Age stratified normative data for Māori on the Wechsler Adult Intelligence Scale (4th edition; WAIS-IV)

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Culture impacts neuropsychological test performance. This has been shown to be the case for Māori, the Indigenous people of New Zealand. The current study presents normative data that reflects a normative level of performance for a Māori population on the Wechsler Adult Intelligence Scale (4th edition; WAIS-IV). Participants were 284 neurologically healthy adults who self-identified as Māori, stratified across gender and seven age ranges, were recruited from seven different areas of the North and South Islands of New Zealand and were representative of the main Māori iwi/tribes. They were administered the WAIS-IV according to standard criteria. Normative data are presented across subtests for each of the seven age ranges. Normative data are not presented by gender as an ANVOA indicates few significant differences by gender.

Keywords: *Māori, neuropsychology, assessment, normative data, Wechsler Adult Intelligence Scale*

INTRODUCTION

It is now widely acknowledged that culture impacts neuropsychological test performance (Ardila, 2007; Franzen et al., 2021; Pedraza & Mungas, 2008; Uzzellet al., 2013). Individuals from culturally and linguistically diverse backgrounds may be disadvantaged on neuropsychological tests, which are predominantly developed in western countries. This is of relevance in an Aotearoa (New Zealand) context where disparities are already evident in the incidence and health outcomes of neurological conditions for Māori, the Indigenous people of Aotearoa.

For example, the average age of stroke onset for Māori is 61 years, compared to 64 years for Pasifika people and over 75 years for Pākehā (European New Zealanders (Feigin et al., 2006). There is also some evidence that the chance of being dependent at 12 months post-stroke is three times higher for Māori compared to Pākehā (McNaughton et al., 2002; Ministry of Health, 2003). Furthermore, for traumatic brain injury (TBI), compared with Pākehā, Māori have a greater risk of mild TBI (RR 1.23, 95% TBI (RR 1·23, 95% CI 1·08 -1·39), accounting for 31% of all TBIs despite comprising only 16.5% of the population (NZ Statistics, 2018).

These disparities persist despite the Ministry of Health's commitment to fulfil the special relationship between Māori and the Crown under Te Tiriti o Waitangi (Ministry of Health CO, 2019). This commitment demands response to the widespread and ongoing impact of colonisation that deeply harms Māori and continues to negatively affect the health of Māori (Ministry of Health, 2019).

Neuropsychological testing is commonly administered to individuals who have experienced brain injury as part of their assessment and treatment plan. However, neuropsychological tests that are widely used in Aotearoa have almost entirely been developed in either the United States or the United Kingdom and, as such, the test developers, the test content, and the standardised data that accompany the tests reflect a western worldview and tend to disadvantage individuals who diverge from a western cultural background (Manly, 2005; Tan et al., 2021). Only a few studies have investigated the cultural bias in neuropsychological measures when applied to Māori (Dudley et al., 2017; Ogden et al., 2003; Ogden & McFarlane-Nathan, 1997; Shepherd, & Leathem, 1999; Zawaly, et al., 2019), with only one study adopting a Kaupapa Māori Methods approach (Haitana et al., 2010). Collectively, these studies provide cumulative evidence of test bias in neuropsychological testing when assessing Māori.

Test bias can manifest in several ways including, but not limited to, construct bias, method bias and item bias. Construct bias is present when the concept being measured is not equivalent across cultural groups. Method bias occurs when variations in responses are caused by the instrument rather than the actual predispositions of the respondents that the instrument is attempting to uncover, and item bias is the presence of some characteristic of an item that results in differential performance for individuals of the same ability but from different ethnic, sex, cultural, or religious groups. (Fernández, & Abe, 2018; Pedraza, 2020; van de Vijver, & Tanzer, 2004).).

Anastasi and Urbina (1997) also argue that all neuropsychological tests and accompanying normative data favour people from the same culture as the test

developers and so, to conduct an unbiased assessment, it is important that normative data is appropriate for the client assessed. In Aotearoa, a survey of psychologists and neuropsychologists was conducted to determine which factors influence test selection (Ross-McAlpine et al., 2018), As well as the primary question 66% of the sample also voiced concerns about the cultural sensitivity of some tests and thought that New Zealand normative data was needed (Ross-McAlpine et al., 2018).

Extant research suggests that Māori perform better on measures that have been adapted to include content that is familiar to them. For example, Ogden and McFarlane (1997), and Ogden et al. (2003) found that the performance of the Māori participants improved when the test items were adapted to reflect a Māori world view. Conversely, in their evaluation of the Peabody Picture Vocabulary Test-111 with Māori children, Haitana et al. (2010), found that some of the variance in the overall lower performance of Māori children was due to a lack of exposure to English words by those who attended Māori-medium schools. Familiarity with test content has been identified by cross-cultural neuropsychologists as an advantage with test takers (Manly, 2005).

Ogden and McFarlane (1997) also found that when responding to the Vocabulary subtest of the WAIS-R, the Māori males in their study provided answers that differed from the standard scoring criteria as prescribed in the WAIS-R manual, and therefore, received no points despite their answers being familiar to them and arguably 'correct' in their vernacular. These authors also found cultural differences in the perceived level of difficulty of certain stimuli, suggesting that knowledge that is standard or valued by Māori, may differ from conventional material against which they were being evaluated.

In addition to test content being a source of bias, evidence also shows that the neuropsychological process itself can impact on the performance of individuals who belong to ethnic minority groups (Brickman, et al., 2006). Factors such as the assessment setting, having a culturally matched assessor, the cultural competence of the clinician, the attitude of the examinee toward tests, as well as heightened anxiety of the person being assessed may have an influence on performance. Studies conducted in Aotearoa with Māori report similar findings (Dudley et al 2019; Ogden & McFarlane, 1997; Ogden et al. 2003; Shepherd & Leathem, 1999).

