Iron status and socio-economic indicators among women of childbearing age in South Africa: A secondary analysis of DHS data.

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Abstract

Introduction: The nutritional double burden of disease refers to the phenomenon of undernutrition, wasting, stunting, micronutrient deficiency coinciding with overweight, obesity, and diet-related non-communicable diseases, within individuals, households and populations throughout the lifecycle.

Objectives: This study aimed to determine whether there were differences in haemoglobin levels between anthropometric categories and socio-economic factors among women aged 16 to 45 years old in South Africa.

Methods: Data was obtained from the DHS South Africa survey 2016. There were 2662 women between 16 and 49 years old included in the sample. Variables selected for analysis included, height and weight haemoglobin adjusted for altitude, wealth index and access to improved water and sanitation. Variables were tested for normality using Q-Q plots. Frequencies and percentages were reported for categorical data. Non-parametric continuous variables were reported as medians and interquartile ranges. As data was not normally distributed, analysis was conducted using the Kruskall-Wallis test and Mann-Whitney U test. The type I error rate was set to p<0.05. Where it was found that a significant difference exists, post hoc Dunn tests were performed to determine the location of the differences.

Results: Anaemia was prevalent among 30.7% of the sample and 61.8% were either overweight or obese. Haemoglobin levels were significantly different between normal weight women and women with a body mass index in the obese class I and obese class II categories respectively (Kruskall-Wallis =10.992; 4df; p=0.027). There were significant differences in haemoglobin levels between women with access to improved sanitation and those without access (Mann-Whitney U test p=0.038; n=2662), but haemoglobin levels were similar between women with access to improved water and those without (Mann-Whitney U test p=0.685; n=2662). Poorer women had significantly different haemoglobin levels to the wealthiest women in the sample.

Conclusion: The nutritional double burden of disease is present in South Africa among women of childbearing age. A wealth disparity exists among South African women in terms of haemoglobin levels.

Introduction

The nutritional double burden of disease refers to the phenomenon of undernutrition, wasting, stunting, micronutrient deficiency coinciding with overweight, obesity, and diet-related non-communicable diseases, within individuals, households and populations throughout the lifecycle[1]. Individuals may be simultaneously exposed to underlying risk factors for malnutrition including infection, diet quality and physical activity levels[2].

The prevalence of obesity has been increasing across the world, with prevalence doubling in more than 70 countries since 1980[3]. Anaemia affects one third of women of childbearing age globally and continues to be a major health concern across the developing world[4]. Anaemia during the first or second trimesters of gestation is associated with significantly increased risks for low birth weight and preterm births[5].

It is thought that increased consumption of cheap, staple foods and highly processed foods are causing a concurrent problem of overweight and obesity and undernutrition[6]. Inadequate dietary intake is a direct cause of malnutrition. However, factors indirectly related to nutrition are recognised in the development of malnutrition. These factors include inadequate care for women and children, insufficient health services and an unhealthy environment, and the distribution of resources. These factors are termed nutrition sensitive areas for intervention[7].

This study aimed to determine whether there were differences in haemoglobin levels between anthropometric categories and socio-economic characteristics among women aged 16 to 45 years old in South Africa.

Methods

Data was taken from the DHS 2016 public access dataset with permission from the DHS Programme[8]. The DHS programme is a health surveillance system which provides data on basic demographic and health indicators for use by policy makers and programme managers to design and evaluate health programmes. Surveys have been conducted in South Africa in 1998, 2003 and 2016. Children between birth and five years old, women between 15 and 49 years old and men between 15 and 59 years old are included in the survey. The DHS uses a stratified, cluster sampling method. The survey is designed to obtain a representative national estimate for South Africa, as well as for each of the nine provinces in the country. There were 15 292 households selected for the sample, of which 11 083 were successfully interviewed. Among these, 8514 interviews were completed with women between the ages of 15 and 49 years[9]. Data collection methods are presented elsewhere[8]. Data collection methods can be viewed elsewhere[8].

