

## BRIEF REPORT

# Estimating Premorbid WAIS-RIQ with Demographic Variables: Regression Equations Derived from a UK Sample\*

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### ABSTRACT

A sample of 200 healthy individuals, representative of the adult UK population in terms of age, gender, and occupational classification, completed a full-length WAIS-R. Demographic variables for the participants were recorded (age, gender, years of education, and occupational classification) and used to develop regression equations for the estimation of premorbid WAIS-R IQ. Step wise multiple regression revealed that occupation was the best predictor of IQ for all three WAIS-R scales (FSIQ, VIQ, and PIQ). Age and years of education significantly increased the variance predicted. Together these three variables accounted for 53%, 53%, and 32% of the variance in FSIQ, VIQ, and PIQ, respectively. The results indicated that the demographic approach to the estimation of premorbid WAIS-R IQ has utility beyond the USA. However, in common with findings for American participants (Barona, Reynolds, & Chastain, 1984) the ability to predict PIQ was markedly inferior to that achieved for FSIQ and VIQ. A frequency table of the discrepancies between estimated premorbid IQ and obtained IQ for the present sample is provided for clinical use.

The detection and quantification of acquired neuropsychological deficits rests upon the comparison of an individual's current cognitive functioning with an estimate of his/her premorbid ability (Crawford, 1992). One approach to obtaining this estimate takes advantage of the well-established relationship between demographic variables (e.g., education, occupational status) and IQ (Kaufman, 1990). Wilson et al. (1978) used the U.S. standardization sample to build regression equations for the prediction of Wechsler Adult Intelligence Scale IQ (WAIS; Wechsler, 1955) from five demographic variables. These equations predicted 54%, 53%, and 42% of the variance in Full Scale (FSIQ), Verbal IQ, (VIQ) and Performance (PIQ), respectively. Subsequently, Barona, Reynolds, and Chastain (1984) and Barona and Chastain (1986)

have demonstrated that the demographic approach can be applied to the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981). It should be noted, however, that the predictive power of the WAIS-R regression models was markedly less than that achieved when the WAIS was the criterion measure.

At present, there has been little attempt to employ or evaluate the demographic approach outside of North America. Crawford, Stewart, Cochrane, et al. (1989) used a sample of 151 healthy subjects to build regression equations to estimate premorbid WAIS IQ for the United Kingdom (UK). The regression models incorporated occupational classification, years of education, age, and gender as predictors and accounted for 50%, 50%, and 30% of the variance in FSIQ, VIQ, and PIQ, respectively. However,

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because virtually all clinical neuropsychologists have now replaced the WAIS with the WAIS-R, these regression equations are now obsolete. The aim of the present study was to determine how successfully demographic variables could be used to predict IQ in the UK when the WAIS-R was used as the criterion variable. To our knowledge, the present study represents the first attempt to employ the demographic approach with the WAIS-R outside of North America.

## METHOD

### Participants

The sample consisted of 200 Caucasians (104 females, 96 males) screened by interview to exclude any potential participants with a history of neurological, psychiatric, sensory, or systemic disorders. Participants were recruited from a wide variety of sources, that is, local and national businesses, recreational clubs (e.g., senior citizens clubs, angling clubs), community centers, and so forth; all were offered a small honorarium for their participation. Mean age was 44.3 years ( $SD = 19.2$ ) with a range of 16 to 83 years. Mean years of education was 12.6 ( $SD = 3.0$ ) with a range of 7 to 21 years. In recording years of education participants were credited with 0.5 of a year for every year spent in part-time education. Part-time education was defined to include day-release courses and evening classes provided that they had led, or were leading to, a qualification. Each participant's occupation was coded using the Office of Population Censuses and Surveys (1980) Classification of Occupations; this classification system consists of five categories which can be defined broadly as follows; 1 = professional, 2 = intermediate, 3 = skilled, 4 = semi-skilled, 5 = unskilled. Retired participants, and those describing themselves as house-husbands/housewives, were coded by their previous occupations as were those currently unemployed. Those who had never worked were coded as 5 (i.e., unskilled).

A goodness-of-fit chi-square test was used to compare the distribution of occupational classifications in the present sample with the census-derived figures for the adult UK population. This revealed that the sample and population distributions did not differ significantly  $X^2(4, N = 200) = 5.66, p > .05$ . A similar procedure was used to examine the representativeness of the sample in terms of age distribution. Nine age bands were formed corresponding to those adopted for the

WAIS-R standardization sample, with the exception that the 70-74 age band was replaced with a 70+ age band. A goodness-of-fit test revealed that the sample and population distributions did not differ significantly  $\chi^2(8, TV = 200) = 7.71, p > .05$ ; tables of the distributions for occupation and age are available in an extended version of this paper. Finally, the sample's gender distribution was also representative of the adult UK population  $yf(l, N$

### Procedure

All participants completed a full-length WAIS-R (UK) according to standardized procedures (Lea, 1986; Wechsler, 1981). Stepwise multiple regression was used to regress the three WAIS-R scales (i.e., FSIQ, VIQ, and PIQ) on the four demographic variables, that is age, gender, years of education, and occupational classification.