In the international literature methodologies to improve the reliability and validity of neuropsychological measures when used in diverse populations have been suggested by various cross-cultural neuropsychologists and include but are not limited to; the modification or discontinuation of tests that are not salient or relevant to a particular culture or language; to construct tests which are more culture fair and salient to diverse cultural groups, or; obtain local normative data appropriate for specific groups; Feigin and Barker-Collo (2007) have argued for some years for local normative data in Aotearoa. The current study has chosen to address the existing situation by obtaining data that reflects a normative level of performance for a Māori population on the Wechsler Adult Intelligence Scale subtests (Wechsler, 2008).

The WAIS-IV was selected as the focus of this research as it is the most widely used neuropsychological measure for assessing cognitive functioning in adults 16 years and older, in Aotearoa. However, the standardised normative data that accompanies the WAIS-IV were derived from an American population and are the yardstick to which Māori who undergo this assessment are compared. Our previous publication (Dudley et al., 2019) provides means and standard deviations stratified for age and gender in a Maori sample for this measure. The study found that variables such as income and education may be factors that impact the performance of Māori although gender was not found to impact performance. The present study builds upon these previous findings by presenting normative conversion tables which allow clinicians to convert raw scores to their scaled score equivalents for each WAIS-IV subtest for each age range.

METHOD

This study aligned with some of the domains and criteria provided by the CONSIDER statement for the reporting of research that aims to strengthen Indigenous health research and advance Indigenous health outcomes and development (Huria et al., 2019). A Māori-centred approach was adopted for this study in that the whole sample which was comprised of participants who identified as Māori, were administered an assessment tool from a western knowledge base. The data were analysed using the SPSS Data Analysis Software.

Participants

Participants were 284 neurologically healthy adults who self-identified as Māori. Potential participants were screened for conditions such as major depressive disorder that could possibly affect cognitive test performance. Exclusion criteria were the same as those used for the WAIS-IV standardisation sample (refer to the WAIS-IV Technical and Interpretive Manual). Participation in the study was voluntary and participants provided written consent. All participants spoke English fluently, which reflected the findings of the New Zealand census whereby 96.1% of the Aotearoa population are English fluent (Statistics New Zealand, 2013). The sample was stratified for gender and grouped into seven age brackets (16-20 years, 21-30 years, 31-40 years, 41-50 years, 51-60 years, 61-70 years, 70+ years). The age range was from 16 years to 90 years (M = 45.40, SD = 19.84). Years of education was grouped to approximate grades of the Aotearoa education system with most of the sample having completed some high school or obtained a tertiary qualification.

Recruitment occurred across seven locations throughout the North and South islands of Aotearoa to maximise representation of the major iwi (tribes) throughout the country. Those iwi included: Ngāpuhi, Te Rarawa, Te Aupōuri, Ngāti Kūri, Ngāti Hine, Ngāti Whātua, Tainui, Tuhoe, Ngāti Maniapoto, Ngāti Tūwharetoa, Ngāti Porou, Whānau-ā-Apanui, Ngāti Kahungungu, Ngai Tahu, Te Arawa, Ngāti Awa, Te Ati Haunui-ā-Pāpārangi, Ngāti Raukawa, and Ngāti Tama. Most of the sample affiliated to one iwi (66%), whilst

22% identified with 2 iwi, 7% with 3 iwi, and 5% with 4 or more iwi. The number of participants recruited from the North and South Islands were proportionate to the total Māori population for each island as indicated in the New Zealand 2013 Census (i.e., 90% of Māori live in the North Island; (Statistics New Zealand, 2013). A summary of the demographic data is presented in Table 1.

Table 1. Characteristics of the sample

Characteristic	N (total = 284)	%
Gender		
Male	140	49.3
Female	144	50.7
Age (years)		
16-20	40	14.1
21-30	41	14.4
31-40	43	15.1
41-50	40	14.1
51-60	40	14.1
61-70	40	14.1
71+	40	14.1
Education Years (completed)		
≤5 (primary school)	5	1.8
6-7 (intermediate school)	12	4.2
8-12 (high school)	137	48.2
≥ 13 (tertiary)	130	45.8
Household Income		
$0 - $10,000	32	11.3
$11,000 - $20,000	77	27.1
$21,000 - $30,000	46	16.2
$31,000 - $40,000	28	9.9
$41,000 - $50,000	33	11.6
$51,000 - $60,000	5	1.8
$61,000 - $70,000	23	8.1
$71,000 +	40	14.1

The Wechsler Adult Intelligence Scale-IV

The WAIS-IV (Wechsler, 2008) is a battery of tasks assessing various aspects of cognition. The battery contains 15 subtests, with raw scores on each subtest converted to scaled scores using normative data tables. Each subtest scaled score has a mean of 10 and standard deviation of 3.

Ten of the 15 subtests produce composite scores: Full Scale IQ (FSIQ), Verbal Comprehension Index (VCI), Perceptual Reasoning Index (PRI), Working Memory Index (WMI), and Processing Speed Index (PSI) based on age-corrected scaled scores. All 15 subtests were administered and scored in accordance with standardised procedures. The WAIS-IV Index/IQ are often described qualitatively that characterises the examinee's level of composite score performance relative to same-age peers. Qualitative ranges include: 130 and above = Very Superior, 120 - 129 = Superior, 110 – 119 = High Average, 90 – 109 = Average, 75 – 89 = Low Average, 70 – 79 = Borderline, 69 and below = Extremely Low (WAIS-IV Technical and Interpretive Manual, p 126).

Procedure

The study was approved by the Auckland University of Technology Ethics Committee. Flyers outlining the study were distributed at universities and Māori health clinics throughout Aotearoa. The study was advertised on Māori radio stations and live presentations were delivered to Māori community groups at all seven recruitment sites. Recruitment, however, was also achieved through whakawhanaungatanga (connections) utilising the researchers' extensive networks within the Māori community. Recruitment was completed over a period of 18 months.

