Normative data for older New Zealanders on the Addenbrooke's Cognitive Examination-Revised

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The purpose of cognitive screening tests is to specify the likelihood of actual cognitive impairment, inferred from the association of the person's score to reference norms. New Zealand is following the trend of developing test norms for cognitive tests for use with older people. The Addenbrooke's Cognitive Examination-Revised (ACE-R) has been a widely used cognitive screening test in New Zealand. Since the withdrawal of the ACE-R due to copyright issues a validation study of the subsequent ACE-III has shown equivalence with the ACE-R. While awaiting development and validation of a 'Kiwi' ACE-III, the present study provides normative data, obtained from a nationwide (population based) sample of 1005 New Zealanders, 45 to 85 years of age, for the ACE-R. The norms are presented for different age groups, sex, New Zealand European and Māori ethnicity and educational bands.

Keywords: older adults, cognitive assessment, population norms

To best understand data derived from assessments, a reference point to what constitutes 'normal' performance is required. This frame of reference is provided by normative data which gives the empirical context and represents the range of performances on a particular test. Normative reference groups are considered the 'gold standard' against which an individual's test performance is compared and contrasted (Feigin & Barker-Collo, 2007).

Unfortunately, many tests which are used have a limited range of norms, often excluding those age groups where cognitive decline may begin to occur (Siegert & Cavana, 1997). Lezak (1987) reviewed the ten most commonly used American tests and found that adequate age norms for older people were virtually non-existent. More recently, there has been a concerted effort to collect population-based test norms for older people. For example, the Mayo clinic (Mayo's Older American Normative Studies, MOANS) has developed normative data for Americans aged 55-97 for fifteen different neuropsychological tests measuring many different cognitive functions (Roberts et al., 2009). There have been attempts to develop age appropriate norms suitable for older New Zealanders on neuropsychological tests with norms developed for: the Rivermead Behavioural Memory Test (Fraser, Glass, & Leathem, 1999), Trail Making Test (Siegert & Cavana, 1997), Rey Auditory Verbal Learning Test (Newlove, 1992), Controlled Oral Word Association Test, Graded Naming Test and the Recognition Memory Test (Harvey & Siegert, 1999). These norms are appropriate for a wide range of older age groups and specific to the New Zealand population.

Results become even more meaningful and accurate when compared to others with as many similar characteristics as possible, (e.g., cultural background, education, age, sex etc). For example, more variance in cognitive assessment scores is found within older age groups; i.e., the older people get, the more heterogeneous their scores become (Hanninen et al., 1996). Education level also impacts on cognitive ability in tests. For example, higher education levels have been associated with reduced variability in cognitive scores over time and a decreased risk in developing cognitive impairments (Christensen et al., 1999). Some cognitive tests take this into consideration by offering a conversion score that takes years of education into account, (e.g., the Montreal Cognitive Assessment, Nasreddine et al., 2005). There are a number of mechanisms that may explain lower rates of cognitive decline in older people with higher levels of education. First, people with lower education may be at more risk of central nervous system damage (e.g., through illness, poor living conditions or dietary deficiency), (Leibovici, Ritchie, Ledésert, & Touchon, 1996); second, people with higher education may have greater neuronal reserve capacity or integrity and/or reduced risk of neuronal damage (Christensen, 2001; Valenzuela & Sachdev, 2006); thirdly, people with higher levels of education may be better able to generate compensatory strategies (Leibovici et al., 1996) and finally, it is possible that people with higher levels of education may be better at doing paper and pen tests which affords them a higher chance of performing well. Research amongst these hypotheses is limited. However, one study found that people with higher levels of education appear to show greater resistance to change on tests with a high learned component (e.g., tests of language and secondary memory) and that "cognitive functions such as attention, implicit memory and visual-spatial analysis, (which might be postulated to have a higher 'nature' rather than 'nurture' component), are relatively unaffected by level of education" (Leibovici et al., 1996, p. 396). However the more recent Maastricht Aging Study suggests that higher education in general is not a protective factor against normal ageing (Van Dijk et al., 2008). These findings highlight the need to have tests that show sub-domain skills (rather than a global score) due to the possibility that deterioration in other domains may be masked by higher verbal and memory skills..

These demographic issues raise concerns about normative data developed in other countries. For example, the National Adult Reading Test (NART) is based on word pronunciation and was originally developed and standardized on a British population (Nelson, 1991).

Scores on this test are based on British pronunciation and familiarity with words such as "drachm"[1] . This represents a challenge to people unfamiliar with British language and may unduly influence a person's score (Harvey & Siegert, 1999). Western-based tests used across different cultures may not meet the requirement for a standardised assessment, with those of other cultures possibly being unfairly disadvantaged and over-diagnosed (e.g., false-positives).

Interpretation of assessment results from New Zealanders, using non-New Zealand norms, may be an inaccurate representation of that person's ability. For example, by virtue of residing in this country, older people have been exposed to different cultural and life experiences, health care, political and social welfare systems to people in other countries. According to the 2008 Dementia Manifesto (Alzheimers New Zealand, 2008), the on-going collection of population-based data is necessary in order to maximise cross-cultural validity. New Zealand has a diverse population comprised of many ethnicities and cultures and as such differs on many socio-demographic, cultural and societal factors compared to normative reference groups from other western countries (Guenole, Englert, & Taylor, 2003; Ogden & McFarlane-Nathan, 1997). Using cognitive assessments without appropriate culturally relevant adaptations, and applying norms derived largely from the western population, has resulted in the overestimation of cognitive impairment in the local populations of developing regions (Mathuranath, Cherian, Mathew et al., 2007) and New Zealand groups (Harvey & Siegert, 1999).

To illustrate the substantial cross-country differences can have on cognitive scores, Table 1 summarises mean scores of the Addenbrooke's Cognitive Examination-Revised, (ACE-R, Mioshi, Dawson, Mitchell et al., 2006) when used in different countries. The ACE-R has been a commonly used cognitive screening test in New Zealand (Strauss, Leathem, Humphries & Podd, 2012). The studies shown compare a clinical sample to a control group – the non-impaired norm.

1 Drachm is a unit of weight formerly used by apothecaries, equivalent to 60 grains or one eighth of an ounce

Table 1.

Cross-country ACE-R score difference in control group participants.

Country	Control Group (N)	ACE-R Mean score	Mean Age (SD)	Education (years)
UK	63	93.7 (4.3)	64.4 (5.7)	12.7 (2.1)
Greece	60	89.1 (7.5)	66.0 (8.9)	10.6 (4.2)
India	135	83.4 (7.2)	68.5 (7.1)	7.90 (5.4)
Japan	62	88.1 (4.3)	66.7 (10.1)	12.3 (3.6)
Spain	32	79.9 (7.6)	74.5 (5.4)	10.9 (1.4)
Korea	84	80.7 (6.0)	67.8 (9.3)	10.1 (4.1)

Note: United Kingdom, (Mioshi et al., 2006), Greece Konstantinopoulou et al. (2010), India (Mathuranath, Cherian, Mathew, George & Sarama, 2006), Japan (Slawek, Derejko, & Lass, 2005), Spain (Garcia-Caballero et al., 2006), Korea (Banerjee, Smith, Lamping et al., 2006).

