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Preoperative cognitive dysfunction in older elective noncardiac surgical patients in South Africa

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Abstract

Background: Cognitive dysfunction after surgery includes delirium and postoperative cognitive dysfunction. Important risk factors for these include increased age and pre-existing cognitive dysfunction. This study describes preoperative cognitive dysfunction and its associated factors in patients aged ≥60 yr awaiting elective noncardiac surgery in a developing country.

Methods: A prospective, contextual, descriptive study design with consecutive convenience sampling was used at Chris Hani Baragwanath Academic Hospital, Johannesburg, South Africa. Assessment of cognition was subjective (through casual conversation, henceforth referred to as observer assessment) and objective (using the Mini-Cog test).

Results: A total of 194 outpatients (median age: 65 yr) were assessed. A score ≤3 (indicating mild cognitive impairment) was obtained by 111 patients (57.2%). Subjective memory complaints were reported by 124 patients (63.9%). Univariate analyses demonstrated significant associations between low Mini-Cog scores and increasing age (r_s=−0.1901; *P*=0.0079), unskilled occupation (*P*=0.0033), low functional status (r_s=−0.1831; *P*=0.0106), low level of education (*P*=0.0005), and frailty (r_s=−0.3010; *P*<0.0001). Logistic regression showed level of education and frailty to be significant. A score ≤3 is more likely in frail patients (odds ratio: 7.54; *P*=0.003) and those with only primary school education (odds ratio: 3.54; *P*=0.003).

Conclusions: Undiagnosed pre-existing cognitive dysfunction was common in older patients awaiting surgery at a regional academic hospital in South Africa. Patients at risk for cognitive dysfunction should be identified through brief preoperative screening.

Keywords: aged; clock drawing test; cognitive dysfunction; Mini-Cog; neurocognitive dysfunction; perioperative; preoperative

Editor's key points

- Cognitive dysfunction after surgery, including delirium and postoperative cognitive dysfunction, is common, particularly in older individuals.
- Subjective and objective (Mini-Cog test) assessments of cognition were determined in a prospective study of 194 patients undergoing elective noncardiac surgery in South Africa.
- Undiagnosed pre-existing cognitive dysfunction was common in older patients awaiting surgery.
- Patients at risk for cognitive dysfunction can and should be identified before operation using brief subjective and objective screening methods to allow interventions to reduce postoperative neurocognitive complications.

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The normal aging brain undergoes a decline in cognitive abilities.[1] Possible factors responsible for altering the trajectory of this decline have been described including pain,[2] depression,[2,3] polypharmacy,[4] previous myocardial infarction,[5] stroke,[6] living alone,[4] certain comorbid conditions such as diabetes mellitus,[4] and low intelligence quotient.[5] Postoperative cognitive changes, that can include delirium and postoperative cognitive dysfunction, were described as early as 1887: 'the use of anaesthetics, in predisposed subjects, has been followed by insanity'.[7]

Subjects predisposed to postoperative cognitive changes include older patients and those with pre-existing cognitive dysfunction.[8] The combination of surgically-induced neuroinflammation[9] and anaesthesia itself may also play a role. Consequences of this cognitive dysfunction include higher 1-yr mortality,[10] increased length of hospital stay,[11] increased medical costs,[11] premature withdrawal from the workplace,[10] and a change in long-term cognitive trajectory.[12]

Various interventions exist which could improve these outcomes.[8] In order to enact these interventions, the baseline cognitive status of older patients must be known. Despite the high prevalence of pre-existing cognitive dysfunction seen in developed countries (6.1%–68%),[2–6,13-15] cognition is not always formally assessed by anaesthetists during the preoperative evaluation.[16] In a resource-constrained environment, a brief 'brain stress test'[17] could simultaneously improve patient care and reduce cost.

The prevalence of undiagnosed preoperative cognitive dysfunction in developing countries, where education levels and disease profiles differ, is unknown. The first objective of this study was to describe the prevalence of neurocognitive disorders in patients ≥60 yr old in a central hospital of 2888 beds in a developing country (Chris Hani Baragwanath Academic Hospital, South Africa). The second objective was to compare the observer and objective assessments of cognitive functioning in these patients. The third objective was to describe factors associated with cognitive dysfunction, including the effect of increasing age and the presence of risk factors for vascular disease.