Variables selected for analysis included body mass index (BMI; kg/m2), haemoglobin (Hb) level (g/dL) adjusted for altitude, wealth index, access to improved water and access to improved sanitation. Underweight was defined as BMI<18.5 kg/m2, normal weight was defined as a BMI between 18.5 and 24.9 kg/m2, overweight was defined as a BMI between 25 and 29.9 kg/m2, obese class I was defined as a BMI between 30 and 34.9 kg/m2, obese class II was defined as a BMI between 35 and 39.9 kg/m2 and obese class III was a BMI>40 kg/m2. Anaemia is defined using haemoglobin levels according to WHO classifications. A haemoglobin level below 12 g/dL among non-pregnant women between the ages of 15 and 49 years is defined as anaemic[10]. The DHS household wealth index defines five categories of wealth, ranging from poorest to richest, based on household assets. The definitions and calculations are presented elsewhere[11]. Improved water sources and improved sanitation facilities were identified according to WHO definitions[12].

Data was analysed using SPSS v26[13]. Variables were initially be tested for normality using Q-Q plots. Frequencies and percentages were reported for categorical data. Normally distributed continuous variables were reported and means and standard deviations. Non-parametric continuous variables were reported as medians and interquartile ranges. As the data was not normally distributed, analysis was conducted using the Kruskall-Wallis test. Bivariate categorical indicators were analysed using the Mann-Whitney U test. The type I error rate was set to p<0.05. In cases where a significant difference was detected, post hoc Dunn tests were performed to determine the location of the differences.

Results

A total of 2662 women between 16 and 49 years of age were included in the final analysis after missing data and outliers were removed. The mean age of the women was 30.25 years (9.98). Of the women in the sample, 7.4% had moderate anaemia, and 23.2% had mild anaemia. The mean BMI was 28.05 kg/m2 (6.94). Underweight was prevalent among 3.8% of the women, while 27.5% of the women were overweight, 19.1% were in the obese class I category, 9.1% were in the obese class II category and 6.1% in the obese class III category. It was found that 11.7% did not have access to improved water, and 31% did not have access to improved sanitation.

There was evidence of a significant difference between BMI categories as presented in Table 1 (Independent Kruskall-Wallis test= 10.992; 4df; p=0.027). Post hoc analysis revealed that haemoglobin level in the normal weight category was significantly different to obese class I and obese class II respectively. Haemoglobin levels were significantly different between women with access to improved water and those without access to improved water (p=0.038). Haemoglobin levels were significantly different for wealth index category (Kruskall-Wallis =10.99; 4df; p=0.027) and Dunn’s pairwise tests showed evidence of significant differences between women from the poorer and richest wealth index categories (p<0.05).

*Table 1: Differences in haemoglobin levels adjusted for altitude between anthropometric and socio-economic factors (n=2662).*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Factor | Category | n | Median | 25th | 75th |
| BMI | Underweight | 102 | 12.75 | 11.55 | 13.93 |
| Normal weight | 911 | 12.7ab | 11.3 | 13.8 |
| Overweight | 732 | 12.7 | 11.4 | 13.8 |
| Obese class I | 513 | 12.9b | 12.0 | 13.9 |
| Obese class II | 242 | 13.0b | 11.8 | 14.0 |
| Obese class III | 162 | 13.0 | 11.97 | 14.03 |
| Kruskall-Wallis =10.992; 4df; p=0.027  a,b Denotes statistically significant difference (p<0.05) adjusted by Bonferroni correction for multiple tests | | | | | |
| Access to improved sanitation | Improved sanitation | 1837 | 12.8 | 11.6 | 13.9 |
| Unimproved sanitation | 825 | 12.7 | 11.4 | 13.7 |
| Mann-Whitney U test p=0.038; n=2662 | | | | | |
| Access to improved water | Improved water | 2350 | 12.8 | 11.5 | 13.9 |
| Unimproved water | 312 | 12.85 | 11.7 | 13.8 |
| Mann-Whitney U test p=0.685; n=2662 | | | | | |
| Wealth index | Poorest | 610 | 12.9 | 11.7 | 13.8 |
| Poorer | 562 | 12.6a | 11.3 | 13.7 |
| Middle | 660 | 12.8 | 11.5 | 13.9 |
| Richer | 532 | 12.65 | 11.5 | 13.9 |
| Richest | 298 | 13.05a | 11.8 | 14.0 |
| Kruskall-Wallis =10.99; 4df; p=0.027  a Denotes statistically significant difference (p<0.05) adjusted by Bonferroni correction for multiple tests | | | | | |

Discussion

This study found significant differences in haemoglobin level between BMI categories among women 15 to 45 years old in South Africa. It was also found that haemoglobin levels were significantly different between women with access to improved sanitation compared to those with no access. Household wealth is also related to haemoglobin levels among South African women.