Once someone was identified as a possible participant, they were contacted by phone or face-to-face to ascertain their eligibility for the study. Those who met eligibility criteria and who provided verbal consent were then scheduled a time and place to conduct the assessment. Each participant was given a choice to hold the assessment at their home or another place of their choice such as their marae (Iwi meeting house), or at a Māori-friendly hauora organisation such as the Ahipara Medical Clinic in Te Tai Tokerau, and He Waka Tapu in Ōtautahi, or a Māori-friendly research clinic such as Te Atawhai Ō Te Ao in Wanganui. Tikanga guided the interview. Karakia (prayer), pepeha (introductions), whanaungatanga (the process of making connections) and kai (food) were all protocols that were observed. Te Reo Māori (the Māori language) was spoken when appropriate. The Participant Information Sheet was read through with the participant to clarify areas of uncertainty and to provide the participant with the opportunity to ask pātai (questions). Those who wished to continue with the interview provided written informed consent. Most administrations took place in a Māori-friendly research clinic (Māori NGO office; n = 224) office workplaces (n = 7), mainstream health clinics (n = 9), marae (n = 3), or at the participant's home (n = 37). All administrative settings conformed to the guidelines for physical environment as stated in the WAIS-IV, Administration and Scoring Manual.

All measures were administered by either the first author who is Māori or a Māori research assistant who held a background in health at a tertiary level. The research assistants were extensively trained in the administration of the WAIS-IV. The time taken to complete the assessment ranged from 2½ hours to 4 hours. Participants were informed they could break for a rest whenever they felt they needed to. Once the WAIS-IV had been administered and completed each participant was thanked and given a koha (gift) as a token of appreciation for their participation.

Quality assurance measures adopted included contacting random participants by phone and enquiring about their experience and to determine if they had made their best effort. Random checks of 10% of participant score sheets were also conducted to ensure accuracy of scoring and of data entry.

Means and standard deviations were generated for each subtest and each age range. Normative data tables were then generated for each age range which allows conversion of raw scores on each subtest to scaled scores with a mean of 10 and standard deviation of 3.

The privacy of the participants was maintained by the de-identification of their individual score sheets which was replaced with a code. The data was entered onto a password protected spreadsheet which was accessible only to the researchers involved in the study.

RESULTS

Table 2 presents raw score means and standard deviations for each age range on each of the 15 WAIS-

IV subtests. A one-way ANOVA with gender as the grouping variable and raw score performance on each of the WAIS-IV subtests indicated that significant between group differences were present for only two subtests, both from the Processing Speed Index (i.e., Digit Symbol, Coding and Symbol Search), with males producing better performances. As such, the normative data are presented here by age range, but not separately by gender.

Tables 3 through 9 present conversion tables, which can be used to convert raw scores on WAIS-IV subtest to scaled scores with a mean of 10 and standard deviation of 3. Each table presents data for a different age range. Norms were calculated for each age range and each subtest separately using the mean score and standard deviation of that score and then fitting the data to a normal distribution. For ease of clinical application, the format of the tables has been designed to replicate those currently used by clinicians from the WAIS-IV manual.

Table 2. Means and standard deviations of raw scores for each subtest across age groups

		16-20 years	21-30 years	31-40 years	41-50 years	51-60 years	61-70 years	71+ years
Block Design	Mean	48.5	49.98	47.47	47.05	39.33	34.45	30.65
	SD	9.89	9.31	8.96	9.33	8.81	9.00	10.55
Similarities	Mean	22.63	23.54	25.42	25.88	25,53	23.38	22.45
	SD	3.85	5.84	4.12	4.01	5.22	3.99	4.50
Digit span	Mean	29.3	29.73	30.28	30.35	28.55	26.35	23.55
	SD	4.76	4.18	5.50	5.01	4.35	4.43	4.43
Matrix Reasoning	Mean	19.08	18.88	16.98	18.20	14.53	12.30	10.95
	SD	3.87	3.78	4.94	4.11	4.90	4.63	4.48
Vocabulary	Mean	24.56	30.20	35.93	38.20	39.80	35.28	33.20
	SD	8.35	11.35	9.29	8.91	8.83	10.16	11.59
Arithmetic	Mean	12.48	13.83	13.70	14.83	14.15	12.83	11.33
	SD	3.26	3.41	3.59	3.62	3.14	2.74	2.93
Symbol Search	Mean	36.78	39.71	33.67	34.68	30.45	26.45	22.58
	SD	7.61	10.24	8.45	7.52	7.62	7.50	6.78
Visual Puzzles	Mean	17.78	17.63	16.86	16.48	14.18	11.78	9.58
	SD	3.83	3.99	4.46	4.64	4.31	4.06	3.19
Information	Mean	9.65	12.24	13.56	14.78	15.35	12.68	11.48
	SD	3.79	4.77	4.87	4.39	4.82	4.42	5.69
Coding	Mean	66.65	87.63	62.70	64.05	58.58	49.60	42.33
	SD	15.88	9.91	16.77	17.51	14.29	14.32	15.72
Letter-number sequencing	Mean	20.25	20.83	20.77	20.45	19.68	18.33	n/a
	SD	2.48	2.55	2.84	2.42	2.07	3.40	
Figure Weights	Mean	17.08	16.85	14.65	14.95	13.28	9.93	n/a
	SD	5.65	4.53	4.08	4.59	4.49	4.17	
Comprehension	Mean	21.18	21.85	24.98	24.48	25.65	22.10	19.65
	SD	5.23	5.82	4.25	5.72	4.73	5.67	5.96
Cancellation	Mean	39.48	39.71	37.02	37.08	34.62	28.90	n/a
	SD	9.97	8.93	11.29	10.30	9.65	9.09	
Picture Completion	Mean	14.10	14.59	13.91	15.18	12.90	11.15	9.45
	SD	3.28	3.09	3.05	3.15	3.37	3.89	3.52