According to one of the cut-off scores proposed in the original ACE-R article (88: sensitivity 0.94, specificity 0.98) (Mioshi et al., 2006), four of these countries' 'normative' samples, (i.e., control groups) would meet criteria for cognitive impairment, including dementia. These findings show the importance of developing specific country norms and cut-offs for screening for cognitive impairment which take into account cultural differences and language barriers between countries. It is also possible that these differences exist within the same country. For example, in Auckland, New Zealand, 56.5 percent of its population identify with the European ethnic group, 18.9 percent with the Asian ethnic group, 14.4 percent with the Pacific peoples ethnic group, and 11.1 percent with the Māori ethnic group (Statistics New Zealand, 2012). Ethnicity is a measure of cultural affiliation and thus reflects the diverse range of cultures and backgrounds in New Zealand. Another factor that may have influenced the differences between samples in Table 1 is educational level. The control group from the original article (Mioshi et al., 2006) was highly educated compared to most other samples. These studies highlight the need for assessments to use appropriately normed reference groups when interpreting individual test scores. Ideally, norms should be developed that match for age, education and ethnicity.

The influence of cultural variation has received little attention in the literature in terms of the validity of psychometric testing, even though researchers agree that validity can be compromised when this is not taken into account and that ethnicity and culture do affect test scores (Lezak, Howieson, & Loring, 2004; Rosselli & Ardila, 2003). Efforts to examine the influence of culture on cognitive functioning scores have found that New Zealand samples perform lower than normative data would anticipate. For example, the California Verbal Learning Test norms (based on USA samples) placed healthy New Zealand participants, (aged 17 to 81 years) in the 16th percentile (Barker-Collo, Clarkson, Cribb, & Grogan, 2002). In a naming test, (Boston Naming Test) university students based in New Zealand made up to 60% more errors than the American normed population; errors were made on naming items such as pretzel, beaver, globe, funnel and tripod (Barker-Collo, 2001). In an unpublished study of community based New Zealander's, (aged from 25 to 65+ years), participants had significantly lower scores on the Montreal Cognitive Assessment compared to the original population (Sothieson, 2010). Results of these studies suggest that New Zealanders would obtain lower scores on the ACE-R as well.

Lower scores in comparison to normative samples are likely to result in a larger proportion of New Zealanders being spuriously identified as having deficits (Feigin & Barker-Collo, 2007). One option to counteract these differences is to develop assessments that are more sensitive to our unique population and culture. For example, in the study cited above (Barker-Collo, 2001), New Zealander's improved their scores considerably when using a New Zealand adapted measure of verbal fluency. Differences in cognitive functioning scores across countries emphasises the need to increase the validity of assessment by using measures that are appropriate to the context and population they are being used with.

In New Zealand ethnic differences in access to, and quality of, health care, structural change in New Zealand society during the last 20 years and epidemiological risk factors have adversely impacted on Māori (Ajwani, Blakely, Robson, Tobias, & Bonne, 2003; Cunningham & Durie, 1999; Hackwell & Howell, 2002; Sutherland & Alexander, 2002; Tobias & Howden-Chapman, 2000; Tukuitonga & Bindman, 2002; Westbrooke, Baxter, & Hogan, 2001). It is highly plausible that the widening social inequalities between ethnic groups have in turn led to widening health inequalities; with performance in cognitive functioning tests being one potential consequence of these inequalities. In fact, ethnic variation is found within New Zealand on performance in neuropsychological tests; with Māori participants performing significantly lower than European participants (Ogden & McFarlane-Nathan, 1997). A person of Māori descent who sustains a head injury, and is assessed with neuropsychology tests developed and normed in the UK or the USA, can show impairments that are more to do with cultural bias of the tests than any effects of brain damage (Ogden, 2001). This is not surprising, given that most standard measures are based on Western schooling and assumptions that favour those from "Western" backgrounds (Rosselli & Ardila, 2003). Dudley, Wilson and Barker-Collo (2014) found Māori clients reported a need for cultural responsiveness from clinicians and cited the failure of the predominant Euro-western paradigm in recognising Māori identity within the therapeutic environment. When cognitive assessments have been translated into Te Reo for Māori speakers, Māori participants show performances that are equal or better than European participants (Ogden & McFarlane-Nathan, 1997). This emphasizes the need for New Zealand-based norms in order to create valid assessment and accurate diagnosis for unique population groups.

Summary

When making decisions about an individual's cognitive abilities it is vital to compare them to a similarly matched reference group to avoid biases impacting on interpretation of scores. Research generally shows that there are significant differences in scores cross-country and cross-culturally. To improve validity of assessment, these measures need to be appropriate to the context and population they are being used with, (Barker-Collo, 2001; Barker-Collo et al., 2002; Feigin & Barker-Collo, 2007). The inclusion in longitudinal large scale health studies of valid and reliable cognitive assessment tools, that have been normed specifically for New Zealand older adults, will provide more accurate assessment and more valid interpretation of test results.

The aim of this paper is to we provide normative data for the ACE-R from a population-based sample of older New Zealanders for the whole sample as well as those for four age groups, education, ethnicity and gender.

Method

Participants

The current sample of 1005 participants was drawn from a population sample collected as part of the New Zealand Longitudinal Study of Ageing (NZLSA). NZLSA expands on the earlier Health, Work and Retirement study (HWR) which recruited a representative sample of older New Zealanders from the New Zealand electoral roll in 2006 aged 55 to 70 years. In 2010 the sample was expanded to include younger and older age groups (ranging from 45-84) and became the New Zealand Longitudinal Study of Ageing (NZLSA); a population-level study. The specific aims of NZLSA are to make observations and test hypotheses about the contributions to ageing people's quality of life within four broad areas: economic participation (e.g. meaning of work, employment, retirement); social participation (e.g. social support, social capital, civic participation); intergenerational transfers (e.g. family care, income, wealth); resilience and health (e.g. physical, emotional, cognitive). Ethics approval for the research was obtained by the Massey University Human Ethics Committee: Southern B, Application 10/23.