The results of this study suggest that women with obesity have higher haemoglobin levels than underweight, normal weight and overweight women. Women with a normal BMI may be at a higher risk of anaemia. This result locates two features of the double burden of disease- a high prevalence of overweight and obesity, as well as micronutrient deficiency, in South African women. Similar findings have been observed in China, where an inverse relationship was found between anaemia and BMI[14]. While iron intake was not accounted for in the present study, it is possible that iron intake varies between women across all BMI categories. The EAR for iron for women 19-50 years old is 8 mg/day. A study on dietary adequacy among women in KwaZulu-Natal found that underweight women consumed 9.24 mg/day (4.33-10.63), normal weight women consumed 7.68 mg/day (5.53; 11.97) and overweight women consumed 7.29 mg/day (5.50; 9.34) while those in the obese categories consumed 8.12 mg/day (5.86; 11.41)[15]. Basic staple foods have been fortified with iron in South Africa since 2003[16]. However, evidence suggests that foods fortified with iron are not a significant contributor to iron intake in South Africa[17].

Significant differences were observed between wealth index groups for haemoglobin. A similar relationship between wealth status and anaemia in other sub-Saharan African countries. The prevalence of anaemia was 25% higher among the richest women in Burundi compared with the poorest[18].

The current study found an association between access to improved sanitation and haemoglobin levels. Schistosomiasis and protozoan infections are common in areas of poor sanitation, causing diarrhoea and blood loss[19]. In addition to blood loss, enteric infections can contribute to the development of anaemia as inflammation and infection promote the production of hepcidin. Hepcidin is an iron-regulating hormone which prevents iron absorbed into the duodenal cells from entering circulation.

Anaemia during the first or second trimesters of gestation is associated with significantly increased risks for low birth weight and preterm births[5]. Infants born with a low birth weight have been found to be at an increased risk of stunting in Kenya[20]. Stunting risk is higher among children from the Eastern Cape, South Africa, who are born with a low birth weight, even when food insecurity and access to social grants is considered[21]. Therefore, improving the health and nutritional status of women of childbearing age is vital for reducing the burden of childhood malnutrition. Improvements in antenatal care and healthcare for women of childbearing age should be prioritised by the South African Department of Health.

This study reported differences in haemoglobin levels between anthropometric and socio-economic categories. However, reporting haemoglobin on its own may result in overestimations of normal iron status among populations. Obesity is associated with chronic, low-intensity inflammatory processes mediated by the toll-like receptor 4 (TLR4) pathway[22]. Inflammation promotes the production of hepcidin. Inflammatory cytokines including IFN-gamma, TNF-alpha and IL-6 are produced during times of infection. These cytokines down regulate erythropoiesis, the production of new red blood cells. High rates of overweight and obesity is a characteristic of countries facing the double burden of disease. Jordaana *et al*., showed that transferrin saturation is a better indicator of iron status in double burden high obesity prevalence areas[23]. Therefore, this study is limited in that only haemoglobin was used as a marker of iron status. Future research should include biomarkers including ferritin and transferrin to better understand the relationship between anthropometric status and iron status as well as to differentiate between nutritional iron deficiency and other causes of anaemia. A strength of this study is the sampling design undertaken by the DHS.

Conclusion

The nutritional double burden of disease is prevalent in South Africa among women of childbearing age. Overweight and obesity are the primary nutritional concern for this segment of the population, and there is a concurrently high prevalence of anaemia. While who are overweight or obese may be more likely to have normal haemoglobin levels, women in the normal weight category may be at risk of anaemia. Inequality of wealth is also reflected in haemoglobin status among South African women.