Table 3. Raw scores with their standard score and z-score equivalents. Age group 1 (16 to 20 years)

Score:	Z	BD	Sim	DS	MR	Voc	Ari	SS	VP	Inf	CD	LNS	FW	Com	Canc	PC
Scaled								Raw Score								
1	-3.00	18.83	11.08	15.02	7.47	-	2.62	13.95	6.29	-	19.01	12.81	.13	5.49	9.57	4.26
2	-2.67	22.10	12.36	16.6	8.75	2.27	3.78	16.47	7.56	-	24.17	13.63	2.0	7.22	12.87	5.35
3	-2.33	25.46	13.66	18.21	10.07	5.11	4.89	19.05	8.86	0.82	29.65	14.48	3.92	9.0	16.25	6.46
4	-2.00	28.72	14.94	19.78	11.34	7.86	5.96	21.56	10.12	2.07	34.89	15.29	5.78	10.72	19.54	7.54
5	-1.67	31.99	16.21	21.36	12.62	10.67	7.04	24.08	11.39	3.33	40.14	16.11	7.65	12.45	22.84	8.63
6	-1.33	35.35	17.51	22.97	13.94	13.46	8.15	26.66	12.69	4.61	45.44	16.96	9.57	14.23	26.22	9.74
7	-1.00	38.61	18.78	24.54	15.21	16.21	9.22	29.17	13.95	5.86	50.77	17.77	11.43	15.95	29.51	10.82
8	-0.67	41.88	20.06	26.12	16.49	18.97	10.3	31.69	15.22	7.12	56.02	18.59	13.3	17.68	32.81	11.91
9	-0.33	45.24	21.36	27.73	17.81	21.81	11.41	34.27	16.52	8.4	61.41	19.44	15.22	19.46	36.19	13.02
10	0	48.50	22.63	29.30	19.08	24.56	12.48	36.78	17.78	9.65	66.65	20.25	17.08	21.18	39.48	14.10
11	+0.33	51.76	23.9	30.87	20.35	27.31	13.55	39.29	19.04	10.9	71.89	21.06	18.94	22.9	42.77	15.18
12	+0.67	55.12	25.2	32.48	21.67	30.15	14.66	41.87	20.34	12.18	77.28	21.91	20.86	24.68	46.15	16.29
13	+1.00	58.39	26.48	34.06	22.95	32.91	15.74	44.39	21.61	13.44	82.53	22.73	22.73	26.41	49.45	17.38
14	+1.33	61.65	27.75	35.63	24.22	35.66	16.81	46.9	22.87	14.69	87.77	23.54	24.59	28.13	52.74	18.46
15	+1.67	65.01	29.05	37.24	25.54	38.5	17.92	49.48	24.17	15.97	93.16	24.39	24.59	28.13	56.12	19.57
16	+2.00	68.28	30.33	38.82	26.82	41.26	19.0	52.0	25.44	17.23	98.41	25.21	28.38	31.64	59.42	20.66
17	+2.33	-	31.6	40.39	-	44.01	20.07	54.51	26.7	18.48	103.65	26.02	-	33.36	62.73	21.74
18	+2.67	-	32.9	42.00	-	46.85	21.18	57.09	-	19.76	109.04	26.87	-	35.14	66.12	22.85
19	+3.00	-	34.18	43.58	-	49.61	22.26	59.61	-	21.02	114.29	27.69	-	36.87	69.39	23.94

Note: In scoring an individual select the raw score closest to that of the individual. Numbers in *italics* are scores above the maximum possible raw total score for a subtest.

Table 4. Raw scores with their standard score and z-score equivalents. Age group 2 (21 to 30 years, inclusive)

Score:	Z	BD	Sim	DS	MR	Voc	Ari	SS	VP	Inf	CD	LNS	FW	Com	Canc	PC
Scaled								Raw Score								
1	-3.00	22.05	6.02	17.19	7.54	-	3.6	8.99	5.66	-	57.9	13.18	3.26	4.39	12.92	5.32
2	-2.67	25.12	7.95	18.57	8.78	-	4.73	12.37	6.98	-	61.17	14.02	4.75	6.31	15.87	6.34
3	-2.33	28.29	9.93	19.99	10.07	3.75	5.88	15.85	8.33	-	64.54	14.89	6.30	8.29	18.90	7.39
4	-2.00	31.36	11.86	21.37	11.32	7.5	7.01	19.23	9.65	2.7	67.81	15.73	7.79	10.21	21.85	8.41
5	-1.67	34.43	13.79	22.75	12.57	11.25	8.14	22.61	10.97	4.27	71.08	16.57	9.28	12.13	24.80	9.43
6	-1.33	37.60	15.77	24.17	13.85	15.10	9.29	26.09	12.32	5.90	74.45	17.44	10.83	14.11	27.83	10.48
7	-1.00	40.67	17.7	25.55	15.1	18.85	10.42	29.47	13.64	7.47	77.72	18.28	12.32	16.03	30.78	11.5
8	-0.67	43.74	19.63	26.93	16.35	22.60	11.55	32.85	14.96	9.04	80.99	19.12	13.81	17.95	33.73	12.52
9	-0.33	46.91	21.61	28.35	17.63	26.46	12.70	36.33	16.31	10.67	84.36	19.99	15.36	19.93	36.76	13.57
10	0	49.98	23.54	29.73	18.88	30.2	13.83	39.71	17.63	12.24	87.63	20.83	16.85	21.85	39.71	14.59
11	+0.33	53.05	25.47	31.10	20.13	33.95	14.95	43.09	18.95	13.81	90.9	21.67	18.35	23.77	42.66	15.61
12	+0.67	56.22	27.45	32.53	21.41	37.81	16.11	46.57	20.30	15.44	94.27	22.54	19.89	25.75	45.69	16.66
13	+1.00	59.29	29.38	33.91	22.66	41.55	17.24	49.95	21.62	17.01	97.54	23.38	21.38	27.67	48.69	17.69
14	+1.33	62.36	31.31	35.29	23.91	45.30	18.37	53.33	22.94	18.58	100.81	24.22	22.87	29.59	51.59	18.70
15	+1.67	65.53	33.29	36.71	25.19	49.15	19.52	56.81	24.29	20.21	104.18	25.09	24.42	31.57	54.62	19.75
16	+2.00	68.6	35.22	38.09	26.44	52.9	20.65	60.19	25.61	21.78	107.45	25.93	25.91	33.49	57.57	20.77
17	+2.33	-	37.15	39.47	-	56.65	21.78	-	26.93	23.35	110.72	26.77	27.40	35.41	60.52	21.79
18	+2.67	-	-	40.89	-	60.5	22.93	-	-	24.98	114.09	27.64	-	37.39	63.55	22.84
19	+3.00	-	-	42.27	-	-	-	-	-	26.55	117.36	28.48	-	-	66.5	23.86