A total pool of 4,339 older New Zealanders were invited to participate in the first NZLSA postal data collection wave in 2010, and comprised (1) HWR participants who participated in the 2008 data collection wave, (2) HWR participants from 2006 who consented to re-enter the study, (3) participants from a related cross-sectional study of retirement planning at Massey University, (4) participants from a pilot study conducted on the NZLSA survey questionnaire, and (5) New Zealanders randomly selected from the New Zealand Electoral Roll to increase the numbers of respondents at the younger (i.e., 45-54) and older (i.e., 70-84) age groups. These groups were sampled from the New Zealand Electoral Roll using the same sampling framework. Māori over-sampling was specifically undertaken during participant selection for NZLSA. A total of 3,312 (76%) from the pool completed NZLSA Wave 1 questionnaires (2010). For more details of the original sampling procedure see Alpass et al., (2007).

The current sample was recruited through the NZLSA database from people who volunteered to have face to face interviews. The present sample study is comprised of 1005 participants; 47.6% male and 52.4% female. Age ranged from 48-83[2] years with a mean age of 61.9 (SD 7.79). Participants were grouped into four age brackets for normative purposes. Those above 75 years and over (n= 81), those aged from 65 to 74 years (n=340), those aged from 55 to 64 years (n=430) and those aged below 55 years (n=152). A large percentage were well educated, having either tertiary education (n= 222, 22.1%) or at least post-secondary or trade qualifications (n=366, 36.4%). Over half the sample were married (n=630, 62.6%) and the majority of the sample described themselves as New Zealand European (n=883, 87.8%). Table 2 compares the participants' demographic data with that of the census data from 2006.

2 The sampling frame was designed to recruit 50 to 84 year olds. Due to the nature of the New Zealand electoral roll which only includes year of birth and not date of birth, and the date of recruitment (May 2010), a number of participants aged aged less than 50 years were also included in the sample.

Table 2.

Characteristics of NZLSA weighted face to face study population compared to general population using census data from 2006.

	% NZLSA sample aged 48-84, N=1005	% General population (2006) aged 45-84, N=1,453,194,
Sex		
Male	45.6	47.6
Female	54.1	52.3
Age		
45-54	29.7	38.4
55-64	36.8	30.0
65-74	22.9	19.4
75-84	10.6	12.2
Primary Ethnic Group Affiliation		
Pakeha/New Zealander or European	86.2	71.1
Māori	7.6	7.6
Pacific Island	0.6	3.2
Asian	1.9	5.5
Other	3.7	12.6
Marital Status		
Married	63.4	59.9
Civil Union/De facto	6.9	-*
Same Sex Civil Union/De Facto	1.5	-*
Divorced/Separated	11.1	14.9
Widow or Widower	11.0	11.7
Single	5.7	7.2
Missing	-	6.3
Highest Qualification		
No Qualifications	17.4	37.2
Secondary School	22.4	27.9
Post-Secondary /trade	36.4	25.4
University Degree	22.1	10.0

*Data not available by age group

The current sample represents 0.05% of the total New Zealand population aged over 45 years. HWR and NZLSA over-sampled for Māori and a post-stratified weighting variable was calculated to account for known discrepancies between the sample and the population. Compared to the general population aged over 45, the current sample were more highly educated, under-sampled in the 45-54 age group and 75+ age group and had a greater proportion of people in the 55-64 and 65-74 age groups. Pacific Peoples and Asian ethnic groups were under represented.

Procedure

Face-to-face interviews were conducted nationwide with a voluntary subset of the 2010 postal survey responders (N=1005) who resided independently in the community. Participants were interviewed in their own home. Interviewers were given specific training in administering questionnaires and tests, with adherence to test manual instructions. The authors were not interviewers. Participants were re-interviewed and assessed in 2012 (N=875).

Materials

Participants completed the 'Kiwi' ACE-R as part of a battery of scales and items used in both face-to-face interviews. Other measures included questions relating to demographics, income and assets, future housing intentions, depression symptoms and anxiety symptoms. Interviews took around one hour to complete. For the purposes of the present study, only demographic and cognitive functioning measures are described.

Addenbrooke's Cognitive Examination Revised (ACE-R, Mioshi et al., 2006).

The ACE-R is a cognitive screening measure for dementia. It was developed originally in 2000 (Mathuranath, Nestor, Berrios, Rakowicz & Hodges., 2000), and revised in 2006 (Mioshi et al., 2006), as an improvement on the Mini Mental State Examination (MMSE, Folstein, Folstein & McHugh, 1975) with lower ceiling effects (expanding the points available), improved sensitivity, and assessment of more cognitive domains, particularly components for memory and frontal/executive functioning (Mathuranath et al., 2000). The ACE-R includes the MMSE within it, but has extra non-MMSE items which improve estimates of cognitive ability by 16% compared to the MMSE (Law, Connelly, Randall et al., 2012). The ACE-R was developed and normed in the United Kingdom and includes norms for clinical and non-clinical populations. The ACE-R has good psychometric properties, with very good internal consistency, (α=0.80) and significant concurrent validity, (as measured by the correlation coefficient between the ACE-R and the Clinical Dementia Rating Scale, -0.32). No significant age or education effect on scores were found (Mioshi et al., 2006).

The measure includes items assessing the cognitive domains of: attention and orientation (e.g., what is the date?), fluency (e.g., naming words beginning with F), language (e.g., writing sentences and repeating words), visual-spatial (e.g., copying a pentagon and drawing a clock face) and memory (e.g., short term, long term, anterograde and retrograde tasks). There are a total of 100 points available across the five domains and it takes 10-15 minutes to administer.

In the past decade the ACE-R has been cited as a potentially useful screening tool in guideline documents by the National Institute for Health and Clinical Excellence (2006). It has been used in one community-based longitudinal study, (Larner, 2009) with adults (aged 24 to 85 years) who were recruited from a cognitive function clinic in the United Kingdom. The ACE-R showed value in repeat testing over a 6-46 month period and was sensitive to cognitive decline, stability and improvement. It was deemed a good measure for cross-sectional and longitudinal assessment of cognitive disorders. Community norms have also been developed in a cross-sectional study with healthy adult volunteers (aged 50-85 years), residing in Brazil, (Amaral-Carvalho & Caramelli, 2012). The study found that years of education affected all ACE-R subs-cores and age influenced the verbal fluency sub-score and the ACE-R total score. Sex affected the attention and orientation and MMSE sub-scores, but not the ACE-R total score. These studies suggest that the Addenbrooke scale has potential use in large community based and longitudinal studies and that age, education and sex need to be considered in the analysis of results.

