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Identification of intrinsic capacity impairment: diagnostic performance of integrated care for older people (ICOPE) screening tools in Zimbabwe

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ABSTRACT

Introduction: The World Health Organization (WHO) Integrated Care for Older People (ICOPE) framework proposes screening (Step-1) and subsequent in-depth assessment (Step-2) to inform personalised interventions to promote intrinsic capacity (IC) in older adults. We aimed to assess the diagnostic performance of screening approaches against in-depth assessments in Zimbabwe.

Methods: This cross-sectional study recruited older adults age ≥65 years in urban Zimbabwe. For both Steps 1 and 2, IC was assessed using WHO ICOPE-proposed and/or alternative assessments for seven domains: cognition, locomotion, vitality, vision, hearing, psychological, and urinary continence. Diagnostic performance of screening approaches was assessed using metrics, including sensitivity and specificity categorised as good (≥0.80), fair (≥0.50–0.79), poor (<0.50).

Results: The 763 adults were mean (standard deviation) age 74.5(7.2) years: 62.9 % female. Frequencies of IC impairments ranged from 18.1 % for hearing to 92.0 % for vision based on screening, and 13.4 % for urinary incontinence to 62.9 % for vision based on in-depth assessments. Performance of 37 different screening approaches and in-depth assessment comparisons were tested. Of the eight screening approaches with the best performance, sensitivity ranged from good (n = 7) to fair (n = 1), while five had fair and three had poor specificity. Sensitivity of screening approaches ranged from 0.65 (95 %CI: 0.58–0.71) for hearing to 0.93 (95 % CI: 0.89–0.96) for locomotion. Specificity ranged from 0.28 (0.22–0.33) for vision to 0.69 (0.65–0.73) for hearing.

Conclusion: Each domain had a screening approach with good or fair sensitivity and mostly fair specificity, supporting use in ICOPE implementation in Zimbabwe, which is urgently needed given the high prevalence of IC impairments.

1. Introduction

Longevity is increasing globally. The United Nations and World Health Organization (WHO) Decade of Health Ageing (2021–2030) aims to increase life expectancy and healthy years lived [1]. Healthy ageing is the development and maintenance of functional ability to facilitate well-being in older age [1]. Functional ability comprises the intrinsic capacity (i.e., the combination of mental and physical capacities), within an enabling environment (i.e., physical, social and policy) [1]. A key action area in this decade is the implementation of the WHO's Integrated Care for Older People (ICOPE) approach to optimise intrinsic capacity (IC) by providing a continuum of integrated care in a health and social care system that prioritises person-centred and coordinated care [2]. The six IC domains defined in 2019, were cognition, locomotion,

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vitality, vision, hearing and psychological capacities [3], with urinary incontinence added more recently [2]. A recent meta-analysis found that IC impairments were associated with mortality, disability, falls, frailty and hospitalisation [4]. We have recently shown that IC impairments are associated with lower quality of life, more pain and greater functional limitation in The Gambia, South Africa, and Zimbabwe [5]. Such adverse outcomes likely increase dependence, caregiver and health system strain and reduce the economic contribution of older people.

The ICOPE care pathway consists of four steps: 1) screening for IC losses and delivery of immediate interventions (e.g., health and lifestyle advice); 2) in-depth assessment to confirm IC loss for those failing Step 1, with assessment of diseases, risk factors, and social and physical environments; 3) development of a personalised care plan based on Step 2 results; and 4) implementation and monitoring of the personalised care plan [2]. Step 1 can be conducted in the community, with those failing the IC tests referred to primary care for subsequent steps [2]. Step 1 requires screening tools with good diagnostic performance [3]. However, published evidence on the diagnostic performance of existing screening tools is scarce and heterogeneous. A 2023 scoping review of screening tools in the six IC domains included three relevant studies from Spain, Andorra and Hong Kong: sensitivity ranged from 44 % for vision in Spain to 100 % for vision in Andorra, whilst specificity ranged from 22 % for vision in Andorra to 93 % for locomotion in Hong Kong [6,7]. A more recent study from Brazil found that sensitivity ranged from 50 % for vitality to 94 % for locomotion, while specificity ranged from 57 % for locomotion to 94 % for sensory capacity [8]. According to a WHO progress report, ICOPE implementation in Africa is in the early stages, such as ongoing healthcare worker training in Botswana [9]; however, the diagnostic performance of Step 1 screening tools is unknown.

In Africa, the number of older adults (≥60 years) is expected to triple by 2050 potentially leading to IC impairements [10,11]. Zimbabwe is not an exception; we have recently shown a high prevalence of IC impairments in urban settings: 88 % of those aged ≥70 years had ≥2 IC impairments, mostly affecting locomotion (89 %), cognition (61 %) and vision (60 %) [5]. The Zimbabwean National Healthy Ageing Strategic Plan, published in 2017, acknowledged that maintaining intrinsic capacity was important for healthy ageing in Zimbabwe and committed to improving the measurement of ageing indicators, including intrinsic capacity [12]. However, IC measurement has not yet been implemented. First, adaptation of ICOPE screening tools is needed to improve IC measurement and the quality of available data to inform practice and policy, in both Zimbabwe and the wider region.

Adaptation of Step 1 screening tools has been proposed to 1) improve diagnostic performance (specificity and sensitivity) [13]; 2) contextualise measurements (e.g., using local colloquial syntax and vocabulary); and 3) for pragmatic reasons (e.g., using self-reported problems in place of auditory and visual tests) [14]. Therefore, this study aimed to use the ICOPE-recommended Step 1 tools, Step 2 assessments and relevant adaptations to determine the diagnostic performance (using sensitivity and specificity) of Step 1 approaches. A secondary aim was to report the prevalence of IC impairments.