Note: In scoring an individual select the raw score closest to that of the individual. Numbers in *italics* are scores above the maximum possible raw total score for a subtest.

Table 5. Raw scores with their standard score and z-score equivalents. Age group 3 (31 to 40 years, inclusive)

Score: Scaled	z	BD	Sim	DS	MR	Voc	Ari	SS	VP	Inf	CD	LNS	FW	Com	Canc	PC
								Raw Score								
1	-3.00	20.59	13.06	13.78	2.16	8.06	2.93	8.32	3.48	-	12.39	12.25	2.41	12.23	3.15	4.76
2	-2.67	23.55	14.42	15.60	3.79	11.13	4.11	11.11	4.95	.56	17.92	13.19	3.76	13.63	6.88	5.77
3	-2.33	26.59	15.82	17.47	5.47	14.28	5.34	13.98	6.47	2.21	23.63	14.15	5.14	15.08	10.71	6.80
4	-2.00	29.55	17.18	19.28	7.1	17.35	6.52	16.77	7.94	3.82	29.16	15.09	6.49	16.48	14.44	7.81
5	-1.67	32.51	18.54	21.10	8.73	20.42	7.70	19.56	9.41	5.43	34.69	16.03	7.84	17.88	18.17	8.82
6	-1.33	35.55	19.94	22.97	10.41	23.57	8.93	22.43	10.93	7.08	40.40	16.99	9.22	19.33	22.00	9.85
7	-1.00	38.51	21.3	24.78	12.04	26.64	10.11	25.22	12.4	8.69	45.93	17.93	10.57	20.73	25.73	10.86
8	-0.67	41.47	22.66	26.6	13.67	29.71	11.29	28.01	13.87	10.3	51.46	18.87	11.92	22.13	29.46	11.87
9	-0.33	44.51	24.06	28.47	15.35	32.86	12.52	30.88	15.39	11.95	57.17	19.83	13.30	23.58	33.29	12.90
10	0	47.47	25.42	30.28	16.98	35.93	13.7	33.67	16.86	13.56	62.7	20.77	14.65	24.98	37.02	13.91
11	+0.33	50.43	26.78	32.10	18.61	39.0	14.88	36.46	18.33	15.17	68.23	21.71	16.0	26.38	40.75	14.92
12	+0.67	53.47	28.18	33.97	20.29	42.15	16.11	39.33	19.85	16.82	73.94	22.67	17.38	27.83	44.58	15.95
13	+1.00	56.43	29.54	35.78	21.92	45.22	17.29	42.12	21.32	18.43	79.47	23.61	18.73	29.23	48.31	16.96
14	+1.33	59.39	30.90	37.60	23.55	48.29	18.47	44.91	22.79	20.04	85.00	24.55	20.08	30.63	52.04	17.97
15	+1.67	62.43	32.30	39.47	25.23	51.44	19.70	47.67	24.3	21.69	90.71	25.51	21.46	32.08	55.87	19.00
16	+2.00	65.39	33.66	41.28	26.86	54.51	20.88	50.57	25.78	23.3	96.24	26.45	22.81	33.48	59.6	20.01
17	+2.33	68.35	35.02	43.10	-	*57.58*	22.06	53.36	27.25	24.91	101.77	27.39	24.16	34.88	63.33	21.02
18	+2.67	-	36.42	44.97	-	-	-	56.23	-	26.56	107.48	28.35	25.54	36.32	67.16	22.05
19	+3.00	-	-	46.78	-	-	-	59.02	-	-	113.01	29.29	26.89	-	70.89	23.06

Note: In scoring an individual select the raw score closest to that of the individual. Numbers in *italics* are scores above the maximum possible raw total score for a subtest.

Table 6. Raw scores with their standard score and z-score equivalents. Age group 4 (41 to 50 years, inclusive)