The ACE-R has been modified for use with New Zealanders, (the 'Kiwi' ACE-R; Taylor, 2008) and permission was obtained from the developers to use the modified version in the NZLSA face-to-face interviews. In accordance with suggestions from the developers, more site specific anterograde, retrograde and delayed recall memory components were modified to make the ACE-R more culturally acceptable. For example, using a New Zealand address in memory tasks and recalling the current New Zealand Prime Minister rather than the United States of America President. Other countries have followed these suggested guideline changes and have found little change to the psychometric properties of the measure (Alexopoulos, Mioshi, Greim & Kurz., 2007; Garcia-Caballero Garcia-Lado, Gonzalez-Hermida et al., 2006; Konstantinopoulou, Kosmidis, Kiosseoglou, Karacostas & Taskos, 2010). In the present study alternate versions were used in 2010 and 2012. The same cut-off scores are used as developed for the original ACE-R (82: sensitivity=0.84, specificity=1.00; and 88: sensitivity=0.94, specificity=0.98) (Mioshi et al., 2006).

Supplementary Cognitive Measures.

To allow for cross-country comparisons, further cognitive measures used in a large representative longitudinal study in the United States, the Health and Retirement Study (HRS), were included in the NZLSA face-to-face interviews in 2010. The questions include items from existing measures, the Wechsler Intelligence Scale-Revised (WAIS-R, Wechsler, 1981) and the Telephone Interview for Cognitive Status (TICS, Brandt, Spencer & Folstein, 1988). They include items that assess memory, (e.g., immediate, delayed and working), mental status, (e.g., knowledge, language and orientation), abstract reasoning, (e.g., similarities subtest), vocabulary, (e.g., definitions) and numeracy, (e.g., maths problems). Results from the HRS sample are publicly available and allow for cross-nation comparisons of cognitive ability on these items.

Results

Data Analyses

All statistical analyses were conducted using the Statistical Package for Social Sciences, SPSS (version 20.0, Chicago, IL). Pearson's correlations were used to assess the direction and strength between variables. Student T-tests and Analysis of Variance (ANOVA) were used to test for differences between groups, and where significant, post-hoc analyses were used to explore differences between sub groups. Effect sizes were calculated using η2 or Cohen's d.

'Kiwi' ACE-R scores.

Scores on the 'Kiwi' ACE-R ranged from 56-100 at Time 1. The mean was 93.65 and the standard deviation (SD) was 5.10. The total ACE-R score in this sample did not differ significantly from the original normed sample (M=93.7, SD=4.30), t (1066) = -0.07, p<0.94, or on any of the sub-domains. Table 3 shows a summary of the ACE-R total score and sub-domain scores at Time 1 and Time 2. There was a slight drop in mean ACE-R total scores between Time 1 and Time 2 and a paired sample t-test showed this change was significant, p<.001. Attention/orientation, memory and visual-spatial subscales also demonstrated significantly lower means at Time 2. Just over half those who were retested had a decrease in ACE-R score between waves (474, 54.4%), while 34% improved. Around a quarter of those whose scores declined (102) did so by only one point (23%). A further 250 (52.7%) declined between 2 and 5 points, 93 (20%) between 6 and 10 pints, and 23 participants (4.8%) declined by over 11 points. Comparing those who declined to those who stayed the same or improved, decliners were older (mean difference 1.24 years, p<.05) and were more likely to rate their memory as poorer now (2012) than it had been at Time 1 (p<.001).

Normality.

'Kiwi' ACE-R scores, for the current sample, approximate a normal distribution curve. The data was highly

Table 3.

'Kiwi' ACE-R Total and sub-domain scores (n=1005 at T1, n=875 at T2).

Domain (points available)		Min.	Max.	Mean(sd)	p
ACE-R total (100)	T1	56	100	93.65 (5.10)	<.001
	T2	52	100	92.15 (6.36)	
Attention/Orientation (18)	T1	12	18	17.85 (0.52)	<.05
	T2	13	18	17.76 (0.65)	
Memory (26)	T1	5	26	23.89 (2.46)	<.001
	T2	5	26	23.25 (3.05)	
Verbal Fluency (14)	T1	0	14	11.55 (2.06)	ns
	T2	0	14	11.38 (2.21)	
Language (26)	T1	14	26	24.95 (1.57)	ns
	T2	10	29	24.84 (1.74)	
Visual-spatial (16)	T1	10	16	15.39 (0.97)	<.001
	T2	8	16	14.91 (1.26)	

Reliability and validity.

The Chronbach's alpha measuring internal consistency was α = 0.70. Alpha was derived from totals of sub-domain items (n=26). Total 'Kiwi' ACE-R score correlated highly with all of the sub-domains; Pearson correlations are shown in Table 4.

Table 4.

Pearson's correlations (R) of the 'Kiwi' ACE-R total and sub-domain scores.

	'Kiwi' ACE-R	Attention/ Orientation	Memory	Verbal Fluency	Language	Visual-spatial
ACE-R	1	0.38**	0.77**	0.70**	0.71**	0.44**
Attention/ Orientation		1	0.21**	0.17**	0.28**	0.10**
Memory			1	0.28**	0.40**	0.19**
Verbal Fluency				1	0.35**	0.20**
Language					1	0.22**
Visual-spatial						1

** Correlation is significant at p<0.00

Concurrent validity was assessed through Pearson correlations with other cognitive tasks included in the interviews. Total 'Kiwi' ACE-R scores in this sample correlated significantly with most other cognitive tasks: MMSE (r=0.67, p<0.001) (embedded in the 'Kiwi' ACE-R), Free Recall (r=0.50, p<0.001) (TICS), Delayed Recall (r=0.52, p<0.001) (TICS), Numeracy (r= 0.37, p<0.001 (adapted from Lipkus, Samsa, and Rimer [2001], see Ofstedal et al., 2005 for more detail), Word Similarity (r=0.46, p<0.001) (WAIS-R) and Word Meaning (r=0.47, p<0.001) (WAIS-R). These results are suggestive of good concurrent validity. No other studies have researched the association of the 'Kiwi' ACE-R with non-dementia related cognitive scales. The correlation between Time 1 and Time 2 ACE-R total scores was r=.73, p<.001, suggesting good test-retest reliability.

Normative data stratified by significant demographic variables.

The 'Kiwi' ACE-R showed significant associations with the demographic variables, age, education, ethnicity and sex. Thus norms are provided for each of these demographic parameters.

Age. One way ANOVA showed a main effect for age on 'Kiwi' ACE-R scores, F (3, 951) = 36.58; p<.00, η2 =0.10, (medium effect). Post hoc comparisons using the Tamahane's 2 (unequal variances) test indicated that older age groups had significantly lower scores than younger age groups. The largest mean difference was -5.12 which was between the two age groups <55 and 75+. Significant differences between the age groups also occurred within the sub-domains when the age gap was at least ten years (except in the attention/orientation domain). The mean scores for the four different age groups are given in Table 5. Age remained significant when education, gender and ethnicity were controlled, [F (6, 932) = 33.13, p<.00, η2 = 0.17], suggesting it would be appropriate to provide norms by age group.