2. Methods

2.1. Study design and population

This study is part of the KOSHESAI (**K**eeping **O**lder people healthy, de**S**igning and evaluating effective **HE**alth **S**ervices to maintain functional **A**b**I**lity) ("KOSHESAI" meaning to lift-up and cherish in Shona) project in Zimbabwe (Chingono et al. under review). Adults age ≥65 years were recruited from two suburbs in Harare, Zimbabwe, between January and July 2025. The study aimed to recruit 732 older people (366 in each suburb) to provide a 3.5 % precision to detect a 70 % successful provision of appropriate on-the-spot care or appropriate referral for healthy ageing interventions, assuming 90 % tested positive in ≥1 IC domain and allowing for 10 % loss to future follow-up. Participants were identified through 1) community sensitisation strategies such as distribution of study flyers, study video, home visits of potentially eligible older adults, engagement with churches and social gatherings; 2) referral from primary healthcare facilities, social care registers, community-based organisations and trained peers delivering healthy ageing interventions; and 3) older people who had taken part in research before and consented to be contacted about future studies. Participants were included if they were aged ≥65 years and committed to being resident in the study area for follow-up after four months. The current analysis is cross-sectional, using baseline data only.

2.2. Data collection procedures and definitions

Data were collected using standardised procedures by trained researchers who administered questionnaires through Open Data Kit [15] (sociodemographic, self-report of functional difficulties or activity limitations and diseases) and conducted physical assessments (e.g., vision, hearing, timed get-up-and-go [TUG], short physical performance battery [SPPB], which includes chair rise time, gait speed, and balance measurements). Table 1 shows Step 1 screening and 2 assessments that were conducted independently on the same day, by different researchers, and based on the WHO-proposed and, where applicable, alternative assessments with justifications. See Supplementary material, pages 2–3 for details on the screening and assessments, including the exact questions used and the definition of sociodemographic characteristics. Body mass index (BMI) was computed using height and weight measures and categorised as underweight (<18.5 $kg.m^2$), normal (18.5–24.9 $kg.m^2$), and overweight (25–29.9 $kg.m^2$) and obese (≥30 $kg.m^2$) [16].

2.3. Ethical approval

All participants provided written informed consent or through a proxy for those with cognitive impairment before data collection. Ethical approval was secured from Medical Research Council of Zimbabwe (reference MRCZ/A/3077; 15 December 2023).

2.4. Statistical analysis

Descriptive statistics summarised participant characteristics: mean and standard deviation for age and counts and percentages for categorical variables. Prevalence of IC impairments in different domains was presented in counts and percentages. Counts of diagnostic outcomes based on screening versus in-depth assessment were used to calculate the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy (Formulas shown in Supplementary material, page 4) with 95 % confidence intervals (CIs) computed. For both sensitivity and specificity, diagnostic performance was defined as good (≥80 %), fair (< 80 % but ≥50 %), or poor (< 50 %) [17]. Using the lower and upper bounds of 95 % confidence intervals, five categories defined the range of diagnostic performance (see Supplementary material, page 4). For each domain, the diagnostic performance of the WHO-proposed and alternative screening approaches was computed. For screening approaches with poor diagnostic performance, modifications hypothesised to improve performance were explored. Modifications 1) combined WHO and alternative approaches (e.g., whisper test fail *or* self-reported hearing difficulty); 2) modified either the WHO-proposed or alternative approaches by applying exclusions, e.g., excluding self-reported hypertension and only using diabetes diagnosis for vision screening.

Additionally, for vision, the diagnostic performance of screening approaches against combined distance and near vision, as well as distance and near vision separately, was explored. The diagnostic performance of WHO-proposed and context-specific cut-offs for Step 2 assessments (i.e., SPPB and hearWHO) was explored. In total, the diagnostic performance of 37 Step 1 and 2 combinations was assessed

Table 1
Step 1 screening and step 2 assessments, with thresholds used to define intrinsic capacity impairments and justification for alternative approaches.

Domain	Step 1 Screening *A: WHO-proposed approach* *B: Possible alternative approach*	Step 2 Assessment	Justification for alternative screening approaches or assessments
Cognition	A: Incorrect response to either orientation (4 questions) or recall (3 words)[2] B: Self-reported forgetfulness in the last 12 months B. Self-reported difficulty remembering or concentrating[¥]	RUDAS score ≤22[27]	Loss of memory is associated with cognitive impairment and dementia. Self-reported forgetfulness in last 12 months is used in the UK primary care to support the diagnosis of dementia [28] The Washington Group Short Set[29] on Functioning questions are widely used to measure self-reported functioning difficulty
Locomotion	A: Five chair rise time in ≥15 s[2] B: TUG in ≥16 s[30] B. Self-reported mobility difficulty[*¥]	SPPB score ≤5[†] SPPB score ≤9[2] ≥2 falls in last 12 months	Falls are important outcomes related to locomotion impairment, and TUG is one of the tests used to determine locomotion impairment in the World guidelines for falls prevention and management for older adults The Washington Group Short Set[29] on Functioning questions are widely used to measure self-reported functioning difficulty
Vitality	A: Self-reported weight or appetite loss in the last 3 months[2]	MNA-SF score ≤7 or 8–11 with unintentional weight loss[20]	No alternative screening or assessments were used
Vision	A: Self-reported problems with eyes or having a diabetes or hypertension diagnosis[2] B: Self-reported difficulty in seeing[¥]	Fail in either near or distance vision measured using the WHO Eyes app vision assessment chart[2]	The Washington Group Short Set[29] on Functioning questions are widely used to measure self-reported functioning difficulty
Hearing	A: Fail in whisper test, i.e. <3 passes on either ear (including repeat test if applicable) based on 6 random number-letter-number combinations B: Self-reported difficulty in hearing[¥]	hearWHO[2] score ≤40[‡] hearWHO score <50	The Washington Group Short Set[29] on Functioning questions are widely used to measure self-reported functioning difficulty The WHO score measurement is influenced by background noise, hence adjusting for this is important.
Psychological	A: Any *Yes* response to PHQ-2 binary questions B: Any *Yes* response to GAD-2 binary questions	PHQ-9 score ≥8 or self-reported suicide ideation GAD-7 score ≥8	GAD-2 and GAD-7 measure anxiety, which is one of many dimensions of depressive symptoms [2]
Urinary incontinence	Self-reported urge incontinence Self-reported stress incontinence	ICIQ[31] score ≥7 Bothersome score ≥4 due to either sudden need to urinate or getting up at night to urinate [β]	Stress and urgency incontinence are two types of urinary incontinence [2] ICIQ-MLUTS (Male Lower Urinary Tract Symptoms) questionnaire has been used for in-depth assessment of incontinence[31]