References

1. WHO. **The double burden of malnutrition. Policy brief**. Geneva: World Health Organisation 2017.
2. Tzioumis E, Adair LS. Childhood dual burden of under- and overnutrition in low- and middle-income countries: A critical review. **Food and Nutrition Bulletin** 2014 35(2): 230-243.
3. The GBD 2015 Obesity Collaborators. Health effects of overweight and obesity in 195 countries over 25 years. **The New England Journal of Medicine** 2015 377(1).
4. WHO. Malnutrition fact sheet 2020. Available from: <https://www.who.int/news-room/fact-sheets/detail/malnutrition> accessed on 11 November 2020.
5. Haider BA, Olofin I, Wang M, Spiegelman D, Ezzati M, Fawzi WW. Anaemia, prenatal iron use, and risk of adverse pregnancy outcomes: systematic review and meta-analysis. **BMJ**. 2013: 3443:346.
6. Popkin BM, Corvalan C, Grummer-Strawn LM. Dynamics of the double burden of malnutrition and the changing nutrition reality. **The Lancet** 2020 395(10217): 65-74.
7. Ruel, M.T. & Alderman, H. Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? **Lancet** 2013 382(9891): 536-551.
8. National Department of Health, Statistics South Africa, South African Medical Research Council and ICF [Dataset] ZAIR71FL.  **South African Demographic and Health Survey 2016**. Pretoria, South African and Rockville, Maryland, USA [Producers]. ICF [Distributor].
9. Statistics South Africa. South Africa- Demographic and Health Survey 2016; 2019.
10. World Health Organisation. **Worldwide Prevalence of Anaemia 1993- 2005**. WHO 2008.
11. United States Agency for International Development. Demographic and health surveys, data [Internet] 2002. Available from: <http://dhsprogram.com/data>.
12. WHO and UNICEF. **Progress on drinking water, sanitation and hygiene: 2017 update and SDG baselines.** Geneva: World Health Organisation and United Nations Children’s Fund 2017.
13. IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp
14. Qin Y, Melse-Boonstra A, Pan X, Yuan B, Dai Y, Zhou J, Zimmermann MB, Kok FJ, Zhou M, Shi Z. Anaemia in relation to body mass index and waist circumference among Chinese women. **Nutr J** 2013; 12:10.
15. Napier C, Oldewage-Theron W. Dietary intake and nutritional status of adolescent girls and young women in Durban, South Africa. **Journal of Family Ecology and Consumer Sciences** 2015 43.
16. Republic of South Africa (RSA). Department of Health. Government notice. No. R2003. Regulations relating to the fortification of certain foodstuffs. Section 15(1) of the Foodstuffs, Cosmetics and Disinfectants Act, No. 54 of 1972
17. Friesen VM, Mbuya MNN, Aaron GJ, Pachon H, Adegoke O, Noor RA, Swart R, Kaaya A, Wieringa FT, Neufeld LM. Fortified foods are major contributors to apparent intakes of vitamin A and iodine, but not iron, in diets of women of reproductive age in 4 African countries. **The Journal of Nutrition** 2020150(8): 2183- 2190.
18. Jiwani SS, Gatica-Dominguez G, Crochemore-Silva Im Maiga A, Walton S, Hazel E, Baille S, Bosu WK, Busia K, Ca T, Coulibaly-Zerbo F, Faye CM, Kumapley R, Mehra V, Soma SMA, Verstraeten R, Amouzou A. Trends and inequalities in the nutritional status of adolescent girls and adolescent women in sub-Saharan Africa since 2000: A cross-sectional series study. **BMJ Global Health** 2020 5: e002948. doi:10.1136/ bmjgh-2020-002948.
19. Hechenbleikner EM, McQuade JA. Parasitic colitis. **Clin Colon Rectal Surg** 2015 28(2): 79-86.
20. Nshimyiryo A, Hedt-Gauthier B, Mutaganzwa C, Kirk CM, Beck K, Ndayisaba A, Mubiligi J, Kateera F, El-Khatib Z. Risk factors for stunting among children under five years: A cross-sectional population-based study in Rwanda using the 2015 Demographic and Health Survey. **BMC Public Health** 2019 19:175.
21. McLaren SW, Steenkamp L, Feeley A, Nyarko J, Venter D. Food insecurity, social welfare and low birth weight: Implications for childhood malnutrition in an urban Eastern Cape Province township. **SAJCH** 2018 12(3): 95-99.
22. Rogero MM, Calder PC. Obesity, inflammation, toll-like receptor 4 and fatty acids. **Nutrients** 2018 10(4): 432.
23. Jordaana EM, Van den Berga VL, Van Rooyen FC, Walsh CM. Obesity is associated with anaemia and iron deficiency indicators among women in the rural Free State, South Africa. **South African Journal of Clinical Nutrition** 2020 33(3): 72-78.