Methods

This study was approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (clearance certificate M171030). The population included patients ≥60 yr of age presenting for elective noncardiac surgery at Chris Hani Baragwanath Academic Hospital's gynaecological, orthopaedic, or general surgical outpatient departments. All patients provided written informed consent. Patients with previously diagnosed dementia, patients who had had surgery in the previous 6 months, and patients unable to communicate in English were excluded.

An online sample size calculator was used (calculator.net). A sample size of a minimum of 190 participants was calculated (95% confidence interval; 5% margin of error) based on a prevalence of 15%, averaged from existing literature,[2,3,13] in 6000 possible outpatients. Consecutive convenience sampling was used.

A case report form was compiled after an extensive literature review and in consultation with a geriatrician. Casual conversation with the participant resulted in an observer assessment of their cognitive function (normal or abnormal). Participants were asked by a single rater (LA) to describe a typical day, how they had arrived at the hospital, the weather, preferred pastimes, and whether they had grandchildren. Markers of possible cognitive dysfunction included inappropriate answers, increased length of time required to express ideas, memory impairment, repetitions, excessive pauses, circuitous speaking, or inability to continue the conversation. Participants were asked whether they had subjective cognitive complaints with the question 'have you had trouble remembering things lately?' The question was also addressed to accompanying informants where applicable.

A Mini-Cog test[18] was then performed as an objective screening measure in a private consultation room free from noise and distraction. The Mini-Cog test, considered as a 'cognitive vital sign', is a quick and simple test to perform.[18] The test comprises the registration and recollection of three unrelated words, and a clock-drawing test, scored out of five. A normal clock has all 12 numbers, written only once each, in a clockwise direction, with anchoring numbers (12, 3, 6, and 9) in the correct position. A time of 11:10 must be shown, with one hand pointing at the number 11 and the other at the number 2; length of hands is unimportant. While Borson and colleagues[18] used scores of ≤2 out of 5 to represent possible cognitive dysfunction, this study, like others,[6,19] used a score of ≤3 in order to detect even incipient cognitive dysfunction.

Despite its brevity, the Mini-Cog tests a variety of functions: the word recall component tests memory and attention, and the clock-drawing component tests comprehension, planning, visual memory and reconstruction, visuospatial abilities, motor programming and execution, numerical knowledge, abstract thinking, concentration, and frustration tolerance.[20] In the initial validation study of the Mini-Cog, a split sample of community-dwelling older adults was used, and the test had a sensitivity of 99% and specificity of 93% for dementia (of various subtypes).[18] Further evaluation of the participants comprised a structured dementia history modified from the Consortium to Establish a Registry for Alzheimer's Disease and the Clinical Dementia Rating Scale. It should be noted that there is no universally agreed gold standard test for dementia diagnosis, as this depends on subtype, and either lengthy assessment batteries for all-cause dementia or methods for evaluating specific cognitive domains are used.[21]

The Mini-Cog avoids many of the pitfalls presented by other available cognitive screens such as the Montreal Cognitive Assessment (MoCA) and Mini-Mental State Examination. A so-called 'culture-free' test, the Mini-Cog is less affected by language, literacy, and education level.[22] Despite these advantages, the Mini-Cog is a less sensitive test than the MoCA for subtle deficits such as mild cognitive impairment, for which it was designed.[23]

Patient characteristics and a checklist for medical comorbidities known to increase the risk of cognitive dysfunction were documented. Current prescribed medications were reviewed for polypharmacy and drugs deemed inappropriate for older patients as per Beer's List.[24] Weekly alcohol consumption was recorded in units. Depression was briefly screened for using a Patient Health Questionnaire-2 (PHQ-2) assessment.[25]

Frailty, a pre-disability state, was assessed using the FRAIL scale. This scale addresses five components: fatigue (over a 4-week period), resistance (walking up 10 steps alone without resting or aids), ambulation (walking several hundred yards), illness (the presence of five or more comorbidities), and loss of weight (≥5% within the preceding 12 months). Each component scores 1 point, and patients are classified as robust (score of zero), pre-frail (1–2) or frail (3 or more).[26] Functional status and the patient's degree of dependence were assessed using a Modified Rankin Scale.[27] Both scales were administered verbally, and did not require that the patient leave the room.

