Is there a miss-match between who gets iron supplementation and who needs it? A cross sectional study of iron supplements, Iron Deficiency Anaemia and socio-economic status in Australia

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Running title: Anaemia and iron supplementation in Australia

Keywords: Anaemia; iron supplements; socioeconomic status; Australia.

Abstract

Iron Deficiency Anaemia (IDA) is more prevalent in lower socio-economic groups, however, little is known about who actually receives iron supplements. This paper aims to determine whether the groups most likely to have IDA are the most likely to be taking iron supplements. Logistic regression analysis was conducted using the cross-sectional, nationally representative National Nutrition and Physical Activity Survey (NNPAS), and National Health Measures Survey (NHMS). After adjusting for other factors, those whose main language spoken at home was not English had twice the odds of having IDA compared to those whose main language spoken at home was English (95%CI: 1.00 – 4.32). Those who were not in the labour force also had twice the odds of having IDA as those who were employed (95%CI: 1.16 – 3.41). Those in income quartile 1 had 3.7 times the odds of having IDA compared to those in income quartile 5 (95%CI: 1.42 – 9.63). Those whose main language spoken at home was not English were significantly less likely to take iron supplements (p=0.002) than those whose main language spoken at home was English. There was no significant difference in the likelihood of taking iron supplements between those who were not in the labour force and those who were employed (p=0.618); between those who were in income quartile 1 and in higher income quartiles; and between males and females (p=0.854), after adjusting for other factors. There is a mismatch between those who are most in need of iron supplements, and those who currently receive them.

Introduction

The links between iron deficiency anaemia (IDA) and socio-economic status are well established within developed countries [9; 8; 28; 18]. With it being noted that women and children from disadvantaged groups – those with low incomes, the poorly educated and migrants are at particular risk. However, there is a more limited body of research demonstrating this link in Australia. While it is generally accepted that the same disadvantaged groups are at greater risk, there is very limited information on the prevalence of IDA in Australia and the groups who may be at risk [6]. Of the limited research that has been conducted it is generally accepted that Indigenous people within Australia, who are also known to have disproportionately high rates of low income and poor education, are more likely to experience IDA [17]. There is also some evidence to suggest that migrants, those living in low income areas and the homeless are also at higher risk [5].

Despite the general recognition of the inequalities surrounding anaemia, little is known about who actually receives iron supplements, and whether the groups who are most at risk of IDA are actually more likely to use supplements. There is limited evidence from the United States that shows low income women and migrant women were less likely to use iron supplements [11]; however, no research has been reported on this relationship in Australia.

The Australian Health Survey undertaken in 2012 offers a unique opportunity to address this lack of research. This survey, conducted by the Australian Bureau of Statistics, has collected nationally representative data on haemoglobin and ferritin levels collected from patient biomedical tests, and iron supplementation use through its National Nutrition and Physical Activity Survey and National Health Measures Survey components. This study aims to 1) use

the Australian Health Survey to identify the groups who are most at risk of IDA and 2) determine whether these groups are more likely to use iron supplements.

Methods

The Australian Health Survey has been flagged as the most comprehensive survey to date of the health of the Australian population, and includes three components: the National Health Survey, the National Nutrition and Physical Activity Survey, and the National Health Measures Survey. This study will focus on the National Nutrition and Physical Activity Survey (NNPAS) and National Health Measures Survey (NHMS) [4].

The NNPAS consists of 9,519 households from all areas of Australia, excluding households in very remote Australia. The survey also excluded those living in non-private dwellings, such as motels, boarding schools, hospitals and nursing homes. Within each state of Australia, each person had an equal chance of selection, except those aged 65 and over, who had a double chance of selection in order to improve estimates for this age group. The response rate for the NNPAS was 77%. Within each household information was collected from one adult and one child aged 2 to 17 years, giving a total sample of 12,153 persons. The NNPAS was conducted between May 2011 and June 2012. All participants in the NNPAS aged 5 years and over were then invited to voluntarily participate in the NHMS. This collected blood and urine samples from participants aged over 11 years, and urine samples only for those aged 5 to 11 years. The response rate for the NHMS was 37% [4].