## RESULTS

The mean score (and  $SD$ ) for WAIS-R FSIQ was 102.5 (13.12) with a range from 71 to 140. The means for VIQ and PIQ were 102.4 (12.81) and 102.0 (13.40), respectively. The correlation matrix for the three criterion and four predictor variables is presented in Table 1. Stepwise regression revealed that occupational classification was the single best predictor of IQ for all three scales, accounting for 42%, 43%, and 25% of the variance in FSIQ, VIQ, and PIQ, respectively. Of the three remaining demographic variables, education and age significantly increased the variance predicted at successive steps of the analyses ( $p < .001$  for both variables for all three IQ scales). The final regression models predicted 53%, 53%, and 32% of the variance in FSIQ, VIQ, and PIQ, respectively with standard errors of estimate of 9.11, 8.83, and 11.2. The regression equations for each of the three IQ scales are presented below:

$$\text{Predicted FSIQ} = 87.14 - (5.21 \times \text{occupation}) + (1.78 \times \text{education}) + (.18 \times \text{age})$$

$$\text{Predicted VIQ} = 87.42 - (5.08 \times \text{occupation}) + (1.77 \times \text{education}) + (.17 \times \text{age})$$

$$\text{Predicted PIQ} = 90.89 - (4.34 \times \text{occupation}) + (1.33 \times \text{education}) + (.16 \times \text{age})$$

Table 1. Correlation Matrix for WAIS-R IQ Scores and the Demographic Predictor Variables in a Healthy UK Sample.

|            | FSIQ  | VIQ   | PIQ   | Age   | Gender | Occupation |
|------------|-------|-------|-------|-------|--------|------------|
| VIQ        | .94*  |       |       |       |        |            |
| PIQ        | .87*  | .66*  |       |       |        |            |
| Age        | .10   | .08   | .11   |       |        |            |
| Gender     | -.19* | -.21* | -.13* | .19*  |        |            |
| Occupation | -.65* | -.65* | -.50* | .09   | .19*   |            |
| Education  | .58*  | .59*  | .43*  | -.33* | -.26*  | -.65*      |

Note.  $N = 200$ .

\*  $p < .05$ .

Table 2. Demographic Prediction of WAIS-R IQ: Distribution of Positive Predicted Minus Obtained IQ Discrepancies in Healthy Participants.

| Predicted-obtained Discrepancy | % of Ss when FSIQ Predicted | % of Ss when VIQ Predicted | % of Ss when PIQ Predicted |
|--------------------------------|-----------------------------|----------------------------|----------------------------|
| 1                              | 47.5                        | 50.5                       | 46.0                       |
| 2                              | 42.5                        | 44.5                       | 43.0                       |
| 3                              | 38.5                        | 40.0                       | 40.0                       |
| 4                              | 33.5                        | 35.0                       | 37.0                       |
| 5                              | 28.0                        | 29.0                       | 33.5                       |
| 6                              | 24.5                        | 27.5                       | 32.0                       |
| 7                              | 22.0                        | 25.5                       | 29.5                       |
| 8                              | 19.5                        | 21.5                       | 26.5                       |
| 9                              | 17.0                        | 16.5                       | 23.5                       |
| 10                             | 16.0                        | 15.0                       | 20.1                       |
| 11                             | 14.5                        | 11.5                       | 19.5                       |
| 12                             | 13.0                        | 11.5                       | 15.0                       |
| 13                             | 9.5                         | 8.5                        | 13.5                       |
| 14                             | 8.0                         | 7.5                        | 11.5                       |
| 15                             | 6.5                         | 6.0                        | 10.0                       |
| 16                             | 6.5                         | 6.0                        | 8.0                        |
| 17                             | 3.5                         | 3.0                        | 7.0                        |
| 18                             | 3.0                         | 1.5                        | 6.5                        |
| 19                             | 2.0                         | 1.5                        | 5.5                        |
| 20                             | 2.0                         | 1.0                        | 4.0                        |
| 21                             | 1.5                         | 1.0                        | 3.5                        |
| 22                             | 0.5                         | 1.0                        | 2.0                        |
| 23                             | 0                           | 0.5                        | 0.5                        |
| 24                             | 0                           | 0.5                        | 0.5                        |
| 25                             | 0                           | 0.5                        | 0.5                        |
| 26                             | 0                           | 0.5                        | 0.5                        |
| 27                             | 0                           | 0.5                        | 0.5                        |
| 28                             | 0                           | 0.5                        | 0.5                        |
| 29                             | 0                           | 0.5                        | 0.5                        |
| 30                             | 0                           | 0.5                        | 0.5                        |
| 31                             | 0                           | 0.5                        | 0.5                        |
| 32                             | 0                           | 0.5                        | 0.5                        |

Note. The figures opposite the discrepancy represent the percentage of healthy participants who exhibited that size of positive discrepancy *or larger*. For example, in the case of VIQ, 1% of the sample exhibited a discrepancy of 13 IQ points and a further 7.5% exhibited a discrepancy greater than 13. Therefore the percentage opposite a discrepancy of 13 is 8.5%.