Score: Scaled	z	BD	Sim	DS	MR	Voc	Ari	SS	VP	Inf	CD	LNS	FW	Com	Canc	PC
								Raw Score								
1	-3.00	19.06	13.85	15.32	5.87	11.47	3.97	12.12	2.56	1.61	11.52	13.19	1.18	7.32	6.18	5.73
2	-2.67	22.14	15.17	16.97	7.23	14.41	5.16	14.60	4.09	3.06	17.30	13.99	2.69	9.21	9.58	6.77
3	-2.33	25.31	16.54	18.68	8.62	17.44	6.4	17.16	5.67	4.55	23.25	14.81	4.26	11.15	13.08	7.84
4	-2.00	28.39	17.86	20.33	9.98	20.38	7.59	19.64	7.2	6.0	29.03	15.61	5.77	13.04	16.48	8.88
5	-1.67	31.47	19.18	21.98	11.34	23.32	8.78	22.12	8.73	7.45	34.81	16.41	7.28	14.93	19.88	9.92
6	-1.33	34.64	20.55	23.69	12.73	26.35	10.02	24.68	10.31	8.94	40.76	17.23	8.85	16.87	23.38	10.99
7	-1.00	37.72	21.87	25.34	14.09	29.29	11.21	27.16	11.84	10.39	46.54	18.03	10.36	18.76	26.78	12.03
8	-0.67	40.80	23.19	26.99	15.45	32.23	12.40	29.64	13.37	11.84	52.32	18.83	11.87	20.65	30.18	13.07
9	-0.33	43.97	24.56	28.7	16.84	35.26	13.64	32.2	14.95	13.33	58.27	19.65	13.44	22.59	33.68	14.14
10	0	47.05	25.88	30.35	18.2	38.2	14.83	34.68	16.48	14.78	64.05	20.45	14.95	24.48	37.08	15.18
11	+0.33	50.13	27.20	32.00	19.56	41.14	16.02	37.16	18.01	16.23	69.83	21.25	16.46	26.37	40.48	16.22
12	+0.67	53.30	28.57	33.71	20.95	44.17	17.26	39.72	19.59	17.72	75.78	22.07	18.03	28.31	43.98	17.29
13	+1.00	56.38	29.89	35.36	22.31	47.11	18.45	42.2	21.12	19.17	81.56	22.87	19.54	30.2	47.38	18.33
14	+1.33	59.46	31.21	37.01	23.67	50.05	19.64	44.68	22.65	20.62	87.34	23.67	21.05	32.09	50.78	19.37
15	+1.67	62.63	32.58	38.72	25.06	53.0	20.88	47.24	24.23	22.11	93.29	24.49	22.62	34.03	54.28	20.44
16	+2.00	65.71	33.9	40.37	26.42	56.02	22.07	49.72	25.76	23.56	99.07	25.29	24.13	35.92	57.68	21.48
17	+2.33	68.79	35.22	42.02	-	*58.96*	-	52.2	27.29	25.0	104.85	26.09	25.64	*37.81*	61.08	22.52
18	+2.67	-	36.59	43.73	-	-	-	54.76	-	26.50	110.80	26.91	27.21	-	64.58	23.59
19	+3.00	-	-	45.38	-	-	-	57.24	-	-	116.58	27.71	-	-	67.98	24.63

Note: In scoring an individual select the raw score closest to that of the individual. Numbers in *italics* are scores above the maximum possible raw total score for a subtest.

Table 7. Raw scores with their standard score and z-score equivalents. Age group 5 (51 to 60 years, inclusive)

Raw Score

Z	Scaled	BD	Sim	DS	MR	Voc	Ari	SS	VP	Inf	CD	LNS	FW	Com	Canc	PC
-3.00	1	12.90	9.87	15.50	-0.17	13.31	4.73	7.59	1.25	0.89	15.71	13.47	-0.19	11.46	5.67	2.79
-2.67	2	15.81	11.59	16.94	1.44	16.22	5.77	10.10	2.67	2.48	20.43	14.15	1.29	13.02	8.85	3.90
-2.33	3	18.80	13.37	18.41	3.11	19.23	6.83	12.70	4.14	4.12	25.38	14.86	2.82	14.63	12.14	5.05
-2.00	4	21.71	15.09	19.85	4.73	22.14	7.87	15.21	5.56	5.71	30.00	15.54	4.30	16.19	15.32	6.16
-1.67	5	24.62	16.81	21.29	6.34	25.05	8.91	17.72	6.98	7.30	34.72	16.22	5.78	17.75	18.50	7.27
-1.33	6	27.61	18.59	22.76	8.01	28.06	9.97	20.32	8.45	8.94	39.57	16.93	7.31	19.36	21.79	8.42
-1.00	7	30.52	20.31	24.20	9.63	30.97	11.01	22.83	9.87	10.53	44.29	17.61	8.79	20.92	24.97	9.53
-0.67	8	33.43	22.03	25.64	11.25	33.88	12.05	25.34	11.29	12.12	49.01	18.29	10.27	22.48	28.15	10.64
-0.33	9	36.42	23.81	27.11	12.91	36.89	13.11	27.93	12.76	13.76	53.86	19.00	11.80	24.04	31.44	11.79
0	10	39.33	25.53	28.55	14.53	39.80	14.15	30.45	14.18	15.35	58.58	19.68	13.28	25.65	34.62	12.90
+0.33	11	42.24	27.25	29.99	16.15	42.71	15.19	32.96	15.60	16.94	63.30	20.36	14.76	27.21	37.80	14.01
+0.67	12	45.23	29.03	31.46	17.81	45.72	16.25	35.56	17.07	18.58	68.15	21.07	16.29	28.82	41.09	15.16
+1.00	13	48.14	30.75	32.90	19.43	48.63	17.29	38.07	18.49	20.17	72.87	21.75	17.77	30.38	44.27	16.27
+1.33	14	51.05	32.47	34.34	21.05	51.54	18.33	40.58	19.91	21.76	77.59	22.43	19.25	31.94	47.45	17.38
+1.67	15	54.04	34.24	35.81	22.71	54.55	19.39	43.18	21.38	23.40	82.44	23.14	20.78	33.55	50.74	18.53
+2.00	16	56.95	35.97	37.25	24.33	57.46	20.43	45.69	22.80	24.99	87.16	23.82	22.26	35.11	53.92	19.64
+2.33	17	59.86	37.69	38.69	25.95	-	21.47	48.20	24.22	26.58	91.88	24.50	23.74	36.67	57.10	20.75
+2.67	18	62.85	-	40.16	27.61	-	22.53	50.80	25.69	-	96.73	25.21	25.27	-	57.10	21.90
+3.00	19	65.76	-	41.60	-	-	-	53.31	27.11	-	101.45	25.89	26.75	-	63.57	23.01

Note: In scoring an individual select the raw score closest to that of the individual. Numbers in *italics* are scores above the maximum possible raw total score for a subtest.

