.81 | <.001 | 1.17 | 0.030 |
| Currently employed vs. not employed | 2.17 | <.001 | 0.72 | 0.146 |
| Current smoker vs. non smoker | 0.14 | 0.782 | −0.14 | 0.699 |
| Physically activ ≥150 min/week vs. less | 1.57 | 0.013 | 0.14 | 0.753 |
| MoCA German vs. Turkish | 2.27 | <.001 | 1.13 | 0.026 |
| Second migration generation vs. first | 2.92 | <.001 | –** | –** |

*defined by recommended age- and sex-dependent criteria (see methods).
**not included in the multivariable model because highly correlated with age.

was associated with all subtests except language. Differences in the MoCA sum score were statistically significant for all three subgroups with $p < 0.001$. For more details see Table 5.

## Discussion

### *Main findings and comparison with other studies*

This study provides data of the cognitive function assessed by the MoCA for a population-based sample of Berliners with Turkish roots. The mean MoCA score in our sample was lower compared to the normative data even after correcting for the level of school education as proposed by Nasreddine et al. (2005).

The cognitive performance of our study participants was positively associated with younger age, higher educational level and the preference of German (instead of Turkish) as test language for the MoCA. Employment status, diabetes, hypertension and overweight/obesity as well as lifestyle factors such as smoking and physical activity were not associated with cognitive function in our sample. Our results confirmed several previous studies investigating cognitive perfomance with the MoCA, which showed an association of age and education with MoCA test performance (Chertkow et al., 2011; Dominguez, 2011; Malek-Ahmadi et al., 2015; Rossetti, Lacritz, Cullum & Weiner, 2011). Recent studies highlighted the education bias of the MoCA and the authors suggested that further normative data rather than changes in cut-off points are needed (Bernstein, Lacritz, Barlow, Weiner, & DeFina, 2011; Rossetti, Lacritz, Cullum & Weiner, 2011). Carson et al. postulated in general the use of a new cut-off of 23 points for discriminating healthy persons from those with mild cognitive impairment as result of a metaanalysis including nine population-based studies with the aim to determine the diagnostic accuracy of the MoCA (Carson, Leach, & Murphy, 2017).

We found a mean MoCA score of 23.3 ± 4.3 in our study sample. This corresponds to the proposition of the cut-off at 23 points, but is considerably lower than proposed by Nasreddine et al. Two studies conducted in Turkish populations in Turkey suggested even a cut-off score of 21 for discrimination between normal function and mild cognitive impairment (Ozdilek & Kenangil, 2014; Selekler et al., 2010). In contrast to most studies, Selekler et al. considered age and educational level as not having any influence on the MoCA score, however, their number of patients with Alzheimer dementia or MCI was rather small (Selekler et al., 2010). Similarly, Yancar Demir et al. did not find an influence of education, however, since the educational level in their study was compared only between 'under 5 years' to '5 years and more' one can assume that the study sample had a very low educational level in general (Yancar Demir & Özcan, 2015). Ozdilek et al. confirmed the cut-off score of 21/30 for impaired cognitive function for the Turkish version of the MoCA (MoCA-TR), but, in contrast, emphasized the importance of the development of local norms and cut-off scores considering educational level (Ozdilek & Kenangil, 2014). Kaya et al. computed cut-off scores for the three different educational levels ≤5 years (18/30), 6–11 years (21/30), and 12 and more years (23/30) to specifically consider the part of the population in Turkey with little formal education (Kaya et al., 2014). Rosetti et al. showed in a population-based multi-ethnic sample of more than 2000 participants that the proposed cut-off scores may not be applicable to diverse patient populations with lower levels of education (Rossetti et al., 2011).

To overcome the educational differences, a one-point correction was proposed by the authors of the MoCA (Chertkow et al., 2011; Nasreddine, Phillips, & Chertkow, 2012). In our study sample this resulted in a mean MoCA sum score of 24.6 ± 3.6 (one-point-correction) and 25.0 ± 3.5 (two-point-correction), respectively. With these corrections, the achievement of 26 points seems to be more likely. However, there is little and rather heterogeneous evidence on using such educational correction, although the MoCA is available in many

