The prevalence of anaemia among Saudi school girls: a comparison of two techniques

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Abstract

Purpose – Continuous integration of health screens to investigate and track variations in the students' healthiness over time is essential. However, the sustainability of this practice remains challenging. The purpose of this paper is to identify the prevalence of anaemia based on haemoglobin (Hb) estimation among Saudi school girls in Jeddah city by examining capillary and venous blood.

Design/methodology/approach – The design is investigative, using primary data to define the prevalence of anaemia based on two techniques. Samples of venous ($n = 408$) and capillary ($n = 797$) blood from Saudi school girls in Jeddah city was collected and compared using: Reflotron Plus System method (capillary blood) and ABX MICROS 60-OT Automated Haematology Analyser for (venous blood).

Findings – When the capillary blood was used, the prevalence of anaemia was 40 per cent ($n = 319$ out of 797). Using the venous blood, the prevalence was 29.4 per cent ($n = 120$ out of 408). Comparison of Hb data for both tests showed a significant difference in Hb levels with levels between the 10g and 12 g/dl particularly and both measurements demonstrated good agreement (ICC = 0.87, 95 per cent CI (0.845, 0.892)).

Research limitations/implications – The data were collected only in Jeddah city. Further studies should include a national sample that is representative of both gender from different backgrounds and geographical areas in the kingdom of Saudi Arabia.

Practical implications – The high prevalence of anaemia within the school girls' population require decision makers to devise a set of maintainable projects to progress students' general health, including health education and supplementation such as iron, particularly if anaemia is diagnosed to be nutrition-related. This particularly applied to the health centres at female schools that have anaemia screening programmes that going on in Saudi schools.

Originality/value – This study reveals a technique-based measures of anaemia prevalence that have public and practical health implications.

Keywords Saudi Arabia, Anaemia, Capillary, Haemoglobin, School girls, Venous blood

Paper type Research paper

Introduction

School health is a security in a country's future and in the capacity of its people to succeed economically and as a society. Consequently, good health is essential inputs and important outcomes of basic education. Children must be in good physical shape to fully take part in education and gain its greatest benefits. In addition, an early detection of health status for school children can help prevent complications for different diseases (UNESCO, 2002).

Anaemia is reflected as a public health problem in nations of the Eastern Meditation Region, with prevalence figures varying from 14 to 42 per cent among adolescents (Bagchi, 2004).

Haemoglobin (Hb) concentration is the most common test used in screening anaemia. The correct interpretation of Hb values requires the considered changing factors such as age and gender in selecting appropriate cut-off values. Interpretive reference data of Hb

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are age- and sex- oriented and different data sets are available. Adolescent anaemia was defined using the WHO (1994) cut-off values for Hb which is < 12.0 g/dl for 12-14 years and 15 + girls. In Saudi Arabia, the health centres at female schools have a continuous anaemia-screening programmes going on at all education levels (Aljaaly, 2012).

Full assessment could be applied where field settings, participants' consent and good funds are available; Hb concentration should be assessed based on venous blood method. However, the capillary-based method can be used for surveys conducted for anaemia screening such as those directed by the School Health Department in Saudi Arabia (Aljaaly, 2012).

Saudi studies on anaemia used diverse approaches for gathering and analysing samples of blood to identify Hb levels such as the HemoCue tests and venepuncture. Different cut-off values to interpret Hb values were also used (Abou-Zeid *et al.*, 2006; Abalkhail and Shawky, 2002).

The Saudi data on anaemia show that anaemia is a frequent problem in Saudi children and adolescents and different types of anaemia were reported. Anaemia types included both nutritional such as iron deficiency anaemia and genetic (hemoglobinopathies or inherited Hb defects, such as sickle-cell-anaemia or thalassaemia) (Aljaaly, 2012). A national pre-marital screening programme is going on in Saudi Arabia to define genetic disorders, including the sickle-cell gene and the thalassaemia (El-Hazmi, 2004).

In Jeddah city, anaemia was prevalent among 21 per cent ($n = 800$) school students of both genders (5-11, 12-14 and 15+ years) (Abalkhail and Shawky, 2002).

Materials and methods

Hb level was investigated among intermediate (13-15 years old) and high school students (16-18) for both Saudi and non-Saudi using the following two methods.

The capillary based technique (finger prick test) using the Reflotron® Plus System method by Roche

This system incorporates a plasma-separating system, which allows the use of the whole blood as well as serum and plasma. Participants' blood was collected into capillary blood collection tubes suitable for Hb tests and all instructions and precautions during capillary blood collection was followed strictly. Results were recorded immediately using a specific serial number applied to each participant. The Reflotron® method is used as a quantitative approach in determining some clinical chemistry parameters, including Hb concentrations. The Reflotron Plus system works on the principle of reflectance photometry and is simple in use. It consists of a portable, battery-operated photometer and a supply of a capillary blood collection system, which includes test strips. The capillary blood collection system is designed for tests using undiluted specimens. The Reflotron system incorporates a plasma-separating system, which allows the use of the whole blood as well as serum and plasma. It includes control materials for checking the performance and cleaning of the system. Participants' blood was collected into capillary blood collection tubes suitable for Hb tests (Roche, 2010).