[†] This score was the optimal cut-off to predict self-reported mobility difficulty in adults aged ≥70 years in the Fractures-E3 study[19].
[¥] Questions taken from The Washington Group Short Set on Functioning[29].
[*] Mobility difficulty is present when any difficulty in walking outside or climbing stairs is reported.
[‡] Data collection room noise adjusted cut-off informed by the 5th percentile of hearWHO score (≤40) of the 40–45 years age group in urban Zimbabwe[5].
[β] Questions taken from ICIQ-MLUTS (Male Lower Urinary Tract Symptoms) questionnaire[31]
Further methodological details are provided in Supplementary materials.
GAD: Generalised Anxiety Disorder; ICIQ: International Consultation on Incontinence Questionnaires; MNA-SF: Mini Nutritional Assessment Short Form; PHQ: Patient Health Questionnaire; RUDAS: Rowland Universal Dementia Assessment Scale; SPPB: Short Physical Performance Battery; TUG: Timed 'Get up and Go'.

(cognition 4, locomotion 9, vitality 1, vision 8, hearing 6, psychology 3, and continence 6). Agreement between screening and in-depth assessments was assessed using GwetAC1 index (range 0–1), which is more robust to sample distribution than Cohen's Kappa, with higher values defining better agreement: moderate (0.4–0.6), good (0.6–0.8) and very good (0.8–1) [7]. Analyses were performed using R statistical software (version 4.3.1) [18].

3. Results

3.1. Sociodemographic characteristics

In total, 994 older adults were assessed for eligibility, 98 (9.9 %) were ineligible (93 were <65 years; five did not reside in the study area), 132 (13.3 %) did not attend the clinic for data collection by end of baseline data collection, one (0.1 %) did not consent at the research clinic and three (0.3 %) had their data collected at home. In total, 763 of all assessed for eligibility (76.8 %) consented and provided data for analysis (Supplementary Figure 1). Most participants were female (62.9 %), had either no formal education or at most a primary level (68.3 %), and were widowed (56.0 %) (Table 2).

3.2. Cognition

Prevalence of self-reported forgetfulness and failure of orientation or recall was 18.7 % and 57.3 %, respectively, while 19.5 % participants had a Rowland Universal Dementia Assessment Scale (RUDAS) ≤22 (Table 3). Self-reported forgetfulness had poor sensitivity (0.27, 95 % confidence intervals [CI], 0.20–0.34) and good specificity (0.83, 95 % CI: 0.80–0.86) while orientation or recall testing had fair-to-good sensitivity (0.85, 0.79–0.90) with fair-to-poor specificity (0.49, 0.45–0.53) (Table 4). Using self-reported difficulty remembering or concentrating did not produce higher sensitivity (Supplementary Table 2). Also, combining both screening assessments did not improve sensitivity and specificity (Supplementary Table 2).

3.3. Locomotion

The proportions with locomotion impairment based on TUG and chair rise time screening, were 46.5 % and 59.1 % (Table 3). Using a context-derived SPPB cut-off of ≤5 [19] identified fewer participants to be impaired compared to the WHO-proposed cut-off of ≤9 [2], 26.5 % versus 75.8 % (Table 3).

The correlation coefficients between SPPB components ranged from 0.296 (balance score versus chair rise time) to 0.477 (chair rise time versus gait time) (see Supplementary Table 1). Chair-rise time had a better sensitivity and specificity than TUG (Table 4). The sensitivity of chair-rise time was better when a context-derived SPPB cut-off was used, compared to the WHO-proposed cut-off, 0.93 (0.89–0.96) versus 0.74 (0.70–0.78), but specificity was poorer than when the WHO-proposed cut-off was used, 0.56 (0.51–0.60) versus 0.95 (0.92–0.99) (Table 4). Self-reported mobility difficulty had comparable sensitivity and specificity to the use of chair-rise time (Table 2). Using self-report of ≥2 falls as the reference did not result in better sensitivity or specificity (Supplementary Table 2).

3.4. Vitality

Self-reported weight or appetite loss identified 46.7 % as impaired, compared to 34.6 % based on the Mini Nutritional Assessment Short-Form [20] (Table 3). The screening questions had a fair-to-good sensitivity, 0.75 (0.69–0.80), and fair specificity, 0.68 (0.64–0.72) (Table 4).

3.5. Vision

The prevalence of vision impairment based on self-reported eye problems, or a diabetes or hypertension diagnosis, and self-reported 'seeing difficulty' was 92.0 % and 77.9 %, respectively (Table 3). In-depth assessment identified 62.9 % of participants to have a corrected or uncorrected distance or near vision impairment, with impairment in distance vision being more common than near vision, 62.3 % versus 12.1 % (Table 3). Both screening tests had good sensitivity (>82 %) but poor specificity (<35 %). Excluding a hypertension diagnosis from screening questions (given its non-differential high prevalence), to only include self-reported eye problems or a diabetes diagnosis improved the specificity (0.30 (0.25–0.35)) to a level similar to that of self-reported 'seeing difficulty' 0.31 (0.25–0.36) (Table 4). Combining self-reports of eye problems and difficulty seeing did not improve the sensitivity or specificity (Supplementary Table 2).