**Table 5.** Subscores of the Montreal Cognitive Assessment (MoCA) by educational level, language preference and age group

| | Education in years | | | | Language preference | | | Age in years | | | | | | Total ($n$ = 282) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ≤9 ($n$ = 101) | 10-12 ($n$ = 93) | >12 ($n$ = 53) | | German ($n$ = 142) | Turkish ($n$ = 140) | | ≤30 ($n$ = 51) | 31-40 ($n$ = 74) | 41-50 ($n$ = 90) | 51-60 ($n$ = 42) | >60 ($n$ = 25) | | |
| Domain (maximal achievable points) | Mean ± SD* | | | $p$-value | Mean ± SD* | | $p$-value | Mean ± SD* | | | | | $p$-value | Mean ± SD* |
| Visuo-executive functions (5) | 3.4 ± 1.2 | 3.9 ± 1.2 | 4.3 ± 1.1 | **<0.001** | 3.9 ± 1.1 | 3.4 ± 1.4 | **<0.001** | 4.1 ± 1.1 | 4.1 ± 1.1 | 3.8 ± 1.1 | 3.4 ± 1.4 | 2.2 ± 1.4 | **<0.001** | 3.7 ± 1.3 |
| Trail B (1) | 0.6 ± 0.5 | 0.8 ± 0.4 | 0.8 ± 0.4 | **0.029** | 0.8 ± 0.4 | 0.6 ± 0.5 | **<0.001** | 0.84 ± 0.4 | 0.8 ± 0.4 | 0.7 ± 0.4 | 0.5 ± 0.5 | 0.2 ± 0.4 | **<0.001** | 0.7 ± 0.5 |
| Cube copying (1) | 0.5 ± 0.5 | 0.7 ± 0.5 | 0.9 ± 0.3 | **<0.001** | 0.7 ± 0.4 | 0.5 ± 0.5 | **<0.001** | 0.78 ± 0.4 | 0.7 ± 0.5 | 0.6 ± 0.5 | 0.6 ± 0.5 | 0.3 ± 0.5 | **0.002** | 0.6 ± 0.5 |
| Clock drawing (3) | 2.3 ± 0.8 | 2.4 ± 0.8 | 2.6 ± 0.8 | 0.071 | 2.4 ± 0.8 | 2.3 ± 0.9 | 0.245 | 2.4 ± 0.8 | 2.4 ± 0.8 | 2.5 ± 0.8 | 2.3 ± 0.9 | 1.7 ± 0.9 | **0.001** | 2.3 ± 0.8 |
| Naming (3) | 2.7 ± 0.5 | 2.7 ± 0.5 | 2.9 ± 0.3 | 0.052 | 2.9 ± 0.4 | 2.5 ± 0.6 | **<0.001** | 2.9 ± 0.3 | 2.8 ± 0.5 | 2.7 ± 0.5 | 2.5 ± 0.7 | 2.5 ± 0.5 | **0.001** | 2.7 ± 0.5 |
| Attention (6) | 4.7 ± 1.3 | 5.1 ± 0.9 | 5.5 ± 0.7 | **<0.001** | 5.3 ± 1.0 | 4.6 ± 1.5 | **<0.001** | 5.4 ± 0.7 | 5.4 ± 0.7 | 4.9 ± 1.2 | 4.6 ± 1.5 | 3.8 ± 1.7 | **<0.001** | 4.9 ± 1.3 |