Education. Analysis of variance showed a significant main effect for education level on 'Kiwi' ACE-R score, F (3, 937) = 31.28, p=<.00, η2=0.09 (medium effect). Post hoc analyses using Tamahane's 2 (unequal variances) test showed that people with tertiary qualifications had significantly higher 'Kiwi' ACE-R scores (M= 95.3, SD=4.8) than all other levels of education; post-secondary/trade (M= 94.1, SD=4.3), secondary school (M=93.5, SD=4.6) and no qualifications (M= 90.0, SD=6.0). The largest mean difference was between tertiary and no qualifications (Mean difference= 4.64). No significant differences were found between post-secondary/trade qualifications and secondary school qualifications. When age, ethnicity and sex were controlled for education remained significant [F (6, 932) = 32.16, p<.00, η2= 0.17). Table 6 shows the mean and standard deviation for each education group, across 'Kiwi' ACE-R domains.

Table 5.
Weighted mean scores (standard deviation) on total 'Kiwi' ACE-R and 5 domain sub-scales across our age groups.

Age Group (confidence interval)	N [1]	'Kiwi' ACE-R	Attention/ Orientation	Memory	Verbal Fluency	Language	Visual-spatial
45-85	1001[2]	93.65 (5.10)	17.85 (0.52)	23.89 (2.46)	11.55 (2.06)	24.95 (1.57)	15.39 (0.97)
95 % CI		93.33-93.96	17.82-17.88	23.74-24.04	11.42-11.67	24.85-25.04	15.33- 15.45
<55	298	95.01 (4.02)	17.91 (0.35)	24.19 (2.10)	12.10 (1.84)	25.27 (1.31)	15.59 (0.83)
95% CI		94.53-95.48	17.87-17.95	23.91-24.39	11.89-12.30	25.10-25.40	15.48-15.67
55-64	368	94.42 (4.27)	17.87 (0.36)	24.30 (2.21)	11.70 (1.90)	25.11 (1.36)	15.50 (0.82)
95% CI		93.99-94.86	17.84-17.91	24.04-24.49	11.50-11.89	24.94-25.23	15.40-15.57
65-74	230	92.34 (6.04)	17.76 (0.81)	23.53 (2.81)	11.08 (2.27)	24.79 (1.55)	15.15 (1.14)
95% CI		91.55-93.12	17.65- 17.87	23.17- 23.89	10.79-11.39	24.56-25.98	15.02-15.32
75+	105	90.12 (5.67)	17.85 (0.38)	22.59 (2.81)	10.43 (1.96)	24.09 (2.02)	14.97 (1.19)
95% CI		89.03-91.21	17.77-17.93	22.14-23.22	10.06-10.86	23.75-24.49	14.76-15.22

[1] Weighted Ns
[2] Lower N is due to missing data for age group (i.e., data for participant age is missing for four participants).

Table **6:** Weighted means (standard deviations) for 'Kiwi' ACE-R score by highest qualification attained and by age group.

Education Level	N[1]	'Kiwi' ACE-R	Attention/ Orientation	Memory	Verbal Fluency	Language	Visual-spatial
No qualifications							
45-85	175	90.92 (6.13)	17.69 (0.71)	23.02 (2.95)	10.68 (2.21)	24.35 (2.05)	15.16 (1.21)
95% CI		90.01-91.83	17.58-17.80	22.58-23.46	10.35-11.01	24.04-24.65	14.98-15.34
<55	34	93.54 (5.74)	17.74 (0.61)	23.76 (2.05)	11.59 (2.29)	24.69 (2.35)	15.76 (0.43)
55-64	61	92.54 (1.56)	17.81 (0.46)	23.35 (3.19)	11.15 (1.59)	24.71 (1.46)	15.49 (0.89)
65-74	56	88.91 (6.63)	17.61 (0.95)	22.55 (3.01)	9.77 (2.58)	24.29 (1.85)	14.68 (0.19)
75+	23	88.05 (6.59)	17.56 (0.73)	22.26 (3.19)	10.19 (1.70)	23.52 (2.59)	14.49 (1.37)
Secondary school							
45-85	225	93.61 (4.97)	17.88 (0.37)	23.97 (2.45)	11.42 (2.02)	24.93 (1.75)	15.39 (0.92)
95% CI		92.96094.26	17.83-17.93	23.65-24.29	11.15-11.68	24.70-25.15	15.27-15.51
<55	69	93.54 (5.74)	17.91 (0.33)	24.82 (1.51)	11.81 (2.19)	25.35 (1.32)	15.59 (0.78)
55-64	78	92.98 (5.43)	17.85 (0.39)	23.90 (2.32)	11.18 (2.20)	24.64 (2.18)	15.36 (0.98)
65-74	57	93.65 (4.09)	17.87 (0.41)	23.83 (2.76)	11.57 (1.54)	25.06 (1.14)	15.31 (0.89)
75+	22	89.84 (5.50)	17.91 (0.28)	21.83 (3.07)	10.67 (1.68)	24.29 (2.23)	15.13 (1.11)
Post-secondary /trade							
45-85							
95% CI	336	94.15 (4.11)	17.90 (0.37)	24.11 (2.25)	11.64 (1.96)	25.07 (1.25)	15.41 (0.91)
		93.73-94.57	17.86-17.94	23.88-24.34	11.43-11.84	24.94-25.20	15.31-15.50
<55							
55-64	95	94.38 (4.11)	17.94 (0.22)	24.06 (2.55)	11.79 (1.52)	25.14 (1.32)	15.58 (0.67)
65-74	162	94.92 (3.52)	17.88 (0.40)	24.49 (1.84)	11.82 (1.91)	25.23 (1.08)	15.46 (0.79)
75+	74	93.38 (4.71)	17.87 (0.49)	23.86 (2.39)	11.39 (2.31)	24.97 (1.27)	15.26 (1.08)
	35	91.58 (4.17)	17.56 (0.73)	23.48 (2.60)	10.86 (2.24)	24.33 (1.54)	14.99 (1.33)
Tertiary							
45-85	222	95.55 (4.52)	17.86 (0.64)	24.32 (2.15)	12.42 (1.63)	25.36 (1.19)	15.57 (0.91)
95% CI		94.96-96.15	17.78-17.95	24.03-24.60	12.21-12.63	25.21-25.52	15.45-15.69
<55	101	95.73 (3.47)	17.92 (0.35)	24.06 (2.03)	12.74 (1.38)	25.48 (0.71)	15.50 (1.07)
55-64	68	96.54 (2.66)	17.90 (0.29)	24.90 (1.51)	12.45 (1.51)	25.59 (0.68)	15.68 (0.67)
65-74	41	93.34 (7.87)	17.60 (1.34)	23.92 (3.13)	11.67 (2.20)	24.63 (2.23)	15.50 (0.86)
75+	12	95.88 (3.16)	17.90 (0.30)	24.55 (1.64)	12.05 (1.21)	25.55 (0.67)	15.72 (0.71)