Data were collected by one author (LA) and analysed in consultation with a biostatistician using STATA version 14.1 (StataCorp, College Station, Texas, USA). Data were not normally distributed. Categorical variables were summarised using frequencies and percentages. Numerical variables were analysed using medians and inter-quartile (IQR) ranges. Comparison between observer assessments and objective cognitive assessments was done using a χ^2 test. Univariate analyses between Mini-Cog scores and factors influencing cognition were done using Mann–Whitney or Kruskall–Wallis tests. Spearman's rank-order correlation was used to measure the strength and direction of the association between certain variables. Where a difference was found between groups, a *post hoc* test (Bonferroni correction) was done. $P<0.05$ was considered statistically significant, and factors with $P<0.2$ were included in a logistic regression analysis.

Results

A total of 205 patients were approached to participate in this study; 11 patients did not meet the selection criteria, resulting in a sample size of 194 participants (Fig 1). Patient characteristics are presented in Table 1.

Cognitive function was assessed by the observer through casual conversation as normal for 116 (59.8%) participants and abnormal for 78 (40.2%) participants. The objective assessment of cognitive function, using Mini-Cog scores, is presented in Table 2. The median score (IQR) was 3 (2–4). A score ≤3 was obtained by 111 (57.2%) participants. Examples of abnormal clocks drawn by study participants are shown in Fig 2. A McNemar test of observer assessments and Mini-Cog scores showed a statistically significant relationship between the discordant proportions (P=0.002).

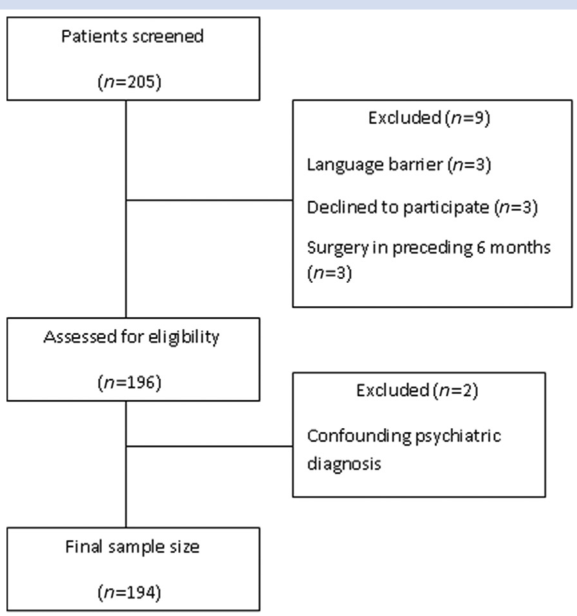

Fig. 1. CONSORT diagram.

Table 1 Patient characteristics.

Characteristic	*n* (%)
Sex	
Male	57 (29.4)
Female	137 (70.6)
Age (yr)	
60–70	136 (70.1)
71–75	33 (17.0)
>75	25 (12.9)
Race	
Black	180 (92.8)
Coloured	7 (3.6)
Indian	4 (2.1)
White	3 (1.5)
Department	
Gynaecology	8 (4.1)
Orthopaedics	122 (62.9)
General surgery	64 (33.0)
Occupation	
Skilled	50 (25.8)
Unskilled	144 (74.2)
Marital status	
Divorced	24 (12.4)
Married	66 (34.0)
Single	52 (26.8)
Widowed	52 (26.8)
Social support	
Yes	180 (92.8)
No	14 (7.2)
Highest level of education	
Primary school	47 (24.2)
Grades 8–10	86 (44.3)
Grade 11–tertiary	61 (31.5)

Subjective memory loss was reported by 124 (63.9%) participants. A significant relationship was demonstrated between Mini-Cog scores and subjective memory complaints, with lower scores in those participants who reported memory loss (P=0.026).

Table 2 Mini-Cog scores.

Words recalled	*n* (%)
0	13 (6.7)
1	31 (16.0)
2	79 (40.7)
3	71 (36.6)
Clock-drawing test	***n* (%)**
0	99 (51.0)
2	95 (49.0)
Total Mini-Cog score	***n* (%)**
0	13 (6.7)
1	19 (9.8)
2	38 (19.6)
3	41 (21.1)
4	41 (21.1)
5	42 (21.7)