| Numbers (fwd/backw) (2) | 1.6 ± 0.6 | 1.6 ± 0.6 | 1.8 ± 0.4 | **0.034** | 1.7 ± 0.6 | 1.5 ± 0.6 | **0.011** | 1.8 ± 0.5 | 1.7 ± 0.6 | 1.6 ± 0.5 | 1.4 ± 0.7 | 1.1 ± 0.8 | **<0.001** | 1.6 ± 0.6 |
| Vigilance (1) | 0.8 ± 0.4 | 0.9 ± 0.3 | 0.9 ± 0.3 | 0.234 | 0.9 ± 0.3 | 0.8 ± 0.4 | **0.006** | 0.9 ± 0.9 | 0.9 ± 0.3 | 0.9 ± 0.3 | 0.9 ± 0.4 | 0.7 ± 0.5 | 0.095 | 0.9 ± 0.3 |
| Serials 7 s (3) | 2.3 ± 1.0 | 2.6 ± 0.7 | 2.8 ± 0.6 | **0.001** | 2.6 ± 0.7 | 2.3 ± 1.1 | **<0.001** | 2.8 ± 0.6 | 2.5 ± 0.8 | 2.4 ± 0.9 | 2.3 ± 1.1 | 2.0 ± 1.1 | **0.013** | 2.5 ± 0.9 |
| Language (3) | 1.3 ± 1.0 | 1.5 ± 1.0 | 2.0 ± 1.0 | **0.001** | 1.4 ± 1.1 | 1.5 ± 1.0 | 0.312 | 1.7 ± 1.0 | 1.4 ± 1.0 | 1.4 ± 1.1 | 1.3 ± 1.1 | 1.2 ± 1.0 | 0.388 | 1.4 ± 1.0 |
| Sentence repetition (2) | 0.8 ± 0.8 | 0.9 ± 0.8 | 1.2 ± 0.7 | **0.004** | 0.9 ± 0.8 | 0.9 ± 0.7 | 0.957 | 1.0 ± 0.7 | 0.8 ± 0.8 | 0.9 ± 0.8 | 0.7 ± 0.7 | 0.8 ± 0.8 | 0.268 | 0.9 ± 0.8 |
| Verbal fluency (1) | 0.5 ± 0.5 | 0.6 ± 0.5 | 0.8 ± 0.4 | **0.015** | 0.5 ± 0.5 | 0.6 ± 0.5 | **0.040** | 0.6 ± 0.5 | 0.6 ± 0.5 | 0.6 ± 0.5 | 0.6 ± 0.5 | 0.4 ± 0.5 | 0.411 | 0.6 ± 0.5 |
| Abstraction (2) | 1.6 ± 0.6 | 1.7 ± 0.5 | 1.9 ± 0.3 | **<0.001** | 1.7 ± 0.6 | 1.6 ± 0.6 | **0.630** | 1.8 ± 0.4 | 1.7 ± 0.5 | 1.6 ± 0.6 | 1.7 ± 0.6 | 1.3 ± 0.8 | **0.024** | 1.7 ± 0.6 |
| Recall (5) | 2.7 ± 1.6 | 3.3 ± 1.6 | 3.5 ± 1.4 | **0.005** | 3.5 ± 1.5 | 2.6 ± 1.6 | **<0.001** | 4.0 ± 1.3 | 3.3 ± 1.4 | 2.9 ± 1.5 | 2.1 ± 1.7 | 2.1 ± 1.5 | **<0.001** | 3.0 ± 1.6 |
| Orientation (6) | 6.0 ± 0.2 | 6.0 ± 0.2 | 6.0 ± 0.2 | 0.962 | 6.0 ± 0.2 | 5.9 ± 0.2 | 0.096 | 6.0 ± 0.0 | 6.0 ± 0.1 | 6.0 ± 0.2 | 5.9 ± 0.3 | 5.9 ± 0.4 | **0.020** | 6.0 ± 0.2 |
| MoCA sum score (30) | 22.4 ± 4.0 | 24.2 ± 3.2 | 26.0 ± 2.6 | **<0.001** | 24.5 ± 3.6 | 22.0 ± 4.7 | **<0.001** | 25.8± 2.7 | 24.0 ± 4.0 | 23.3 ± 3.7 | 21.3 ± 4.8 | 19.0 ± 5.2 | **<0.001** | 23.3 ± 4.3 |