3.6. Hearing

The correlation between the right and left whisper test scores was strong ($r = 0.656$). Prevalence of hearing impairment based on whisper test, by self-reported hearing difficulty, and by combined whisper test or hearing difficulty, was 18.1 %, 36.4 %, and 40.6 %, respectively (Table 3). On an in-depth assessment using hearWHO and a context-derived cut-off of ≤40[5] or the WHO-proposed cut-off of <50 [2], hearing impairment was detected in 29.3 % and 81.5 % of participants, respectively (Table 3).

The correlation between the combined (left + right) whisper test score (0–12) and hearWHO score was moderate ($r = 0.408$) (Supplementary Figure 2). A hearWHO cut-off of <50 had better specificity and poorer sensitivity for both screening approaches. Using the context-derived hearWHO cut-off as the reference, the whisper test, compared to self-reported hearing difficulty, had better specificity (0.93 (0.91–0.95) versus 0.72 (0.68–0.76)) but poorer sensitivity (0.45 (0.39–0.52) versus 0.56 (0.50–0.63) (Table 4). Screening using a combination of both self-reported difficulty and whisper test failure improved and balanced both sensitivity and specificity: 0.65 (0.58–0.71) and 0.69 (0.65–0.73) (Table 4).

Table 2
Characteristics of study participants age ≥ 65 years in urban Zimbabwe.

Characteristic	Number (%) $n = 763$
Mean age ± SD	74.5 ± 7.2
Sex	
Male	283/763 (37.1 %)
Female	480/763 (62.9 %)
Educational attainment	
No education or primary only	521/763 (68.3 %)
Secondary & above	242/763 (31.7 %)
Employment status	
Employed†	94/763 (12.3 %)
Retired	118/763 (15.5 %)
Unemployed	551/763 (72.2 %)
Marital status	
Married	272/762 (35.7 %)
Single‡	63/762 (8.3 %)
Widowed	427/762 (56.0 %)
Living status	
Living alone	64/754 (8.5 %)
Living with someone	690/754 (91.5 %)
Current tobacco use	96/763 (12.6 %)
Does not consume alcohol	606/763 (79.4 %)
BMI categories	
Underweight (<18.5 kg.m^2)	56/756 (7.4 %)
Normal (18.5–24.9 kg.m^2)	274/756 (36.2 %)
Overweight (25–29.9 kg.m^2)	219/756 (29.0 %)
Obese (≥30 kg.m^2)	207/756 (27.4 %)
Self-report of common chronic diseases	
Diabetes	94/757 (12.4 %)
Hypertension	523/759 (68.9 %)
HIV*	97/453 (21.4 %)

BMI: body mass index; SD: standard deviation.
† Includes part-time, full-time and self-employed.
‡ Includes never married, separated, and divorced.
* 39.3 % ($n = 300$) self-reported to never had a HIV test.

Table 3
Number and proportion with intrinsic capacity impairments according to ICOPE Step 1 screening, and Step 2 assessment.

	Impairment prevalence	
	Step 1 Screening, ($n = 763$)	Step 2 Assessment, ($n = 763$)
Cognition		
Self-reported forgetfulness	143/763 (18.7 %)	
Orientation or recall test fail	437/763 (57.3 %)	
Forgetfulness or orientation or recall test fail	480/763 (62.9 %)	
Self-reported difficulty remembering or concentrating	413/763 (54.1 %)	
RUDAS ≤22		149/763 (19.5 %)
Locomotion		
TUG ≥16 s	353/759 (46.5 %)	
Chair-rise ≥15 s	449/760 (59.1 %)	
Self-reported mobility difficulty	404/763 (52.9 %)	
SPPB ≤5		192/724 (26.5 %)
SPPB ≤9		549/724 (75.8 %)
≥2 falls in last year		82/762 (10.8 %)
Vitality		
Weight or appetite loss	356/763 (46.7 %)	
MNA-SF malnutrition or risk with weight loss		264/763 (34.6 %)
Vision		
Eye problems, diagnosed diabetes or hypertension	702/763 (92.0 %)	
Seeing difficulty	594/763 (77.9 %)	
Eye problems or diabetes diagnosis	598/761 (78.6 %)	
Distance or near vision		479/762 (62.9 %)
Distance vision		475/762 (62.3 %)
Near vision		92/762 (12.1 %)
Hearing		
Whisper test fail	138/762 (18.1 %)	
Self-reported hearing difficulty	278/763 (36.4 %)	
Whisper test fail or self-reported hearing difficulty	310/763 (40.6 %)	
HearWHO ≤40		223/762 (29.3 %)
HearWHO <50		621/762 (81.5 %)
Psychological		
PHQ-2	394/763 (51.6 %)	
GAD-2	260/763 (34.1 %)	
PHQ-2 or GAD-2	433/763 (56.7 %)	
PHQ-9 ≥ 8		194/756 (25.7 %)
GAD-7 ≥ 8		98/756 (13.0 %)
PHQ-9 ≥ 8 or GAD-7 ≥ 8		215/756 (28.4 %)
Incontinence		
Urge	378/763 (49.5 %)	
Stress	121/763 (15.9 %)	
Urge or stress	404/763 (52.9 %)	
ICIQ ≥7		102/763 (13.4 %)
Bothersome symptoms		333/763 (43.6 %)

GAD: Generalised Anxiety Disorder; ICIQ: International Consultation on Incontinence Questionnaires; MNA-SF: Mini Nutritional Assessment Short Form; PHQ: Patient Health Questionnaire; RUDAS: Rowland Universal Dementia Assessment Scale; SPPB: Short Physical Performance Battery; TUG: Timed 'Get up and Go'.

Table 4
Diagnostic performance and agreement metrics based on step 1 screening and 2 step assessments.