Ethnicity. Analysis of variance showed a significant main effect for ethnicity, $F (4, 952) = 3.33$, $p<.00$, $\eta2=0.01$ (small effect). When age, education and sex were controlled for this main effect increased in significance, [$F (7, 932) = 31.67$, $p<.00$, $\eta2= 0.19$]. Post-hoc Bonferroni analyses showed that New Zealand Europeans (M = 93.84 SD = 4.7) scored significantly higher than Māori (M=92.07, SD=6.29, mean difference = 1.77) and Pacific Peoples (M=87.6, SD=18.64, mean difference = 6.22). There were no significant differences between Māori and New Zealand European scores on the 'Kiwi' ACE-R domain scores. Table 7 shows the 'Kiwi' ACE-R mean scores (standard deviations) and 95% confidence intervals broken down by two ethnic groups (New Zealand European and Māori) and across the four different age groups. Sample sizes for other ethnic groups were too small to warrant subsample analysis (e.g., by age).

Gender. When examining the sample as a whole, there was a significant gender difference. A two-tailed t-test of independent means showed that females scored significantly higher on the ACE-R (M= 94.58, SD= 4.65), than males (M= 92.70, SD= 5.36), $t (944) = -5.91$, $p<.00$, $d= -0.37$ (medium effect). Levene's test indicated unequal variances ($F= 13.82$, $p=0.001$), so degrees of freedom were adjusted. This effect remained significant and increased when age, education and ethnicity were controlled for [$F (4, 932) = 46.40$, $p<.001$, $\eta2= 0.16$]. Women performed significantly better in the domains of fluency, language and memory and also were better at free recall and delayed recall of word lists. Table 8 shows the 'Kiwi' ACE-R means (standard deviations) and 95% confidence intervals for males and females for the sample as a whole and across the four age groups.

Explaining the variance.

Age, education, ethnicity (Māori and New Zealand European) and sex individually explained 9-19% of the variance in 'Kiwi' ACE-R score. When these variables were entered as predictors into a linear regression model, controlling for the covariance effects, together they explained 19.8% of the variance [F (4, 919) = 57.66, p<.00]. This suggests that there is a large interaction between the variables, [F (4, 870) = 2.53, p<.04].

Table **7.**

Weighted 'Kiwi' ACE-R and sub-domain means, (standard deviations) and 95% confidence intervals for New Zealand European and Māori by age group.

Age Group	N[1]	'Kiwi' ACE-R	Attention/ orientation	Memory	Verbal Fluency	Language	Visual-spatial
New Zealand European							
45-85	862	93.84 (4.73)	17.86 (0.47)	24.01 (2.25)	11.55 (2.03)	24.99 (1.48)	15.41 (0.95)
95% CI		93.53-94.1	17.84-17.89	23.86-24.16	11.41-11.68	24.89- 25.09	15.35-15.47
<55	247	95.45 (3.47)	17.93 (0.29)	24.32 (1.93)	12.14 (1.73)	25.38 (1.10)	15.62 (0.71)
55-64	315	94.6 (3.93)	17.87 (0.37)	24.38 (1.93)	11.69 (1.91)	25.12 (1.39)	15.52 (0.82)
65-74	202	92.5 (5.39)	17.78 (0.76)	23.67 (2.61)	11.13 (2.27)	24.82 (1.43)	15.21 (1.13)
75+	98	90.01 (5.55)	17.88 (0.32)	22.79 (2.66)	10.46 (2.05)	24.08 (1.94)	14.96 (1.20)
Māori							
45-85	76	92.07 (6.29)	17.77 (0.65)	23.22 (3.25)	11.50 (2.32)	24.52 (2.07)	15.48 (0.85)
95% CI		90.63-93.50	17.62-17.92	22.48- 23.96	10.53-11.58	24.05-24.99	15.29-15.68
<55	32	92.93 (6.4)	17.70 (0.69)	23.89 (2.22)	11.27 (2.48)	24.40 (2.44)	15.62 (0.57)
55-64	30	92.08 (6.48)	17.87 (0.46)	23.03 (4.02)	10.99 (2.13)	24.61 (1.82)	15.35 (1.00)
65-74	10	91.25 (4.78)	17.81 (0.75)	22.38 (3.00)	10.56 (2.31)	24.83 (1.52)	15.55 (0.88)
75+	4	89.29 (9.91)	17.50 (1.27)	21.49 (4.37)	11.05 (3.03)	24.04 (2.29)	15.19 (1.46)

[1] Weighted Ns

Table **8.**

Weighted means (standard deviations) and 95% confidence interval for 'Kiwi' ACE-R scores across sex and age group.

Age Group	N[1]	'Kiwi' ACE-R	Attention/ Orientation	Memory	Verbal Fluency	Language	Visual-spatial
Male							
45-85	475	92.69 (5.35)	17.86 (0.42)	23.41 (2.67)	11.21 (2.15)	24.78 (1.67)	15.41 (0.97)
95% CI		92.21-93.17	17.83-17.90	23.17-23.65	11.01-11.40	24.63-24.93	15.33-15.50
>55	134	93.49 (4.87)	17.88 (0.41)	23.52 (2.50)	11.74 (1.82)	24.79 (1.69)	15.54 (0.96)
55-64	177	93.67 (4.88)	17.88 (0.33)	23.93 (2.47)	11.33 (2.06)	24.95 (1.69)	15.56 (0.78)
65-74	117	92.24 (5.30)	17.81 (0.53)	23.35 (2.78)	10.92 (2.43)	24.90 (1.32)	15.24 (1.09)
75+	47	87.87 (5.92)	17.89 (0.41)	21.28 (2.63)	9.90 (1.96)	23.85 (2.03)	14.94 (1.16)
Female							
45-85	524	94.58 (4.64)	17.85 (0.58)	24.34 (2.15)	11.86 (1.93)	25.14 (1.38)	15.37 (0.97)
95% CI		94.18-94.97	17.80-17.90	24.16-24.53	11.69-12.02	25.02-25.26	15.29- 15.46
>55	164	96.24 (2.95)	17.93 (0.30)	24.67 (1.61)	12.39 (1.74)	25.63 (0.77)	15.61 (0.71)
55-64	191	95.12 (3.49)	17.87 (0.40)	24.57 (1.92)	12.02 (1.70)	25.22 (1.14)	15.42 (0.88)
65-74	111	92.57 (6.65)	17.71 (1.04)	23.76 (2.83)	11.28 (2.17)	24.69 (1.82)	15.12 (1.18)
75+	58	91.95 (4.78)	17.82 (0.43)	23.81 (2.44)	10.92 (2.04)	24.34 (1.84)	15.04 (1.23)

[1] Weighted Ns

Outliers.