The venous blood technique (venepuncture test)

Blood samples were collected by a phlebotomist and analysed using the (ABX MICROS 60-OT Automated Haematology Analyser. Part number: RAB042 AInd.D). The same

code number used for a participant in the first method, used for the second method. The venepuncture test carried out to confirm the capillary values. The WHO (1994) cut-off levels for anaemia used to interpret Hb values (blood Hb < 12.0 g/dl for 12-14 years and 15+). Precision, accuracy, and reliability of venepuncture test was approved by Morris *et al.* (1999).

A comparison between capillary and venous was done among students who agreed to do both tests ($n = 408$ students).

Statistical analysis

SPSS PASW Statistics for Windows (version 18) was used in entering, managing data and in generating the statistics in this study.

Mean, SD, percentages and χ^2 were used. The significant levels of $p < 0.05$ unless otherwise mentioned. Intraclass correlation test (Doi and Williams, 2013; Indrayan, 2012) was conducted to calculate the agreement between both techniques on participants who had done both tests ($n = 367$).

Exclusion criteria

Those reported to have sickle cell anaemia or thalassaemia minor as previously diagnosed and reported by participants were excluded from the analysis concerning intraclass correlation test.

Ethical consideration

An ethical clearance obtained from the Ethics and Research Committee at Medical Applied College, King Abdulaziz University and the School Health Department at Ministry of Education in Saudi Arabia. Then, information letters and consent forms were provided to students and their parents before collecting data. Students who returned their letters completed and signed to withdraw blood were agreed by the main researcher to participate in the survey.

Results

Anaemia prevalence using capillary blood or FP samples was 40 per cent ($n = 319$ out of 797) (Table I) and data for Hb concentration was normally distributed (Figure 1) (mean $= 12.24 \pm 1.24$ g/dL) (Table II). While, the prevalence of anaemia based on measured venous blood samples was 29.4 per cent ($n = 120$ out of 408) (Table I) and distributions of data tended to be positively skewed (Figure 2) (mean $= 12.38 \pm 1.22$ g/dL) (Table II) for the surveyed population. Hb data of both tests were compared, and results showed a significant difference in results of Hb level with levels between the 10 and 12 g/dl particularly. Both measurements demonstrated good agreement (ICC $= 0.87$, 95 per cent CI (0.845, 0.892)). Anaemia prevalence did not statistically differ by age group or nationality (Saudi or non-Saudi) (Table III). Anaemia was higher among the older age group (16-18 years); compared to younger grouped (13-15 years) but results

Table I.
Prevalence of anaemia according to method of blood sample collection and analysis: FP & venous tests

Diagnosis of anaemia	Diagnosis of anaemia (FP) $n = 797$ (%)	Diagnosis of anaemia (venous) $n = 408$ (%)
Anaemic	319 (40)	120 (29.4)
Non-anaemic	478 (60)	288 (70.6)

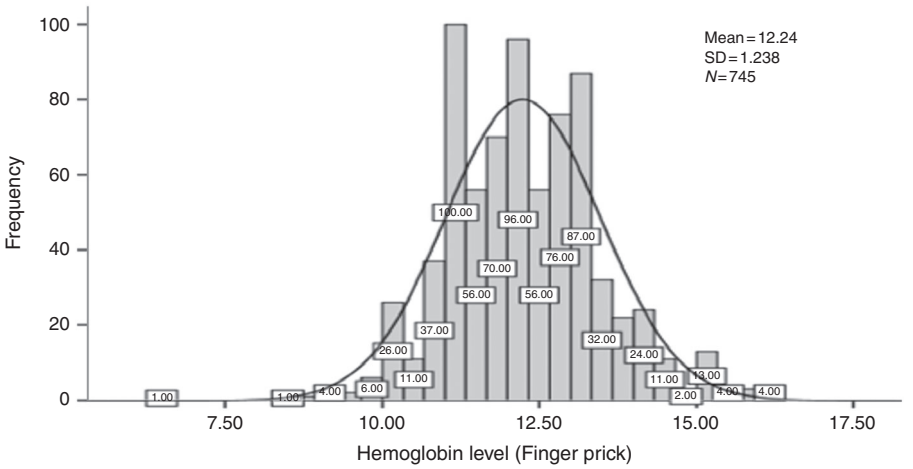

Figure 1. Haemoglobin distribution data: finger prick

Haemoglobin Level	Minimum	Maximum	(mean±SD)
Haemoglobin (gm/dL) (FP)	6.34	16.10	12.24 ± 1.24
Haemoglobin (gm/dL) (V)	6.60	15.80	12.38 ± 1.21