In order to adjust the results obtained from the survey sample to be representative of the entire Australian population, the Australian Bureau of Statistics assigned weights to each person and each household. The weight is a numerical value indicating the number of people in the population that each unit (person or household) represents. Weights were

based upon probability of selection, were adjusted for non-response and calibrated against known population benchmarks from the 2006 Census of Population and Housing [4].

Biomedical measure of anaemia

The NHMS collected iron biomarkers from blood collections of those aged 12 years and over. These consisted of Serum ferritin, Inflammation marker (C-reactive protein), Soluble transferrin receptor, and Haemoglobin. People with inflammation (C-reactive protein >10mg/L) were excluded by the ABS from the ferritin results as inflammation can affect ferritin levels. Based upon Haemoglobin results, the ABS classified individuals as being at risk of anaemia based upon the following reference values for normal and abnormal Haemoglobin levels published by the Work Health Organisation:

Non pregnant females: <120g/L

Pregnant females: <110g/L

Males aged 12 – 14 years: <120g/L

Males aged 15 years and over: <130g/L [4].

Based upon World Health Organisation recommendations, the authors then identified those with Iron Deficiency Anaemia as those at risk of anaemia based upon the above Haemoglobin levels, and having Serum ferritin levels less than 15µg/L [31].

Iron Supplement Use

Respondents were asked about their supplement use in the past 24 hours, and were able to select the exact supplement they used based upon a list of 10,000 dietary supplements registered for use in Australia by the Therapeutic Goods Administration. Respondents were

encouraged to enter the AUST-L numbers on their supplement contains to ensure accurate matching [4]. Based upon the supplements entered, the ABS recorded the nutrient content of the supplements in mg. The authors then classified anyone who consumed 18mg or more of iron per day as a part of their supplement consumption to be taking iron supplements. This is based upon the National Institutes of Health's classification of the nutrient content of a typical multivitamin with iron supplement [22]

Socio-economic variables

The Australia Health Survey, Nutrition and Physical Activity Release contains a number of socio-economic variables. The socio-economic variables included in this study were:

1. Country of birth: Australia or Overseas
2. Main language spoken at home: English or Language other than English
3. Labour force status: Employed (full time or part time), unemployed or not in the labour force
4. Level of non-school qualification: Bachelor degree or above, Advanced Diploma or Diploma or Certificate, or no non-school qualification
5. Equivalised household income quantile.

Statistical Analysis

Initial descriptive analysis was undertaken to determine which socio-economic groups had the highest proportion of people with anaemia. Univariate analysis was initially undertaken to determine the relationship between having anaemia and age, gender, country of birth, main language spoken at home, level of non-school qualification, and income. A logistic regression model was constructed of anaemia, with country of birth, main language spoken

at home, labour force status, level of non-school qualification, and income included as explanatory variables. The model was also adjusted for age and sex.

The analysis was then repeated to look at iron supplement use by socio-economic group. All analysis was undertaken on weighted data, unless otherwise stated and significance was set at the 0.05 level.

Results

There were 123 records on the National Nutrition and Physical Activity Survey and National Health Measures Survey who had IDA. Based upon weighted results from the National Nutrition and Physical Activity Survey and National Health Measures Survey, there were 318 200 people whose haemoglobin levels put them at risk of anaemia (3% of the population) in 2012. Of these people, 71% had Serum ferritin levels that indicated they had IDA (225 600 people). Of the people with IDA, 30% were classified as being overweight based upon their BMI (39% in non-IDA population) and 15% were classified as being obese (37% in non-IDA population).