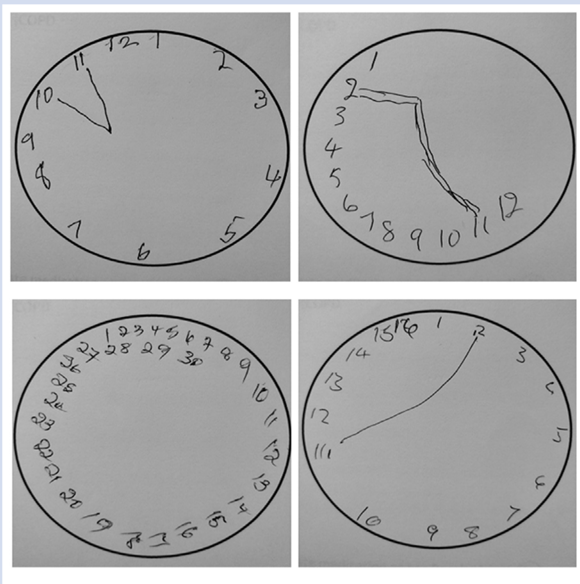

Fig. 2. Examples of abnormal clocks drawn by study participants.

When the Mini-Cog score was compared with gender (P=0.380), marital status (P=0.441), and other social support (P=0.604), no significant interactions were found.

The minimum age in the sample was 60 yr and the maximum was 80 yr. The median (IQR) age was 65 (62–72) yr. There was a weak but significant correlation between age and Mini-Cog scores (r_s=−0.1901; P=0.008).

A significant correlation was found between level of education and Mini-Cog score (P=0.001). Participants who attained primary school education (median Mini-Cog score: 3.0), grades 8–10 (median score: 3.0) and grade 11 to tertiary education (median score: 4.0) were compared. No significant difference existed between primary school and grades 8–10 (P=0.262). A significant difference existed between primary school and grade 11 to tertiary education (P=0.0002), and between grades 8–10 and grade 11 to tertiary education (P=0.014).

When the Mini-Cog score was compared with occupation, a significant difference was found between skilled workers and unskilled workers (P=0.003), with skilled workers achieving higher median (IQR) Mini-Cog scores of 4 (3–5), and unskilled workers median (IQR) scores of 3 (2–4).

Comorbidities associated with cognitive dysfunction are presented in Table 3. No significant interaction with Mini-Cog score was found for any one comorbid condition. There was also no significant difference in Mini-Cog score for participants without comorbidities or with multi-morbidity (P=0.798). Participants with two or more risk factors for vascular disease (n=67; 34.5%) showed no significant difference in Mini-Cog scores compared with patients with no or only one risk factor (P=0.860).

There was no significant difference in Mini-Cog score between smokers and non-smokers (P=0.658), and no correlation between Mini-Cog score and number of pack years (r_s=−0.0101; P=0.960). There was also no significant difference between Mini-Cog scores of participants who consumed alcohol and those who did not (P=0.585), and no correlation between Mini-Cog score and the number of units of alcohol consumed weekly by the former group (r_s=0.0322; P=0.656).

Of the participants, 148 (76.3%) had no symptoms of depression, 30 (15.5%) had one symptom, and 16 (8.2%) had two symptoms. No significant difference was found between median Mini-Cog scores in these participant groups (P=0.965). There was no significant difference between polypharmacy and Mini-Cog score (P=0.912), or between inappropriate medications taken and Mini-Cog score (P=0.742).

FRAIL scale scores and Modified Rankin scores are presented in Table 4. There was a weak but significant correlation between frailty and Mini-Cog scores (r_s=−0.3010; P<0.0001), and a weak but significant correlation between functional status and Mini-Cog scores (r_s=−0.1831; P=0.011). A stepwise logistic regression demonstrates that the best predictors of Mini-Cog score were education and frailty (Table 5).

Discussion

This study of 194 older patients showed a high prevalence of undiagnosed cognitive dysfunction (57.2%) using the Mini-Cog test. The prevalence of pre-existing cognitive dysfunction in other studies ranges between 6.1% and 68%.[2–6,13] Use of different cognitive assessment tools and heterogeneous patient populations may account for this range. None of the studies reviewed approximate our own study population of predominantly black females in a developing country; previous studies involved predominantly white[34] or male populations[4–6] in developed countries.[2–6,13]

Few other studies[6,28] used the Mini-Cog,[18] the brevity of which lends itself to a busy and resource-constrained clinical environment. A study from the USA in 2012 used a cut-off score of ≤3 for possible cognitive dysfunction, with a lower prevalence of 44% in a comparable population size (n=186), but much older patients (mean age 73 yr), who were all planned for postoperative ICU admission.[6]