The distribution of discrepancies between predicted IQ and obtained IQ is presented in Table 2. Only positive discrepancies are presented (i.e., cases in which the predicted premorbid IQ exceeded the IQ obtained by testing) because it is this half of the distribution which is of principal concern to clinicians.

## DISCUSSION

The present results demonstrate that demographic variables can be employed to predict WAIS-R performance outside of North America. In the case of FSIQ and VIQ, over 50% of the variance in test performance can be accounted for by the three demographic variables of occupation, years of education, and age. Given that the problem of estimating premorbid ability is one commonly faced by all clinical neuropsychologists, these results should encourage attempts to develop demographic equations in other countries. However, it should be noted that, in common with the U.S. findings, the ability of demographic variables to predict PIQ was markedly inferior to that achieved for FSIQ and VIQ. Although the sample employed in the present study was markedly smaller than the U.S. standardization sample, it was nevertheless representative of the adult UK population in terms of the distributions of age, gender, and occupational classification. Because of this, the equations should have reasonable stability. However, it would be important to examine the accuracy of the present equations in a cross-validation sample.

In clinical practice the predicted IQs derived from the present equations can be compared with the IQs obtained by testing. A substantial discrepancy in favor of the estimated premorbid IQ raises the possibility of cognitive deterioration. The probability of a particular size of discrepancy in favor of the estimated premorbid IQ occurring in the normal population can be assessed by referring to Table 2. For example, in the case of FSIQ, a discrepancy in favor of premorbid IQ of more than 17 points occurred in less than 5% of the present healthy sample. Therefore, a discrepancy of this magnitude is

significant at the .05 level and would constitute one source of evidence for the presence of impairment.

The most common formal alternative to the demographic approach to estimating premorbid IQ is through the use of present ability measures, such as the National Adult Reading Test (NART; Nelson, 1982), which are relatively resistant to many forms of cerebral dysfunction. The advantages of this latter approach is that it is liable to be a more powerful predictor of the criterion variable (i.e., WAIS or WAIS-R performance). For example, the healthy sample used to generate the UK demographic equations for the WAIS (Crawford et al., 1989) was also used to cross-validate the NART (Crawford, Stewart, Parker, Besson, & De Lacey, 1989). Therefore, it is possible to compare directly the two methods in the same sample. The NART predicted 66% of FSIQ in comparison with the previously noted figure of 50% for the demographic equation and had a correspondingly smaller standard error of estimate (7.4 vs. 9.1).

The lesser predictive power of demographic methods is potentially offset by their major advantage; namely, that the estimates they provide are independent of an individual's current cognitive status. Because there is evidence for a degree of impairment of NART performance in some neuropsychiatric disorders (see Crawford, 1992), the NART will tend to systematically underestimate premorbid ability. Furthermore, the demographic approach can be employed with clients for whom the NART would clearly be inappropriate (i.e., dysarthric or dyslexic cases).

The principal practical aim of both approaches is to improve the detection and quantification of impairment by providing an individualized comparison standard for a client's current level of functioning. To evaluate the utility of the demographic approach in this regard, studies have examined whether the combination of current ability measures (WAIS or WAIS-R) and demographic estimates of premorbid IQ achieve greater discrimination between healthy and neurological samples than is achieved by current ability measures alone (e.g., Eppinger, Craig, Adams, & Parsons, 1987; Wilson, Rosenbaum,

& Brown, 1979). Wilson and colleagues (1979) carried out a discriminant function analysis which demonstrated that the inclusion of the demographic estimate significantly improved discrimination in comparison with WAIS indices alone. Eppinger et al. (1987) found that although the discrepancy between obtained WAIS-R scores and the demographic estimate achieved better classification accuracy than WAIS-R scores alone, the improvement did not achieve statistical significance. The utility of combining current IQ measures with NART-based estimates of premorbid IQ has only been examined in one study. Crawford, Hart, and Nelson (1990) reported that the NART significantly improved discrimination between a healthy sample and samples with either a diagnosis of dementia or CT-scan evidence of cortical atrophy. Unfortunately, there are, as yet, no studies that have directly compared the discrimination achieved when current ability measures are paired with NART versus demographic estimates of premorbid IQ. Such studies would indicate whether or not the superior robustness of demographic estimates outweighs their lesser criterion validity.

Given that a conclusion on the relative utility of the two methods is not yet possible, a reasonable clinical course would be to obtain estimates of premorbid IQ using both methods because neither are time-consuming. Alternatively, a two-stage process could be adopted. Crawford, Allan, Cochrane, and Parker (1990) built a regression equation from a sample of 659 healthy participants that can be used to estimate an individual's expected NART score on the basis of their age, gender, years of education, and occupation. This equation can be used to assess the likelihood that an individual's NART performance is impaired. In cases where the expected and obtained NART scores do not differ significantly, then the NART could be used to provide the primary estimate of premorbid IQ (because of its superior criterion validity). A significant difference between expected and obtained NART scores would be indicative of impaired NART performance. In such circumstances more weight should be placed on demographic

estimates of premorbid IQ because there is a danger that the NART systematically underestimates premorbid ability.

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