Test	Sensitivity (95 % CI)	Specificity (95 % CI)	PPV (95 % CI)	NPV (95 % CI)	Accuracy (95 % CI)	Gwet's AC1 (95 % CI)
Cognition						
Self-reported forgetfulness vs RUDAS ≤22	0.27 (0.20–0.34)	0.83 (0.80–0.86)	0.28 (0.21–0.35)	0.82 (0.79–0.85)	0.72 (0.69–0.75)	0.60 (0.54–0.65)
Orientation or Recall test fail vs RUDAS ≤22	0.85 (0.79–0.90)	0.49 (0.45–0.53)	0.29 (0.25–0.33)	0.93 (0.90–0.96)	0.56 (0.53–0.60)	0.17 (0.09–0.24)
Locomotion						
TUG ≥16 s vs SPPB≤5	0.78 (0.72–0.84)	0.67 (0.63–0.71)	0.46 (0.41–0.52)	0.89 (0.86–0.92)	0.70 (0.67–0.73)	0.45 (0.38–0.51)
Chair-rise ≥15 s vs SPPB≤5	0.93 (0.89–0.96)	0.56 (0.51–0.60)	0.43 (0.38–0.48)	0.95 (0.93–0.98)	0.65 (0.62–0.69)	0.33 (0.26–0.40)
Self-reported mobility difficulty vs SPPB≤5	0.85 (0.80–0.90)	0.62 (0.58–0.66)	0.45 (0.39–0.50)	0.92 (0.89–0.95)	0.68 (0.65–0.71)	0.39 (0.32–0.46)
TUG ≥16 s vs SPPB≤9	0.55 (0.51–0.60)	0.89 (0.85–0.94)	0.94 (0.92–0.97)	0.39 (0.34–0.44)	0.64 (0.60–0.67)	0.30 (0.23–0.37)
Chair-rise ≥15 s vs SPPB≤9	0.74 (0.70–0.78)	0.95 (0.92–0.99)	0.98 (0.97–0.99)	0.54 (0.48–0.59)	0.79 (0.76–0.82)	0.62 (0.57–0.68)
Self-reported mobility difficulty vs SPPB≤9	0.63 (0.59–0.67)	0.86 (0.81–0.91)	0.93 (0.91–0.96)	0.42 (0.37–0.48)	0.68 (0.65–0.72)	0.41 (0.34–0.48)
Vitality						
Weight or Appetite loss vs MNA-SF malnutrition/risk	0.75 (0.69–0.80)	0.68 (0.64–0.72)	0.55 (0.50–0.61)	0.84 (0.80–0.87)	0.70 (0.67–0.74)	0.43 (0.36–0.49)
Vision						
Eye problem or diabetes or hypertension diagnosis vs Near or Distance vision	0.94 (0.92–0.96)	0.11 (0.07–0.15)	0.64 (0.60–0.68)	0.51 (0.38–0.63)	0.63 (0.60–0.66)	0.43 (0.36–0.50)
Self-reported seeing difficulty vs Near or Distance vision	0.83 (0.80–0.86)	0.31 (0.25–0.36)	0.67 (0.63–0.71)	0.51 (0.44–0.59)	0.64 (0.60–0.67)	0.37 (0.30–0.44)
Eye problems or diabetes diagnosis vs Near or Distance vision	0.84 (0.80–0.87)	0.30 (0.25–0.35)	0.67 (0.63–0.71)	0.52 (0.44–0.59)	0.64 (0.60–0.67)	0.38 (0.31–0.45)
Hearing						
Whisper test fail vs hearWHO≤40	0.45 (0.39–0.52)	0.93 (0.91–0.95)	0.73 (0.66–0.81)	0.80 (0.77–0.84)	0.79 (0.76–0.82)	0.67 (0.62–0.73)
Self-reported hearing difficulty vs hearWHO≤40	0.56 (0.50–0.63)	0.72 (0.68–0.76)	0.45 (0.39–0.51)	0.80 (0.76–0.83)	0.67 (0.64–0.71)	0.41 (0.34–0.48)
Whisper test fail vs hearWHO≤50	0.21 (0.18–0.24)	0.95 (0.91–0.99)	0.95 (0.91–0.99)	0.21 (0.18–0.25)	0.35 (0.31–0.38)	−0.30 (−0.37–0.24)
Self-reported hearing difficulty vs hearWHO≤50	0.38 (0.35–0.42)	0.73 (0.66–0.80)	0.86 (0.82–0.90)	0.21 (0.18–0.25)	0.45 (0.41–0.48)	−0.07 (−0.14–0.01)
Self-reported hearing difficulty or Whisper test fail vs hearWHO≤40	0.65 (0.58–0.71)	0.69 (0.65–0.73)	0.47 (0.41–0.52)	0.83 (0.79–0.86)	0.68 (0.65–0.71)	0.41 (0.35–0.48)
Hearing difficulty or Whisper test fail vs hearWHO<50	0.43 (0.39–0.47)	0.70 (0.63–0.78)	0.86 (0.83–0.90)	0.22 (0.18–0.26)	0.48 (0.44–0.52)	0.01 (−0.07–0.09)
Psychological						
PHQ-2 vs PHQ-9 ≥ 8	0.76 (0.70–0.82)	0.57 (0.52–0.61)	0.38 (0.33–0.43)	0.87 (0.84–0.91)	0.62 (0.58–0.65)	0.27 (0.20–0.34)
GAD-2 vs GAD-7 ≥8	0.65 (0.56–0.75)	0.71 (0.67–0.74)	0.25 (0.20–0.30)	0.93 (0.91–0.95)	0.70 (0.67–0.73)	0.53 (0.47–0.59)
PHQ-2 or GAD-2 vs PHQ-9 or GAD-7 ≥ 8	0.80 (0.75–0.86)	0.52 (0.48–0.57)	0.40 (0.36–0.45)	0.87 (0.83–0.91)	0.60 (0.57–0.64)	0.22 (0.15–0.29)
Urinary incontinence						
Urge vs ICIQ ≥7	0.85 (0.78–0.92)	0.56 (0.52–0.60)	0.23 (0.19–0.27)	0.96 (0.94–0.98)	0.60 (0.56–0.63)	0.29 (0.22–0.37)
Stress vs ICIQ ≥7	0.54 (0.44–0.64)	0.90 (0.88–0.92)	0.45 (0.37–0.54)	0.93 (0.91–0.95)	0.85 (0.83–0.88)	0.80 (0.76–0.84)
Urge vs Bothersome symptoms	0.71 (0.66–0.75)	0.67 (0.62–0.71)	0.62 (0.57–0.67)	0.75 (0.70–0.79)	0.68 (0.65–0.72)	0.37 (0.31–0.44)
Stress vs Bothersome symptoms	0.24 (0.19–0.28)	0.90 (0.87–0.93)	0.65 (0.57–0.74)	0.60 (0.57–0.64)	0.61 (0.58–0.65)	0.33 (0.26–0.41)