Table 8. Raw scores with their standard score and z-score equivalents. Age group 6 (61 to 70 years, inclusive)

Raw Score

Z	Scaled	BD	Sim	DS	MR	Voc	Ari	SS	VP	Inf	CD	LNS	FW	Com	Canc	PC
-3.00	1	7.45	11.41	13.06	-1.59	4.80	4.61	3.95	-0.40	-0.58	6.64	8.13	-2.58	5.09	1.63	-0.52
-2.67	2	10.42	12.73	14.52	-0.06	8.15	5.51	6.43	0.94	0.88	11.37	9.25	-1.20	6.96	3.82	0.76
-2.33	3	13.48	14.08	16.03	1.51	11.61	6.45	8.97	2.32	2.38	16.23	10.41	0.21	8.89	7.72	2.09
-2.00	4	16.45	15.40	17.49	3.04	14.96	7.35	11.45	3.66	3.84	20.96	11.53	1.59	10.76	10.72	3.37
-1.67	5	19.42	16.72	18.95	4.57	18.31	8.25	13.93	5.00	5.30	25.69	12.65	2.97	12.63	13.72	4.65
-1.33	6	22.48	18.07	20.46	6.14	21.77	9.19	16.48	6.38	6.80	30.27	13.81	4.38	14.56	16.81	5.98
-1.00	7	25.45	19.39	21.92	7.67	25.12	10.09	18.95	7.72	8.26	35.28	14.93	5.76	16.43	19.81	7.26
-0.67	8	28.42	20.71	23.38	9.20	28.47	10.99	21.43	9.06	9.72	40.01	16.05	7.14	18.30	22.81	8.54
-0.33	9	31.48	22.06	24.89	10.77	31.93	11.93	23.98	10.44	11.22	44.87	17.21	8.55	20.23	25.90	9.87
0	10	34.45	23.38	26.35	12.30	35.28	12.83	26.45	11.78	12.68	49.60	18.33	9.93	22.10	28.90	11.15
+0.33	11	37.42	24.70	27.81	13.83	38.63	13.73	28.93	13.13	14.14	54.33	19.45	11.31	23.97	31.90	12.43
+0.67	12	40.48	26.05	29.32	15.40	42.09	14.67	31.48	14.50	15.64	59.19	20.61	12.72	25.90	35.00	13.76
+1.00	13	43.45	27.37	30.78	16.93	45.44	15.57	33.95	15.84	17.10	63.92	21.73	14.10	27.77	37.99	15.04
+1.33	14	46.42	28.69	32.24	18.46	48.79	16.47	36.43	17.18	18.86	68.65	22.85	15.48	29.64	40.99	16.32
+1.67	15	49.48	30.04	33.75	20.03	52.25	17.41	38.98	18.56	20.06	73.51	24.01	16.89	31.57	44.08	17.65
+2.00	16	52.45	31.36	35.21	21.56	55.60	18.31	41.45	19.90	21.52	78.24	25.13	18.27	33.44	47.08	18.93
+2.33	17	55.42	32.68	36.67	23.09	58.95	19.21	43.93	21.24	22.98	82.97	26.25	19.65	35.31	50.08	20.21
+2.67	18	58.48	34.03	38.18	24.66	-	20.15	46.48	22.62	24.48	87.83	27.41	21.06	37.24	53.17	21.54
+3.00	19	61.45	35.35	39.64	26.19	-	21.05	48.95	23.96	25.94	92.56	28.53	22.44	-	56.17	22.82

Note: In scoring an individual select the raw score closest to that of the individual. Numbers in *italics* are scores above the maximum possible raw total score for a subtest.

Table 9. Subtest raw scores with their standard score and z-score equivalents. Age group 7 (71 years or more)

Z	Scaled	BD	Sim	DS	MR	Voc	Ari	SS	VP	Inf	CD	LNS	FW	Com	Canc	PC
Score:									Raw Score							
-3.00	1	-1.0	8.95	10.26	-2.49	-1.57	2.54	2.24	0.01	-5.59	-4.83	N/A	N/A	1.77	N/A	-1.11
-2.67	2	2.48	10.44	11.72	-1.01	2.25	3.51	4.48	1.06	-3.71	0.36	N/A	N/A	3.74	N/A	0.05
-2.33	3	6.07	11.97	13.23	0.51	6.20	4.50	6.78	2.15	-1.78	5.70	N/A	N/A	5.76	N/A	1.25
-2.00	4	9.55	13.45	14.69	1.99	10.02	5.47	9.02	3.20	0.10	10.89	N/A	N/A	7.73	N/A	2.41
-1.67	5	13.03	14.94	16.15	3.47	13.84	6.44	11.26	4.25	1.98	16.08	N/A	N/A	9.70	N/A	3.57
-1.33	6	16.62	16.47	17.66	4.99	17.79	7.43	13.56	5.34	3.91	21.42	N/A	N/A	11.72	N/A	4.77
-1.00	7	20.10	17.95	19.12	6.47	21.61	8.40	15.80	6.39	5.79	26.61	N/A	N/A	13.69	N/A	5.93
-0.67	8	23.58	19.44	20.58	7.95	25.43	9.37.	18.04	7.44	7.67	31.80	N/A	N/A	15.66	N/A	7.09
-0.33	9	27.17	20.97	22.09	9.47	29.38	10.36	20.34	8.53	9.60	37.14	N/A	N/A	17.68	N/A	8.29
0	10	30.65	22.45	23.55	10.95	33.20	11.33	22.58	9.58	11.48	42.33	N/A	N/A	19.65	N/A	9.45
+0.33	11	34.13	23.94	25.02	12.43	37.02	12.30	24.82	10.63	13.36	47.52	N/A	N/A	21.62	N/A	10.61
+0.67	12	37.72	25.47	26.52	13.95	40.97	13.29	27.12	11.72	15.29	52.86	N/A	N/A	23.64	N/A	11.81
+1.00	13	41.20	26.95	27.98	15.43	44.79	14.26	29.36	12.77	17.17	58.05	N/A	N/A	25.61	N/A	12.97
+1.33	14	44.68	28.44	29.44	16.91	48.61	15.23	31.60	13.82	19.05	63.24	N/A	N/A	27.57	N/A	14.13
+1.67	15	48.27	29.97	30.95	18.43	52.56	16.22	33.90	14.91	20.98	68.58	N/A	N/A	29.60	N/A	15.33
+2.00	16	51.75	31.45	32.41	19.91	56.38	17.19	36.14	15.96	22.86	73.77	N/A	N/A	31.57	N/A	16.49
+2.33	17	55.23	32.94	33.87	21.39	60.20	18.16	38.38	17.01	24.74	78.96	N/A	N/A	33.54	N/A	17.65
+2.67	18	58.82	34.47	35.38	22.91	64.15	19.15	40.68	18.10	26.67	84.30	N/A	N/A	35.56	N/A	18.85
+3.00	19	62.30	35.95	36.84	24.39	67.97	20.12	42.92	19.15	-	89.49	N/A	N/A	37.53	N/A	20.01