Exploratory data analyses were conducted to identify outliers in the distributions of scores for the 'Kiwi' ACE-R. Statistical analysis of the sample was suggestive that participants who scored equal to, or less than 84 (N=50), were considered outliers (at or below the 5th percentile), suggesting an inability to understand instructions, difficulty with performance due to sensory or motor disorder, or cognitive decline due to degenerative neurological disorder. It is possible that the sample contained cases of undiagnosed mild cognitive impairment or early stage degenerative dementia. Compared to the sample that scored >84, the 5th percentile group were more likely to have no qualifications (40.2% vs. 16.2%), be male (63.7% vs. 46.5%) and older 75+, (29.4% vs. 9.5%). Māori participants made up 16.5% of the 5th percentile group compared to only 7.1% of the higher scoring group. Outliers were maintained in this data set as it is a normative sample, and as such, top and bottom scorers are included.

Cognitive Impairment.

Based on the lower suggested ACE-R cut-off score for cognitive impairment in the original development paper, (82: sensitivity = 0.84, specificity = 1.0), 33 people (3.29%) would be classified as cognitively impaired. Impairment generally increased across age groups. Percentage of participants that scored below the cut-off for each age group are: <55 (3.35%), 56-64 (1.35%), 65-74 (4.78%), 75+ (6.66%). Using a cut-off score of 76.5 (sensitivity 84.5% and specificity 79.6%), derived from a clinical group of older New Zealanders (aged 75 years +) (Strauss et al., 2012), 1.1% of this current community based nationwide sample would be classified as cognitively impaired. Using a more widely accepted cut-off for suspected dementia (>2 standard deviations below a standardized norm mean, ACE-R score of <83.2), then 4.2% of this sample may show signs of cognitive impairment (and possibly dementia). This latter prevalence rate is similar to other community samples such as the HRS study which estimated an impairment rate of 6% of those aged 70+ living in the community (Suthers et al., 2003). It is possible that the lower rate in this

New Zealand sample is an illustration of sampling from a variety of age groups as opposed to just over 70 year olds.

Discussion

The aim of this study was to assess cognitive functioning in older community dwelling New Zealanders and provide demographically stratified national norms for the 'Kiwi' ACE-R.

As expected, the 'Kiwi' ACE-R score was highly correlated with the MMSE and other measures of cognitive ability (comprehension, abstract reasoning and free/delayed memory recall). This suggests that the ACE-R shows good concurrent validity. The alpha coefficient for the 'Kiwi' ACE-R was acceptable based on the recommendation of alpha 0.70 (Chronbach, 1951). Other research using the ACE and the ACE-R report alpha levels ranging from 0.80-0.92 (Garcia-Caballero et al., 2006; Konstantinopoulou et al., 2010; Larner, 2007; Mathuranath et al., 2007; Mioshi et al., 2006) or are unknown, (Alexopoulos et al., 2007; Chade, Roca, Torralva et al., 2008; Jones, Franczak, & Antuono, 2008; Law, Connelly, Randall et al., 2012; Tarek & Gaber, 2008). It is possible that the current study had a lower alpha level compared to other research because the 'Kiwi' ACE-R was being used with a non-clinical sample, and therefore the items in the test created less variance and there was more chance of ceiling effects.

On a number of items all participants scored the maximum points available, (e.g., fragmented letters) or very high in domains, (e.g., 98% scored top points in the attention/orientation domain). This suggests that some items show ceiling effects and are not as good at differentiating between cognitively intact participants and cognitively impaired participants. This will likely impact evidence of cognitive improvement in future testing. For example, if participants score the highest possible points, any improvements that may occur in their cognitive functioning ability will not show within these items or sub-domains. The addition of more difficult items should be explored to address potential ceiling effects in non-clinical populations.

Results suggest that scores on the 'Kiwi' ACE-R do not significantly differ from the original normed control group (Mioshi et al., 2006). The original group were highly educated, (like the present sample) and had a similar mean age. Matching on these two domains likely increased the chances that scores would be similar. These scores suggest that this New Zealand community sample show similar cognitive functioning levels as the United Kingdom group and that the changes made to the 'Kiwi' ACE-R to make it more culturally acceptable did not affect the integrity of the assessment.

The finding that age impacts on 'Kiwi' ACE-R scores reflects previous research that shows cognitive ability declines with age (Albert, Jones, Savage et al., 1993; Christensen et al., 1999; Cullum, Huppert, McGee et al., 2000; Salthouse, 2002) and supports the use of 'Kiwi' ACE-R score age stratified norms (Mioshi et al., 2006). In the future it may be useful, (if sample size permits) to categorise the older age groups into smaller age ranges due to the increased heterogeneity in older age group samples on cognitive testing (Mungas, Beckett, Harvey et al., 2010).

The education effect on 'Kiwi' ACE-R score was significant in this study, showing that people with higher qualifications perform better on the 'Kiwi' ACE-R. Other studies have reported mixed results on the impact of education. In the original normed sample education had little effect on scores; however, the control sample was matched in age to the clinical samples which effectively controlled for educational level (Mioshi et al., 2006). In a Spanish validation study education was dichotomised into less than or greater than 14 years. Significantly different mean original ACE-R scores were found for the two groups and this prompted the development of different cut-off scores for impairment (Garcia-Caballero et al., 2006). Furthermore, a Malayan validation study found education level was the only demographic parameter that affected the original ACE and thus education-stratified cut-off scores were developed (Mathuranath et al., 2000). More recently, a study found that performance of healthy middle-aged and older individuals on the ACE-R was strongly influenced by education and, to a lesser extent, by age (Amaral-Carvalho & Caramelli, 2012). It is possible that the high level of education in the present sample enhanced participants' performances through greater familiarity and comfort with formal assessment, improved maintenance of cognitive skills (Cullum et al., 2000), delay of clinical symptoms (Tuokko, Frerichs, Graham et al., 2003) or provided a surrogate for environmental influences (Powell & Whitlia, 1994). The results in this study highlight the importance of using the qualification level stratified norms, particularly due to the large heterogeneity in education levels that is seen within the New Zealand population.

In this study ethnicity had an impact on 'Kiwi' ACE-R scores. Due to small numbers for a number of different ethnic groups, outliers tended to impact the mean scores quite significantly and thus only New Zealand European and Māori ethnicities were presented in norm groups.