NPV: Negative Predictive Value; PPV: Positive Predictive Value.
GAD: Generalised Anxiety Disorder; ICIQ: International Consultation on Incontinence Questionnaires; MNA-SF: Mini Nutritional Assessment Short Form; PHQ: Patient Health Questionnaire; RUDAS: Rowland Universal Dementia Assessment Scale; SPPB: Short Physical Performance Battery; TUG: Timed 'Get up and Go'.
Additional results, including numbers of True and False Positives and True and False Negatives, are presented in the Supplementary Material.
Diagnostic performance: Good (≥80 % with both CI bounds ≥80 %); fair-to-good (<80 % with upper CI ≥80 %, or ≥80 % with lower CI <80 %); fair (<80 % and >50 %, with both CI bounds within this range); poor-to-fair (<80 % and >50 %, with lower CI <50 %, or <50 % with upper CI >50 %); and poor (<50 % and both CI bounds <50 %).

3.7. Psychological capacity

The prevalence of depression and anxiety was 51.6 % and 34.1 % respectively, based on Patient Health Questionnaire-2 (PHQ-2) and Generalised Anxiety Disorder-2 (GAD-2) screening, and 25.7 % and 18.4 % respectively, based on PHQ-9 and GAD-7 assessment scores of ≥8 (Table 3). Of the 39 participants with no depression symptoms based on PHQ-2 but with anxiety symptoms based on GAD-2, only four (10.3 %) had confirmed anxiety based on GAD-7, of whom two (of the four) had confirmed depression based on PHQ-9, limiting the added benefit of screening with GAD-2. Using a PHQ-9 score ≥8 as the reference, the PHQ-2 showed fair-to-good sensitivity of 0.76 (0.70–0.82) and fair

specificity of 0.57 (0.52–0.61) (Table 4).

3.8. Urinary incontinence

The proportion of participants at screening who self-reported urge, stress, and either urge or stress incontinence was 49.5 %, 15.9 %, and 52.9 %, respectively (Table 3). The proportions with an International Consultation on Incontinence Questionnaire (ICIQ) score≥7 and bothersome symptoms of incontinence were 13.4 % and 43.6 %, respectively (Table 3). Self-reported urge, rather than stress, had a better balance between sensitivity and specificity for both ICIQ scores ≥7 and bothersome symptoms (Table 4). Using a combination of urge or stress screening did not considerably improve the sensitivity or specificity of detecting ICIQ scores ≥7 and bothersome symptoms compared to screening for urge incontinence alone (Supplementary Table 2).

3.9. Summary of ICOPE assessment

Fig. 1 presents a summary of the screening and in-depth assessments, and sensitivity and specificity categories. Of the eight screening approaches with the best diagnostic performance, seven (87.5 %) had good or fair-to-good sensitivity, and three (37.5 %) had poor or poor-to-fair specificity, which included vision and cognition screening.

4. Discussion

This study provides initial evidence on the diagnostic performance of ICOPE screening approaches in Africa, contributing to the limited but growing global literature. Based on WHO-proposed and alternative screening approaches, the best diagnostic performance was observed when testing cognition by orientation and recall, locomotion by chair-rise time, vitality by self-reported weight or appetite loss, vision by self-reported eye problems or a diabetes diagnosis or self-reported seeing difficulty, psychological capacity by PHQ-2, and urinary incontinence by self-reported urgency. Most screening approaches had good sensitivity and fair specificity. Deployment of screening approaches with only fair specificity would mean more time and resources are spent on in-depth assessment for false positives. However, this trade-off would likely be acceptable given the relatively low-cost, non-invasive nature of both the screening tests and the in-depth assessment, plus the minimal psychological impact of a positive result at the screening stage, which is shortly confirmed as negative in the in-depth assessment [21,22]. Overall, evidence from this study supports the use of these screening approaches in Zimbabwe.

The sensitivity for cognition screening reported in the current study (85 %) was higher than previously reported in Brazil (79 %) [8] and Hong Kong (74.7 %) [23], but marginally lower than in Spain (89 %) [7]. However, the 49 % specificity observed in Zimbabwe was lower than in all three countries, all >70 % [7,8,23]. The diagnostic performance of the screening approaches in the current study and how they compare with similar studies from Brazil [8], Hong Kong [23], and Spain [7] is summarised in Table 5. Notably, while the current study used RUDAS for in-depth assessment, the other studies used the Montreal Cognitive Assessment (Brazil, Hong Kong) [8,23] or Mini Cognitive