The majority of the sample reported subjective memory loss (63.9%). While often disregarded as an age-related phenomenon, subjective memory complaints are linked with a higher progression rate to dementia.[29] The relevance of subjective memory complaints extends further, however. A recent working group suggested that the overarching term *perioperative neurocognitive disorders* be used, whether cognitive change is diagnosed before surgery (as in this study), or up to 12 months after surgery.[30] The suggested nomenclature further seeks to align perioperative neurocognitive disorders to the Diagnostic and Statistical Manual for Mental Disorders, fifth edition (DSM-5)[31] definition that applies to the general population. This definition requires both a report of subjectively perceived cognitive complaints (by the patient, an informant, or the clinician) and objective evidence of cognitive dysfunction. As well as differences in objective testing, maintenance or impairment of activities of daily living further classify neurocognitive disorders as mild or major.[31]

Subjective cognitive complaints and objective testing do not always agree,[32] possibly because the former is influenced by emotional factors such as depression and anxiety, and personality traits such as neuroticism.[33] Subjective cognitive complaints may be over-reported in patients with these features; conversely, patients with severe objective dysfunction may be unaware of their decline (anosognosia).[34] There is limited literature in surgical patients, where depression, disturbed sleep, and pain are confounding factors (particularly at 3 months after surgery).[32] The role of subjective cognitive

Table 3 Comparison of comorbidities and Mini-Cog scores.

Comorbidity	Total *n* (%)	Mini-cog score		P-value
		≤3 (*n*=111) *n* (%)	>3 (*n*=83) *n* (%)	
Anaemia	11 (5.7)	7 (6.3)	4 (4.8)	0.8591
Asthma	14 (7.2)	9 (8.1)	5 (6.0)	0.6091
Atrial fibrillation	5 (2.6)	3 (2.7)	2 (2.4)	0.6748
Chronic kidney disease	5 (2.6)	2 (1.8)	3 (3.6)	0.9606
Chronic obstructive pulmonary disease	10 (5.2)	6 (5.4)	4 (4.8)	0.7704
Diabetes mellitus	31 (16.0)	18 (16.2)	13 (15.7)	0.9886
HIV				0.3598
Positive	13 (6.7)	6 (5.4)	7 (8.4)	
Negative	126 (65.0)	69 (62.2)	56 (67.5)	
Unknown	55 (28.3)	36 (32.4)	20 (24.1)	
On treatment	12 (92.3)	5 (4.5)	7 (8.4)	
Hypercholesterolaemia	47 (24.2)	26 (23.4)	21 (25.3)	0.5520
Hypertension	148 (76.3)	83 (74.8)	65 (78.3)	0.6109
Obstructive sleep apnoea	69 (35.6)	39 (35.1)	30 (36.1)	0.9978
Previous myocardial infarction	7 (3.6)	4 (3.6)	3 (3.6)	0.7878
Previous stroke	9 (4.6)	5 (4.5)	4 (4.8)	0.6667
Previous tuberculosis	13 (6.7)	7 (6.3)	6 (7.2)	0.7644
Thyroid disease	6 (3.1)	4 (3.6)	2 (2.4)	0.7376
None	31 (16)	19 (17.1)	12 (14.5)	0.8061

complaints is complex and requires further exploration in surgical patients.

While the influence of increasing age on worsening cognition found in this study is similar to previous studies,[3,6,15] other important factors such as polypharmacy and inappropriate medications were not found to be significant (despite high preponderance of both). However, these are still potential targets for intervention.

It is interesting that no particular comorbidity or the coexistence of multiple vascular risk factors were significantly associated with cognition in this study. Partridge and colleagues,[4] utilising an urban UK sample comprised entirely of vascular patients, found a higher prevalence of cognitive dysfunction (68%) using the MoCA. This may be expected given that the risk factors for atherosclerosis, such as hypertension, hypercholesterolaemia, and diabetes mellitus, are also independent risk factors for cognitive dysfunction.[4]

Despite a high preponderance of the same risk factors in this study, the risk factors may not have culminated in vascular disease severe enough to warrant intervention. The patients in this study were ambulatory outpatients, whereas those in the study by Partridge and colleagues[4] were hospitalised for either elective or emergency vascular surgery. This may reflect greater disease severity or increased cognitive stress in the setting of hospitalisation; however, a study comparing admitted patients and those presenting to a clinic 6 weeks before surgery found no difference in cognitive test scores as a result of location and timing.[15] Finally, Partridge and colleagues[4] did not exclude patients known to have cognitive dysfunction or dementia, as was done in this study. The fact that patients presenting for cardiac surgery have a comparable prevalence[5] of cognitive dysfunction to their noncardiac surgery counterparts suggests that the relationship between vascular risk factors and cognition is complex.