It has been suggested that education and age may have been significant factors in accounting for cultural differences that have been found (Barker-Collo et al., 2002). For example, Barnfield and Leathem (1998) found that Māori performed lower on items that required formal Western education and concepts (e.g., verbal memory). As noted by, Rosselli & Ardila (2003) the effects of culture on neuropsychological assessment may be ameliorated by successful education within the educational system of the dominant culture. Analysis showed that differences on 'Kiwi' ACE-R scores between the two ethnicities were only significant in the no qualification group; New Zealand European ($M=91.48$, $SD=5.78$) scored significantly higher than Māori (87.71, $SD=7.17$) with a mean difference of 3.77 points. When age and education were controlled for in this study, significant differences in 'Kiwi' ACE-R score persist, suggesting that differences between Māori and New Zealand European 'Kiwi' ACE-R scores were present irrespective of education level (despite the difference only being significant in the no qualifications group) and age. Māori were over-represented in the no qualification category. Significant differences between Māori and New Zealand European groups with no qualifications were found in sub-domains of Language (comprehending instructions, repetition of a sentence, naming and language comprehension), Memory (3 item recall, anterograde and recall/recognition) and Fluency (animals).

Another study looking at ethnic differences in cognitive tests found that healthy Māori students with no qualifications (aged 16-30) perform significantly below similarly matched New Zealand Europeans in tasks of vocabulary, speed of comprehension, cognitive switching and immediate/delayed recall of contextual information (Ogden, Cooper, & Dudley, 2003). When looking at similar cognitive tasks in this study (vocabulary and immediate/delayed word lists), Māori performed significantly lower on these tasks as well (when education and age were controlled for).

There is very little research into why ethnic differences in performance on cognitive tasks occurs. It has been suggested that tasks involving Western concepts may be more difficult for Māori participants to score highly on (Barker-Collo, 2001; Barnfield & Leathem, 1998). While other researchers suggest that bilingual speakers produce greater variability in responses (Kohnert, Hernandez & Bates, 1998), potentially due to a difficulty in supressing activation of their first language (Hermans, Bongaerts, De Bot & Schreuder, 1998). In further assessments it may be beneficial to ascertain the primary language spoken of participants, but it is unlikely that in this sample Te Reo, (Māori language) was a common first language.

Despite the knowledge of cultural bias, most researchers acknowledge that test content and administration procedures are invariably culturally bound (Haitana, Pitama, & Rucklidge, 2010). Test developers acknowledge the need to consider the impact of test content, test materials and test conditions on the reliability and validity of a test in an attempt to minimise the effects of cultural bias. Ogden and McFarlane-Nathan (1997) and Shepherd and Leathem (1999) noted that Māori individuals may find clinical assessment environments particularly uncomfortable and thus perform at lower levels. Ultimately, these results illustrate the importance of using appropriate norms for different ethnic groups and ensuring participants feel as comfortable as possible in the testing environment (e.g., assessment in their own home).

Explanatory value can be given to the structural inequalities that exist between ethnicities within New Zealand. Given the multiple risk factors for poorer cognitive functioning, such as physical activity, lower education, (often a surrogate for environmental experiences that can impact on cognition, e.g., illness, health, socio-economic status and better access to medical care) and physical health (e.g., cardiovascular attacks increases risk of cognitive decline) it is plausible that ethnic disparities at a structural level can explain the differences shown in cognitive functioning performance.

Women performed significantly better on the ACE-R than men when controlling for other demographic variables. They also performed better in the domains of fluency, language and memory and were also better on free recall and delayed recall of word lists. Previous research has found significant but small gender differences in cognitive abilities in test situations. The literature indicates that women tend to perform better than men on learning and recall trials, and use semantic clustering strategies to aid retrieval more than males (Kramer, Delis, & Daniel, 2006). Men tend to have higher scores on spatial orientation tasks and women lower scores on episodic memory, perceptual speed, and digit span (Aartsen, Martin & Zimprich, 2004; Oksuzyan, Crimmins, Saito, O'Rand, Vaupel & Christensen, 2010).

Limitations

There are a number of limitations to this study which may impact on the interpretation of findings. One of the most well researched cognitive domains and one that is affected first by the consequences of ageing is processing speed (Salthouse, 1996). Unfortunately the ACE-R does not include this as a domain. This cognitive domain would need to be clinically judged based on the performance of the person and used as qualitative information or tested independently of the ACE-R.

A further limitation is the lack of participants from minority ethnicities such as Pacific Peoples and Asian groups. New Zealand is a multicultural and ageing society and as such cognitive screening tests will need to be developed appropriately to meet the anticipated demand for accurate assessment across different ethnic groups. There is a need to have studies that over-sample these groups in the future.

Although, significant differences were found on the ACE-R across demographic groups, the actual differences in scores were generally small (with the exception of age, particularly for those in the older age group). The clinical significance in some circumstances for such differences would possibly be negligible. However, the ACE-R is just one tool in the diagnosis of dementia or cognitive impairment used primarily as a screen for further investigation. Providing norms for this tool enables clinicians to compare those with difficulties rather than to diagnose.

The present study did not specifically assess subjective cognitive difficulties or whether participants had any existing diagnoses of cognitive impairment. This limits the research into participant's insight into difficulties, as well as the ability to control for cognitive impairment (subjective and objective) in this sample.

Future Directions

In 2012 it became illegal to use the ACE-R due to the recently copyrighted MMSE embedded within it and the ACE-R has since been withdrawn. The ACE-III (a version with no MMSE items) has been validated with total scores on the ACE-III highly correlated to the ACE-R, with similar sensitivity and specificity values for the same cut offs (Hsieh, Schubert, Hoon, Mioshi & Hodges, 2013). There is also a working group developing 'Kiwi' ACE-III. Once this is released a validation study could be instigated to examine any significant differences to 'Kiwi' ACE-R scores.

Due to the lack of a standardized definition of cognitive impairment (Busse, Bischkopf, Riedel-Heller, & Angermeyer, 2003; Petersen, Smith, Waring et al., 1999; Winblad, Palmer, Kivipetlo et al., 2004), rates of impairment are difficult to estimate in the community. As noted in the results section rates of cognitive impairment differ depending on what cut-off score on a particular test is assumed to be the most accurate in differentiating betwen intact cognitive functioning and impaired cognitive functioning. The large variability in options for cut-off scores for the ACE-R suggests that more research is needed to identify and validate appropriate cut-off scores for the ACE-III in New Zealand clinical and community populations.

Conclusion

The data presented in this study provides a basis for interpreting scores from older people assessed with the 'Kiwi' ACE-R. This study confirmed the usefulness and acceptability of this measure in New Zealand and also highlighted the need for specific Māori and New Zealand European norms. The representative, population based sample of older New Zealanders allows for the monitoring of cognition in older adults and provides appropriate reference for comparison. Furthermore, the inclusion of ethnically stratified scores is the first known attempt at providing an appropriate comparison point for older Māori New Zealanders. This research has highlighted the need for different norms for cognitive assessment tools amongst ethnicities, education levels, gender and age groups in New Zealand.

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