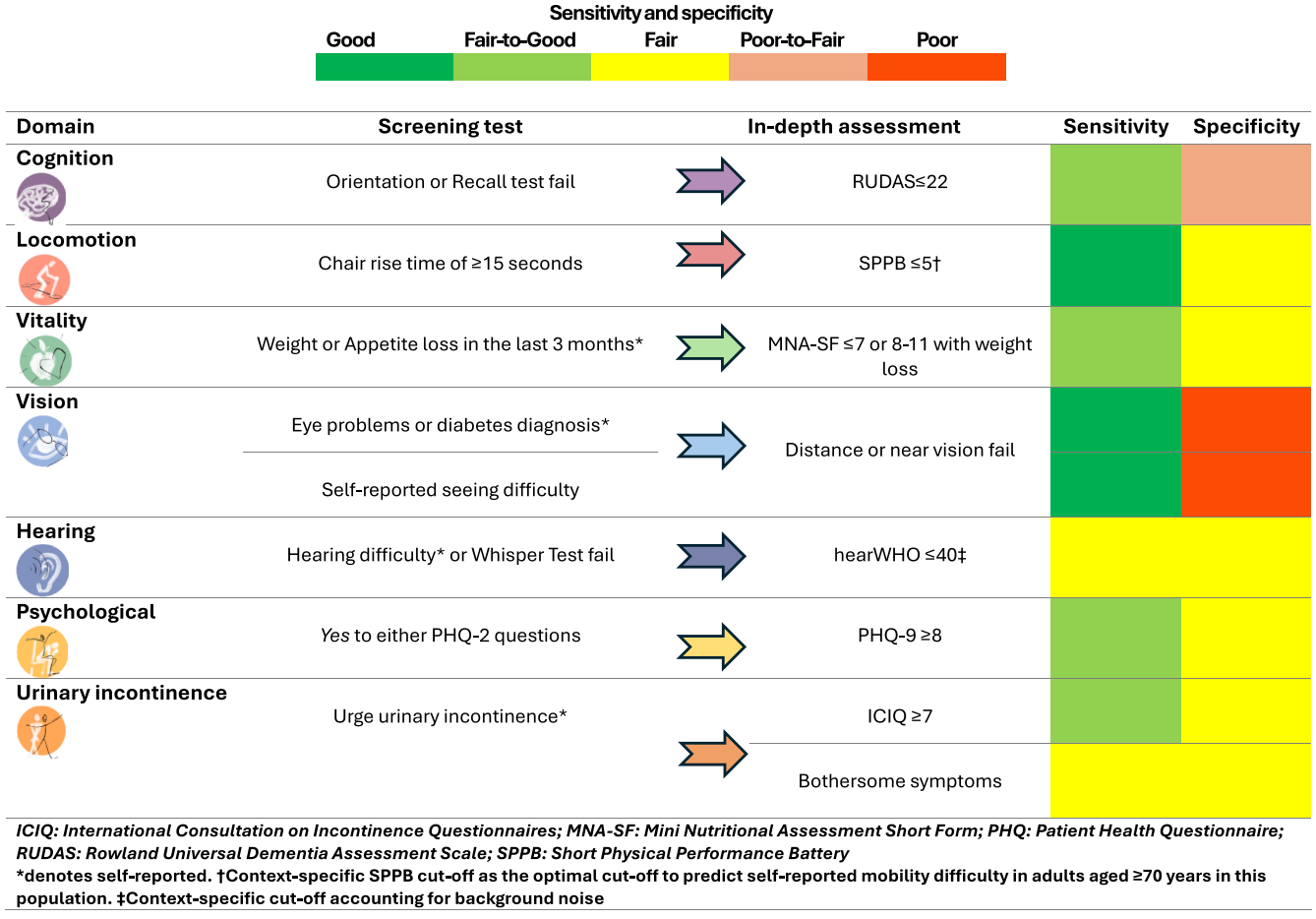

Fig. 1. Summary of Step 1 ICOPE screening versus Step-2 in-depth assessments and related diagnostic performance for intrinsic capacity impairment. *Good (≥80 % with both CI bounds ≥80 %); fair-to-good (<80 % with upper CI ≥80 %, or ≥80 % with lower CI <80 %); fair (<80 % and >50 %, with both CI bounds within this range); poor-to-fair (<80 % and >50 %, with lower CI <50 %, or <50 % with upper CI >50 %); and poor (<50 % and both CI bounds <50 %).*

Examination (Spain) [7], which do not generalise as well as RUDAS to a Zimbabwean context (e.g., clock drawing, translated word registration). For vision, the sensitivity of ≥83 %, based on either 1) self-reported eye problems or diabetes diagnosis or 2) self-reported seeing difficulty, was comparable to findings in Hong Kong (86 %)[23], and higher than in Spain (44 %) [7]. However, the specificity of 30 % in Zimbabwe was lower than reported in Hong Kong (83 %) and Spain (68 %)[7, 23]. It is unclear why these specificities were lower. Using an alternative question regarding self-reported forgetfulness resulted in good specificity but again poor sensitivity, and combining this question with orientation or recall testing did not improve specificity. For vision, alternatively asking about self-reported difficulty in seeing did not improve specificity. The low specificity implies lower efficiency during ICOPE Steps 1 and 2 due to a high number of false positives, who require in-depth assessment. Future ICOPE diagnostic performance studies in Africa should explore modifications to improve the specificity of cognition and vision screening approaches, as was needed in Andorra [13].

This study confirms the utility of modifying screening approaches to improve sensitivity and specificity. The addition of self-reported hearing difficulty to the whisper test improved sensitivity. Furthermore, excluding self-reported hypertension diagnosis from vision screening and focusing only on self-reported eye problems or a diabetes diagnosis resulted in a slight improvement in specificity. Apart from these modifications, the use of context-derived in-depth assessment cut-offs improved sensitivity, i.e., using the lower SPPB cut-off shown to be the optimal threshold to predict self-reported mobility difficulty in older adults in this setting [19], and a lower hearWHO threshold to account for background room noise [5]. These findings underscore the need to use context-derived thresholds for in-depth assessments, particularly to inform those who would require interventions such as hearing or mobility aids.

Beyond establishing diagnostic performance, ICOPE implementation will need re-orientation of health systems in Zimbabwe and other African countries towards person-centred care for older people, moving beyond maternal and child health and the reactive, acute care currently provided 'one disease at a time', to consider proactive, preventative assessment and management of health complexity with ageing. Challenges to this realisation include competing financial and policy priorities, healthcare worker shortages (many of whom have migrated to the global North) and inadequate digital infrastructure (including inconsistent electricity supplies, lack of internet coverage, secure data storage systems, and physical devices) [9]. Nevertheless, awareness is growing, and opportunities for successful, pragmatic implementation exist given ICOPE's flexibility for local co-design and adaptation [9]. For example, in the current KOSHESAI programme, in which this study is nested, peer-support groups are being used to deliver health-promoting interventions after in-depth assessment, which could reduce costs and strain on the health system (Chingono et al., manuscript under review).