Table 1 shows the correlation matrix between the variables included in the modelling: gender, country of birth, main language spoken at home, employment status, level of education attainment, income quartile, and age. Table 2 shows that those whose main language spoken at home, were not in the labour force, were female and in the lowest income quartiles all had the highest proportion of people with IDA.

The results of the univariate analysis show that males were significantly less likely to have anaemia than females (OR 0.046, 95% CI: 0.013 – 0.158, p<.0001); and those in income quantile 1 (OR 5.212, 95% CI: 1.332 – 20.425, p=0.0177), income quantile 3 (OR 9.315, 95% CI: 2.446 – 35.472, p=0.0011) and income quantile 4 (OR 4.191, 95% CI: 1.043 – 16.845,

p=0.0435) were all significantly more likely to have anaemia than those in income quantile 5.

The univariate analysis showed no difference in the likelihood of having anaemia between those born overseas and those born in Australia (p=0.7913); those whose main language spoken at home was English (p=0.1017) and those whose main language spoken at home was not English; between those who were unemployed (p=0.2029) and not in the labour force (p=0.2465), compared to those who were employed; and between those with a Bachelor's degree or above (p=0.9210), those with an Advanced Diploma, Diploma or Certificate (p=0.7103) and those with no non-school qualification.

Table 2 also shows the results of the logistic regression model of IDA, with country of birth, main language spoken at home, labour force status, education level, income, gender and age all included as explanatory variables. Males had 0.34 times the odds of having IDA compared to females (95% CI: 0.20 – 0.59), after adjusting for country of birth, main language spoken at home, labour force status, education level, income and age. After adjusting for other factors, those whose main language spoken at home was not English had twice the odds of having IDA compared to those whose main language spoken at home was English (95% CI: 1.00 – 4.32). Similarly, those who were not in the labour force also had twice the odds of having IDA as those who were employed (95% CI: 1.16 – 3.41), after controlling for country of birth, main language spoken at home, education level, income, gender and age. After adjusting for other factors, there was an increasing chance of having IDA with declining household income, with those in income quartile 1 having 3.7 the odds of having IDA compared to those in income quartile 5 (95% CI: 1.42 – 9.63).

Iron supplement use

There were an estimated 143,000 people in 2011-12 who took iron supplements, representing 0.5% of the Australian population. Those who were born in Australia, those whose main language spoken at home was English, were not in the labour force, were in the highest income quartile, the employed, and those who had a Bachelor's degree had the highest rate of iron supplement use (Table 3).

After adjusting for country of birth, labour force status, education level, income, gender and age, those whose main language spoken at home was not English were significantly less likely to take iron supplements (p=0.002) than those whose main language spoken at home was English. There was no significant difference in the likelihood of taking iron supplements between those who were not in the labour force and those who were employed (p=0.618), after adjusting for other factors. There was also no significant difference in the likelihood of taking iron supplements between those who were in income quartile 1 and in higher income quartiles, after adjusting for other factors. Similarly there was no significant difference in the likelihood of taking iron supplements between males and females (p=0.854), after adjusting for other factors.

Discussion

Using the biomedical results from the National Nutrition and Physical Activity Survey and National Health Measures Survey, we have demonstrated that the socio-economic differences in IDA reported internationally [9; 8; 28; 18] are also seen within the Australian population. People who mainly speak a language other than English at home, and are in lower income quantiles were all more likely to experience IDA. The difference in the likelihood of IDA between groups with different levels of highest education attainment

reported in the univariate analysis was accounted for in the full regression model by the other explanatory variables, most likely income level.

The impacts of anaemia are well documented for children and pregnant women: IDA in pregnancy is associated with numerous adverse outcomes, including low birthweight [27; 13], preterm birth [33; 26; 27], fetal growth retardation [19], neonatal mortality and stillbirth [32; 25], and reduced iron status in mother and infant [2] which, in turn, is linked with impaired mother-infant interactions [23], delayed psychomotor development, lower IQ and poor school performance [21; 29; 10]. Despite prompt correction of IDA in infancy, significant cognitive disadvantage persists more than ten years later [20]. This parallels the irreversible effects of iron deficiency on myelination and glial and neurotransmitter function in rodents at critical periods of early development. [7]. The impacts of IDA in adulthood are less studied, however anaemia has been linked to poor workforce performance [12], and iron supplementation has been shown to improve attention, concentration and IQ [14].