*standard deviation.

languages (Freitas, Simões, Alves, & Santana, 2011; Fujiwara et al., 2010; Lee et al., 2008; Lifshitz, Dwolatzky, & Press, 2012). A study from Singapore found that a one-point-correction should be used for persons with less than 10 years of formal education (Ng, Chew, Narasimhalu, & Kandiah, 2013). Zhou et al. propose even 3–4 additional points for persons with 6 years or less of education (Zhou et al., 2015). Gagnon et al., in contrast, stated that the correction for education could lead to a higher rate of false negative results and hereby to a misinterpretation of the MoCA results (Gagnon et al., 2013). Further comparative population-based and clinical studies with good neurological diagnostic standards are required.

Innovative in our study was the examination of the language preference of the MoCA test among persons with Turkish roots living outside Turkey. The association of Turkish as the preferred test language with poorer test performance can be partly explained with the age difference between the groups. Participants who chose the Turkish version were significantly older than those who chose the German version, however, the multivariable analysis confirmed both factors as independent influencing factors of the cognitive function assessed by the MoCA. Additionally, as a subgroup analysis we performed the multivariable analysis only for participants aged 46 and older showing that language preference remained an independent influencing factor.

Also at the MoCA subtests, differences were observed among educational levels, language preferences and age groups. The educational levels were associated with almost all subtests, except naming and orientation which supports the suggested correction for it. Hu et al. showed similar results with orientation and language being the only subtests that were not influenced by education (Hu et al., 2012). In contrast, Yancer-Demir et al. investigating a Turkish population in Turkey found language being the only subtest that was significantly associated with the MoCA score when comparing persons with different educational levels. In our study, participants who chose Turkish as test language scored worse than persons who chose German in all subtests except language; age as well influenced all subtests of the MoCA except language. This confirms other results showing that language apparently has not the same discriminatory capacity as the other subtests of the MoCA (Lifshitz et al., 2012; Tsai et al., 2011).

In our study sample, hypertension was associated with a lower MoCA score only in the univariable analysis. This result partly corresponds with previous studies that showed the effect of hypertension as one of the influencing factors of lower cognitive function in patient cohorts as well as in broad population samples (Andrews, Das, Anstey, & Easteal, 2015; Fuchs et al., 2013; Llewellyn et al., 2008; Martinic-Popovic, Seric & Demarin, 2006; Moon, Lim, & Han, 2015). Regarding diabetes, results from previous studies have been more heterogeneous. Ruis et al. found associations between diabetes mellitus type 2 and lower cognitive function (Ruis et al., 2009), whereas Luck at al did not show a correlation (Luck et al., 2010). We found an association between diabetes and lower MoCA scores, i.e. lower cognitive function, but this effect disappeared in the multivariable model.

### ***Strengths and limitations***

Firstly, the recruitment strategy of the Turkish migrants via registration office including postal mail, telephone contact, and even home visits to increase the response is an important strength of the study. The response, i.e. a visit to the study centre, was 10% of all contacted persons who were randomly selected. This is remarkably more than in other population-based studies, such as the regular national surveys in Germany (Winkler et al., 2014). Even if the study cannot be regarded as representative for the whole Turkish migrant population in Berlin, our recruitment approach is supporting the use of intense bilingual recruitment efforts in future population-based studies in Germany, as postulated previously by the Robert Koch-Institut, the national public health institution (Saß et al., 2015).

Secondly, this study is, to our knowledge, the first to provide descriptive data for the MoCA in a population-based sample of Turkish migrants living in Germany. Our results show the need to consider an adaptation of the cut-off score to determine impaired cognitive function if the test is used for clinical decision making in migrant populations with varied educational levels.

Thirdly, the use of bilingual study tools (questionnaire and MoCA) probably reduced a potential language bias. Furthermore, all MoCA tests were conducted by five trained medical doctors to ensure homogenous assessment.

However, several limitations of our study have to be considered as well. Since our analysis was part of a large feasibility study regarding improved recruitment of a migration population aged 20–69 years, we had limited data beyond this age group. Further, we chose to focus only on persons recruited via the registration office in order to keep a certain degree of generalizability, which resulted in a reduced number of study participants. In addition, we only had detailed information on education for 88% of the participants. Our analyses were explorative rather than strict hypothesis testing. Therefore, we did not intend to impute missing data. The multivariable analysis was a complete case analysis of those participants with valid data in all included variables.

As the aim of the study was the evaluation of recruitment methods, clinical examinations were limited to a minimum; no neurologic examination as gold standard for dementia screening was performed. However, after the initial history taking and study inclusion of the participants, clinically obvious participants with dementia would have been excluded from study participation. Regarding the assessment of chronic diseases as hypertension or diabetes we had no detailed information about medication or chronicity and therefore were unable to distinguish between well controlled persons and persons who do not see their physician regularly. This could have affected the impact of the measured associations.

## Conclusions

In our study, a higher educational level, lower age, and German as the preferred test language (as compared to Turkish) were positively associated with the cognitive performance of Berliners with Turkish roots. Employment status, diabetes, hypertension and overweight/obesity as well as lifestyle factors such as smoking and physical activity were not associated with cognitive function in our sample. To examine neurocognitive health of migrants, longitudinal population-based and clinical cohort studies that specifically compare migrants and their descendants with the original population of their home countries are required. These investigations should include neuropsychological assessments such as the MOCA and clinical diagnostic procedures as well as relevant socio-demographic factors to develop better strategies for improving prediction and prevention.

## Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

## Informed consent

Informed consent was obtained from all individual participants included in the study.

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## Disclosure statement

No potential conflict of interest was reported by the authors.

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