Finally, this study adds to the evidence on the high prevalence of IC impairments in older African adults, building on our recent multi-country study reporting impairments in adults ≥70 years, which included urban Zimbabwean data [5]. The prevalence of cognitive impairment on screening in this current study, based on failure in orientation or recall (57 %), was slightly lower than recent evidence on self-reported forgetfulness or lack of concentration (61 %) [5]. Locomotor impairment (SPPB<10) prevalence reported here is lower at 76 % than 89 % previously reported in Zimbabwe [5]. For sensory domains, visual impairment (affecting 63 %) is fairly similar to the 60 % recently identified, while hearing impairment (affecting 29 %) was less common than 61 % previously, potentially because this included self-reported hearing difficulty [5]. Vitality impairment (based on MNA-short form) reported here is marginally higher than previously reported, 35 % versus 28 %. Psychological capacity impairment reported in the current study (at 26 %), based on PHQ-9 ≥ 8, is also higher than we have previously reported when using the Shona Symptom Questionnaire (without adaptation for older people), when an unrealistic prevalence of <1 % was detected [5]. Importantly, this current study provides novel evidence on the prevalence of urinary incontinence in older adults in Africa. Previous studies in Africa have focused on women, particularly those of reproductive age. The urge or stress incontinence reported here (53 %) is higher than a pooled prevalence of 27 % among African women age 15–100 years [24]. The urge incontinence reported here (16 %) is also higher than 'urine leaks at least once a day' reported recently by only 6 % of women age ≥60 years from Burkina Faso [25]. A recent scoping review on urinary incontinence in older men failed to include any studies from Africa [26], underscoring the need for research in men.

The strengths of this study include a large sample size (compared to similar studies[7, 8, 23]) and the use of both WHO-proposed and alternative in-context screening approaches (e.g., self-reported difficulty

Table 5
Summary of sensitivity and specificity of IC screening approaches against in-depth assessment approaches used in the current study and other recent studies in Spain [7], Hong Kong [23]and Brazil [8].

Domain	Sensitivity	Specificity	In-depth assessment and cut-off used
Cognition			
Zimbabwe (current study)	0.85	0.49	RUDAS score ≤22
Spain	0.89	0.73	Mini Cognitive Examination score <24
Hong Kong	0.75	0.92	Montreal Cognitive Assessment (MoCA) score <22
Brazil	0.79	0.73	MoCA: illiterate: ≤ 11; 1 to 4 years of study: ≤16; 5 to 11 years of study: ≤19; ≥ 12 years of study: ≤ 25
Locomotion			
Zimbabwe (current study)	0.93	0.56	SPPB score ≤5
Spain	0.52	0.95	SPPB score <10
Hong Kong	0.85	0.93	SPPB score <10
Brazil	0.93	0.57	SPPB score <10
Vitality			
Zimbabwe (current study)	0.75	0.68	MNA-SF score ≤7 or 8–11 with unintentional weight loss
Spain	0.46	0.96	MNA-SF score < 12
Hong Kong	1	0.84	MNA-SF score <8
Brazil	0.50	0.88	MNA-SF score < 12
Vision			
Zimbabwe (current study)	0.84	0.30	WHO Eyes app vision assessment chart: fail in either near or distance vision
Spain	0.44	0.68	Not stated
Hong Kong	0.86	0.83	WHO simple eye chart distance acuity worse than 6/18
Brazil[‡]	0.68	0.94	Self-reported fair or poor vision
Hearing			
Zimbabwe (current study)	0.43	0.70	HearWHO score ≤40
Spain[†]	0.57	0.81	The Hearing test Audiogram App
Hong Kong	1	0.85	Fail in the whisper words and fail both the Weber and Rinne test
Brazil[‡]	0.68	0.94	Self-reported fair or poor vision
Psychological			
Zimbabwe (current study)	0.76	0.57	PHQ-9 score ≥8
Spain	0.47	0.81	Geriatric Depression Scale score ≥ 2
Hong Kong	0.98	0.74	PHQ-9 score ≥10
Brazil	0.68	0.84	Geriatric Depression Scale score >5

All values rounded to 2 decimal places.
[†] Values of the best ear.
[‡] Values are for combined sensory domain as reported and not vision and hearing domains individually

MNA-SF: Mini Nutritional Assessment Short Form; PHQ: Patient Health Questionnaire; RUDAS: Rowland Universal Dementia Assessment Scale; SPPB: Short Physical Performance Battery.

hearing or seeing), or context-derived cut-offs for in-depth assessments (i.e., SPPB, hearWHO). Having efficient screening approaches is crucial in this setting, given financial and human resource constraints. Findings should be interpreted in the context of limitations. Firstly, the convenience rather than random sampling could limit external validity. Secondly, the study was based on an urban population in one country, and generalizability to rural settings and other African countries needs confirmation. Thirdly, context-derived cut-offs used for locomotion and hearing were based on cross-sectional data [19]. Lastly, context and resource limitations prevented formal neuro-psychological evaluation, pure-tone audiometry and ophthalmologist review. HearWHO uses numeric values presented in the English language, which are not familiar to all older people; ideally, options in multiple African languages would be available.

5. Conclusion

Most WHO-proposed screening approaches had good sensitivity and fair specificity in Zimbabwe, although modifications were made for vision and hearing screening. Specificity was poor for cognition and vision screening despite modifications, and future studies should explore additional modifications to improve specificity. Using context-derived cut-offs for in-depth assessment of locomotion and hearing capacities was associated with better sensitivity. Finally, IC impairments are highly prevalent in this context, necessitating the urgent rollout of ICOPE screening, assessment and intervention.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

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