Given the consistent findings regarding the unequal distribution of IDA between different socio-economic groups and the known severity of the impacts of IDA, it was expected that the groups most at risk of IDA would also be more likely to use iron supplements. However, the results have shown that there was no significant difference in the likelihood of using iron supplements between males and females, and those in the lowest income quantile and those in higher income quantiles. Furthermore, those whose main language spoken at home was not English were actually less likely to take iron supplements than those whose main language spoken at home was English.

This mismatch between those who are at high risk of IDA and the use of iron supplements shows that there is a serious need for targeted education programs to raise the awareness

of the impacts of IDA and the treatments that are available. Internationally, education and supplement programs targeted at low income mothers have been shown to be effective at reducing future cases of IDA amongst their children [24], and a similar program may be suitable for adaption within Australia to target children and adults from disadvantaged groups . The results also show that there may be shortcomings within the health care system that ensures those at highest risk of IDA are aware of the implications of IDA and the treatment options available. It is known, for example, that migrant women who are not proficient in English are less likely to utilise health services [16], and thus may be less likely to be aware of IDA.

Previous studies have shown that IDA is more prevalent amongst individuals who are classified as being obese, and following from this, it has also been noted that obesity may be associated with an impaired ability to absorb iron [1]. Thus, iron supplementation may not be a simple solution to IDA amongst obese patients. While only a small proportion of individuals with IDA in this study were also measured as being obese based upon their BMI (15%), this is an issue that warrants consideration when tailoring the most suitable course of treatment for iron deficiency. A number of studies have reported that normal dietary iron absorption was re-established when obese subjects experienced weight loss in a healthy, sustainable manner [3; 30; 15]. Thus, iron supplementation in obese subjects coupled with a healthy weight loss program may be a more suitable treatment option.

Conclusion

The biomedical results contained within the National Nutrition and Physical Activity Survey conducted by the Australian Bureau of Statistics has allowed nationally representative estimates of the groups who are most at risk of IDA to be produced. However, this study has

shown that these groups are not the most likely to use iron supplements. As such, it appears that there is a mismatch between those who are most in need of iron supplements, and those who currently receive them.

Funding source

Funding for the work came from a National Health and Medical Research Council (NHMRC) Project Grant (APP 1070370). Part of the funding for Dr Callander's salary comes from an NHMRC Early Career Fellowship. All authors are independent from the funder and the funder played no part in the study.

Competing interests

The author(s) declare that they have no competing interests.

Author contributions

EC designed the study, undertook the data analysis and drafted the manuscript. DS provided input to the study design, assisted with the interpretation of the results and edited the manuscript.

Acknowledgements

None.

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Table 1: Correlation matrix for variables used in modelling