Notes. Letter-Number Sequencing, Figure Weights and Cancellation subtests are not administered to examines ≥ 70 years.
In scoring an individual select the raw score closest to that of the individual. Numbers in *italics* are scores above the maximum possible raw total score for a subtest.

DISCUSSION

The purpose of this paper was to produce normative data for Māori on the WAIS-IV, in a format accessible and applicable for clinical practice. The impetus for this work arose from an extensive body of literature that indicates current neuropsychological tests and practices, and their accompanying normative data introduces bias when applied to individuals who diverge from non-western cultures and may therefore lead to spurious diagnoses (Brickman et al., 2006; Fernández et al., 2008; Rivera Mindt et al., 2010; Uzzell et al., 2007). This is of particular concern for Māori here in Aotearoa who are culturally dissimilar to the western worldview in which the WAIS-1V was developed (Dudley et al., 2019; Ogden & McFarlane, 1997; Ogden et al, 2003).

Variables such as acculturation, education, and socio-economic (SES) status are complex, culturally influenced indicators and have been consistently identified as contributing to variance in neuropsychological performance (Ardilla, 2007; Arentoft, et al., 2015; Coffey et al., 2005; Manly et al., 1998; Kennepohl et al., 2004; Razani et al., 2007; Walker, Batchelor & Sores, 2010).

The WAIS-IV has been shown to draw heavily on the Western educational experience of the individual (Walker et al., 2010). This is also problematic for Māori who have historically been subjected to a western education system that has marginalised their culture, and ignored Māori pedagogy (Bishop et al., 2009; Gordon, 2018; Durie, 1998; Walker 2016) leading to poor education outcomes. (Statistics New Zealand, 2013; (Bishop. 2009; Ministry of Education, 2013). Therefore, the discrimination and disadvantage that Māori have experienced in the education system continues to disadvantage Māori in the practice of neuropsychology.

In general, cross-cultural neuropsychologists dispute the notion that the variation in performance seen in some cross-cultural studies is due to genetic or biological differences and argue that differences are a product of political or social determinants as demonstrated in several studies where socio-economic factors have been controlled for (Evans et al., 2000; Ibanez-Casas, et al., 2016; Noble et al., 2007). Disappointingly, the significance of SES appears to continue to be downplayed or overlooked in the field of neuropsychology as indicated by a review of 1277 neuropsychology research journals between 2016 and 2019 that found only 13% of the articles provided the socio-economic status of the sample populations (Medina et al., 2021). In clinical practice it is critical for neuropsychologists to conduct a comprehensive evaluation that includes enquiry into the various factors of the socioeconomic background of the person being assessed, to identify those variables that potentially impact performance.

This oversight extends to the WAIS-IV manual which does not include stratification of factors such as an individual's adaptation to the dominant western culture or their socio-economic status, thereby creating possible bias when administered to Māori. In a previous publication using the same sample, the degree to which a person identified with Māori culture, their education, and income levels were found to account for some of the variance in their performance on the Test of Premorbid Functioning (ToPF) (Dudley et al., 2017).).

In response to the consistent requests from Māori whānau for a Māori-friendly environment when undergoing a neuropsychological assessment (Dudley et al., 2014; Dudley & Faleafa, 2016; Ogden & McFarlane, 1997; Ogden et el., 2003; Shepherd & Leathem, 1999), the current study employed culturally appropriate protocols of engagement and rapport-building that honour a Māori worldview. For example, offering the participants a choice of where to hold the interviews, offering the opportunity to have karakia, whanaungatanga and the sharing of kai all led to a sense of feeling included for the participant where otherwise that may have experienced feelings of exclusion and alienation. Incorporating these cultural practices can have a profound effect on the assessment procedure for the participant and a positive influence on their performance. Neuropsychologists in Aotearoa are ethically bound to promote an assessment environment in which the person is motivated to perform well. The hui process (Lacey et al., 2011), and the Meihana Model (Pitama et al., 2017) are two approaches that promote cultural awareness and provide for cultural safety practices and would be well suited for the administration of a neuropsychological assessment with Māori.

A strength of the present data includes the administration of the full WAIS-IV to a large, stratified sample, which was representative of the main iwi from across Aotearoa. To our knowledge, it is the first large scale effort to produce normative data for Māori on any version of the WAIS.

Conclusion

This manuscript presents normative data tables for clinicians to use in scoring the WAIS-IV when administered to Māori. Our hope is that clinicians in Aotearoa will access this data to make fair comparison of an individual's performance against a selection of test scores derived from the administration of the WAIS-1V to a sample that is representative of the Māori population.

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