The influence of education supports the effect of cognitive reserve on counteracting damaging influences.[35] The older South African black population was schooled during the Apartheid era under the Bantu Education Act of 1953,[36] which, until educational reform in the 1980s, resulted in less spending and lower-quality instruction in black schools.[37] Trowbridge

Table 4 Descriptive table of FRAIL scale scores and Modified Rankin scores of participants. CI, confidence interval.

Variable	Total	Mini-cog ≤3 (*n*=111)		Mini-cog >3 (*n*=83)	
	n (%)	*n* (%)	95% CI	*n* (%)	95% CI
Frailty					
Robust	23 (11.9)	7 (6.3)	1.8–10.8	16 (19.3)	10.8–27.8
Pre-frail	141 (72.7)	80 (72.1)	63.7–80.4	61 (73.5)	64.0–83.0
Frail	30 (15.4)	24 (21.6)	14.0–29.3	6 (7.2)	1.7–12.8
Functional status					
Modified Rankin score					
0	59 (30.4)	25 (22.5)	14.8–0.3	34 (41.0)	30.4–51.5
1	70 (36.1)	44 (39.6)	30.5–48.7	26 (31.3)	21.3–41.3
2	47 (24.2)	30 (27.0)	18.8–35.3	17 (20.5)	11.8–29.2
3	16 (8.3)	10 (9.0)	4.6–5.2	6 (7.2)	1.7–12.8
4	2 (1.0)	2 (1.8)	-0.7–4.3	0 (0)	0

Table 5 Logistic regression. CI, confidence interval; OR, odds ratio.

Variable	Adjusted OR	95% CI		P-value
		Lower bound	Upper bound	
Reference: age 60 yr, robust, with grade 11 to tertiary education	0.0072	0.0002	0.2922	0.009
Pre-frail	2.6645	0.9883	7.1837	0.053
Frail	7.5433	2.0244	28.1077	0.003
Grade 8 to 10 education	2.7665	1.3542	5.6517	0.005
Primary school education	3.5455	1.5220	8.2595	0.003
Patient age	1.0531	0.9998	1.1094	0.051

and colleagues[3] also found that patients in the USA with more education were less likely to have cognitive dysfunction; however, 62.4% of that population had more than 12 yr of formal instruction.

Frail patients were more than seven times more likely to have cognitive dysfunction than robust patients. Frailty was also found to be independently associated with cognitive dysfunction by Partridge and colleagues[4] (odds ratio 12.55, $P<0.001$). While no other studies have assessed frailty, this strong association is expected given that these geriatric syndromes often coexist.[38]

The identification of patients with cognitive dysfunction, particularly those with concomitant frailty and a low level of education, is clinically important. A positive screen for cognitive dysfunction impacts informed consent, aids in more accurate risk assessment, and could catalyse interventions to reduce the negative impact of surgery and anaesthesia in this population. Interventions spanning the perioperative period have been suggested, but high-level evidence for these is lacking.[39]

Limitations of this study include the reliance on self-reported data for aspects such as alcohol use and smoking, and the fact that the Mini-Cog is only a screening test (results were not compared with a full neuropsychological battery). Anxiety is a possible confounder that was not controlled for. A further limitation is the relatively small sample of participants with certain comorbid conditions for comparisons; however, this was a secondary objective. There was also an unknown number who remain undiagnosed. For example, 6.7% were known to have HIV, and 28.3% had never been tested. This makes it difficult to accurately comment on the true association of HIV with cognition. Future studies might include larger sample sizes for factors of interest, and assess the effect of a change in education policy post-Apartheid on the cognitive function of older patients awaiting surgery.

We found undiagnosed pre-existing cognitive dysfunction to be common in older patients awaiting surgery in a hospital. These at-risk patients should be identified through brief anaesthetic preoperative screening, allowing interventions to be enacted by the entire multidisciplinary team.

Authors' contributions

Study design, patient recruitment, data collection, data analysis, writing up of first draft of paper, editing of article: LA.

Study development and design, critical revision of article, final approval of version to be published: HP, JS, K-AB-I.

Declarations of interest

The authors declare that they have no conflicts of interest.

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