	Male	Born OS	Language	Employed	Unemployed	Not in the labour force	No non-school	Adv. Dip/ Dip/ Cert.	Bachelor degree	Quartile 1	Quartile 2	Quartile 3	Quartile 4	Quartile 5	Age
Male	1														
Born OS	0.46	1													
Language	0.13	0.35	1												
Emp.	0.15	0.18	-0.01	1											
Unemp.	-0.01	-0.01	0.06	-0.22	1										
Not in the labour force	-0.15	-0.15	0.00	-0.90	-0.06	1									
No non-school qualification	0.43	0.60	0.19	0.30	-0.02	-0.27	1								
Adv. Dip/ Dip/ Cert.	-0.01	-0.18	-0.07	-0.11	0.02	0.14	-0.42	1							
Bach. degree	-0.44	-0.44	-0.13	-0.14	0.00	0.19	0.64	-0.36	1						
Quart 1	-0.08	-0.09	0.14	-0.43	0.08	0.43	-0.21	0.09	0.13	1					
Quart 2	-0.04	-0.11	0.11	-0.31	0.06	0.29	-0.18	0.13	0.06	-0.12	1				
Quart 3	-0.02	-0.10	0.07	-0.08	0.02	0.05	-0.15	0.19	-0.03	-0.13	-0.13	1			
Quart 4	-0.03	-0.11	0.02	0.03	0.01	-0.05	-0.06	0.14	-0.07	-0.13	-0.14	-0.14	1		
Quart 5	0.11	0.26	-0.21	0.50	-0.11	-0.45	0.39	-0.36	-0.05	-0.36	-0.38	-0.40	-0.42	1	
Age	-0.30	-0.34	-0.20	-0.33	-0.07	0.47	-0.41	0.19	0.34	0.24	0.14	-0.01	-0.02	-0.21	1

Table 2: Model of Iron Deficiency Anaemia by socio-economic status

Socio-economic characteristic	**Proportion with IDA**	**Logistic regression model of having IDA**		
		OR	**95% CI**	**p-value**
Country of Birth				
Australia	1.9	REFERENCE		
Overseas	1.8	1.30	0.75 – 2.25	0.352
Main language spoken at home				
English	1.7	REFERENCE		
Language other than English	3.2	2.08	1.00 – 4.32	0.050
Labour force status				
Employed	1.1	REFERENCE		
Unemployed	2.1	1.02	0.17 – 6.03	0.980
Not in the labour force	5.4	1.99	1.16 – 3.41	0.013
Level of non-school qualification				
No non-school qualification	2.3	REFERENCE		
Advanced Diploma or Diploma or Certificate	2.3	1.09	0.57 – 2.10	0.113
Bachelor degree or above	1.5	1.58	0.89 – 2.77	0.798
Income (Quartile 1 contains those with the lowest income)				
Quartile 5	0.7	REFERENCE		
Quartile 4	2.4	2.84	1.14 – 7.04	0.025
Quartile 3	3.0	3.41	1.29 – 9.03	0.014
Quartile 2	3.7	3.22	1.29 – 8.00	0.012
Quartile 1	5.1	3.70	1.42 – 9.63	0.007
Gender				
Females	3.2	REFERENCE		
Males	0.9	0.34	0.20 – 0.59	>.001

Table 3: Model of use of Iron Supplements by socio-economic status

Socio-economic characteristic	**Proportion taking iron supplements**	**Logistic regression model of taking iron supplements**		
		OR	**95% CI**	**p-value**
Country of Birth				
Australia	0.51	REFERENCE		
Overseas	0.42	0.57	0.31 – 1.04	0.067
Main language spoken at home				
English	0.49	REFERENCE		
Language other than English	0.42	0.09	0.02 – 0.04	0.002
Labour force status				
Not in the labour force	0.62	REFERENCE		
Employed	0.56	1.26	0.50 – 3.18	0.618
Unemployed	0.03	0.10	0.01 – 0.79	0.029
Level of non-school qualification				
No non-school qualification	0.54	REFERENCE		
Advanced Diploma or Diploma or Certificate	0.51	0.78	0.32 – 1.89	0.579
Bachelor degree or above	0.66	1.40	0.69 – 2.82	0.354
Income (Quartile 1 contains those with the lowest income)				
Quartile 1	0.48	REFERENCE		
Quartile 5	0.59	0.76	0.29 – 2.00	0.574
Quartile 4	0.25	0.46	0.12 – 1.79	0.263
Quartile 3	0.61	1.04	0.36 – 3.01	0.943
Quartile 2	0.44	0.79	0.26 – 2.44	0.865
Gender				
Females	0.50	REFERENCE		
Males	0.46	0.94	0.51 – 1.74	0.854