Table II. Haemoglobin (Hb) concentrations based on FP & V blood method

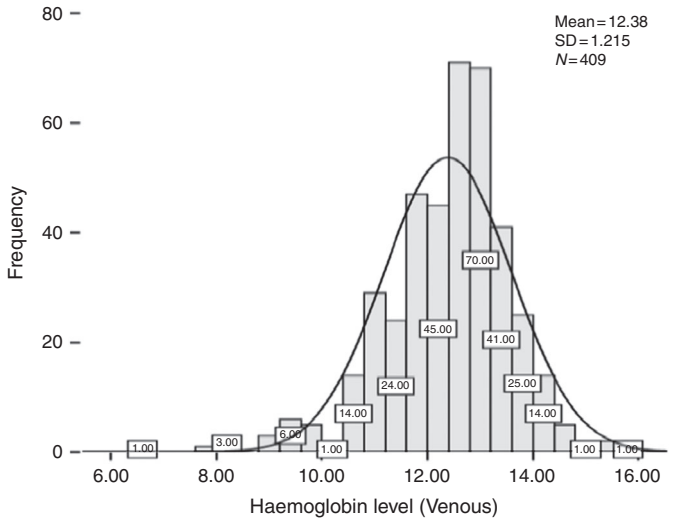

Figure 2. Haemoglobin distribution data: venous blood

did not reach statistical significance between the two groups. Anaemia was significantly more prevalent among those attending governmental sponsored schools (34 per cent), compared to their counterparts in private schools (18 per cent), $p = 0.002$. Although there was no significant association between anaemia prevalence and

Table III.
Association between anaemia prevalence and characteristics of participants

	Anaemia measured by venous blood (Hb < 12.0 g/dl) Total number of anaemic (%)	*p*-value*
Age group (408)		
13-15 years (237)	66 (28)	$p = 0.41$
16-18 years (171)	54 (32)	
Nationality (408)		
Saudi (249)	69 (28)	$p = 0.34$
Non-Saudi (159)	51 (32)	
Type of school (408)		
Public (293)	99 (34)	$p = 0.002$
Private (115)	21 (18)	

Note: *$p < 0.05$

nationality, Saudi girls showed lower proportion of anaemia ((28 per cent); $n = 69$ out of 249 of all Saudi), compared to non-Saudi girls ((32 per cent); $n = 51$ out of 159 of all non-Saudi).

Intraclass correlation test showed an agreement between both techniques on participants who had done both tests ($n = 367$) and demonstrated a good agreement between both tests (ICC $= 0.87$, 95 per cent CI (0.845, 0.892).

Discussion

Regardless the school level, age group or nationality, anaemia is considered as an important public health problem among Jeddah school girls in public and private sector. The 29 per cent (venous blood test) to 40 per cent (finger blood test) of adolescent girls who were anaemic by the WHO definitions of anaemia (Hb < 120 g/L) classify young girls as having a moderate-to-severe public health problem of anaemia (20-39.9 per cent and > 40 per cent), respectively (De Benoist *et al.*, 2008). The measure of Hb depending on HemoCue and automated haematology analysers are available and continues to be used in other developing countries (Srivastava *et al.*, 2014).

Measuring Hb using automated haematology analysers is expensive. However, results are more reliable and accurate than Reflotron systems® that are used to measure Hb using capillary. The Reflotron® is not the only portable dry reagent analyser used to assess HB and there is a well-known system that is called a HomeCue (Srivastava *et al.*, 2014).

The present study found that Hb concentration measured using capillary-based systems has lower levels of precision, compared to that measured using the automated analyser. This is in agreement with results from other Arab female population (Adam *et al.*, 2012).

In some countries, health screens and interventions are significantly decreasing the levels of anaemia among students in a period for five-year. They are also integrated every year to track changes in the population's health over time (Brar *et al.*, 2012). This study is a call for school health officials and researchers to collect data on regular basis. This particularly applied to the health centres at female schools that have anaemia-screening programmes going on at present. As recommended by WHO (2005), anaemia and its potential consequences on school girls should be prevented and treated. Childhood health care programmes earlier at primary schools could expand children's

health and enhance the learning and educational outcomes of school children, particularly girls (UNESCO, 2002). Therefore, we recommend that the decision makers in these health centres do primary screening tests using capillary and do further full assessment tests for those who demonstrated to have low Hb values to confirm anaemia and its types. Continuous earlier screening for anaemia at primary schools is recommended for health sustainability.

Moreover, when conducting research on school children, the collected data need to include a comprehensive information on anaemia status. This is to apply intervention programmes whenever is applicable. To approach sustainable development for such valuable programmes, joint diverse groups of actors, such as academics, practitioners and the general public, should cooperate together to conduct this type of research.

Conclusion

This study revealed a technique -based estimates of anaemia prevalence with different findings that have practical health implications at national level. The prevalence of anaemia (Hb < 12 g/dl) range between 29 and 40 per cent based on FP and venous blood respectively. Therefore, we recommend that the decision makers in Saudi health centres to do primary screening tests using capillary from the finger and do further full screening tests for those who shown to have low Hb values to confirm results of anaemic status.

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