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Simple clinical criteria for diagnosing severe or moderate anaemia in adolescent girls in community settings where haemoglobin testing is not readily available

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1. Introduction

"The problem of malnutrition is a curse that we must remove"

Prime Minister of India, August 15, 2008 Independence Day Speech

The Global Burden of Disease (GBD-2000) estimates that the following countries of South Asia: Bangladesh, Bhutan, Korea, India, Maldives, Mayammar, and Nepal contribute one-fifth of the global population, but contribute to more than 40% of the deaths due to anaemia and almost one-third of the Disability Adjusted Life Years (DALYs) are lost due to anaemia. If anaemia symptoms are left untreated, the symptoms only worsen, rendering the afflicted person very tired and weak, with a chance of developing angina or suffering leg pains while walking. The body's ability to fight infection may also be weakened, thus increasing susceptibility to picking up infections (Nynke 1998). Anaemia is usually defined as haemoglobin concentration below normative cut-off values that are based on age, sex, physiologic state and altitude (WHO, UNICEF and UNU 1998). Among non-pregnant women a haemoglobin level below 12.0 grams/deciliter (g/dl) or Hematocrit below 36% are the cutoffs used to define anaemia in people living at sea level. Among reproductive age group (15-49) women in India, anaemia is widespread, with a prevalence of 55% in 2005-06 (NFHS-3). The incidence of anaemia among ever-married women in India has worsened during the period 1998-99 to 2005-06, with a marginal rise from 52% to 56%.

As anaemia afflicts a huge number of women, its severity in non-pregnant women has been categorised into three levels (WHO, UNICEF and UNU 1998): mild anaemia (10.0-11.9 g/dl), moderate (7.0-9.9 g/dl), severe (less than 7.0 g/dl). According to NFHS-3 estimates, in India 2% of women aged 15-49 years were severely anaemic and 15% moderately anaemic. Again, among adolescent girls/women age 15-19 years, 1.4% were severely anaemic and 12.1% were moderately anaemic. The health risks associated with severe or moderate anaemia are profound. A significant body of evidence supports a causal relationship between severe anaemia and child mortality and maternal mortality, although evidence is lacking or contradictory for the causal relationship between mild/moderate anaemia and child mortality and maternal mortality (Stoltzfus 2001). Severe anaemia is associated with decreased

oxygen-carrying capacity of red blood cells. If acute or prolonged, this condition can lead to congestive heart failure and ultimately death. There is also evidence that moderate anaemia is associated with changes in motor and cognitive development in young children (Zlotkin and Parkin 2009). Because of the negative effects, both severe and moderate anaemia should be prevented if possible, and treated if present.

International recommendations advocate for the early detection and treatment of severe anaemia in primary care settings where its prevalence in population groups such as pregnant women exceeds 2% (Stoltzfua and Dreyfuss 1998). Because of the low cost and feasibility, the WHO has included evaluation of palmar pallor to detect severe anaemia in its algorithm for management of the sick child (WHO and UNICEF 1995). However, in many primary care settings including in many parts of India, haemoglobin or hematocrit cannot be determined on a routine basis, even in the high risk groups. In those settings where the measurement of haemoglobin is not readily available, and even if available, is not affordable, given the magnitude of the problem, there is an immediate need for developing a simple clinical method to identify severe/moderate anaemia in communities, for early initiation of care or referral.

The objective of this study was to develop a simple clinical criterion, enabling adolescents or health workers in communities to identify adolescent girls/women likely to develop moderate or severe anaemia, and then to identify the danger signs or symptoms, subsequently alerting them to seek care for the condition. We did this by evaluating a set of 18 clinical signs/symptoms as predictors of anaemia, and by using a haemoglobin cut-off value of <10.0 g/dl as the 'gold standard' for severe/moderate anaemia.

2. Methods

To develop the screening criteria for diagnosing adolescent girls at risk of severe or moderate anaemia, we used the data collected by the Vistaar Project of IntraHealth International Inc., from its baseline survey in Jharkhand state, India. The baseline survey covered Garhwa, Chatra, Latehar, Hazaribagh and Ramgarh districts of the state, among the adolescent girls aged 15-19 at the time of survey (November-December 2008). A sample size of 1000 adolescent girls was fixed for each district, drawn from 100 primary sampling units (PSUs) spread over all the geographic regions of the district. In order to obtain statistically robust

rural and urban estimates 25 percent of the sample for each district was obtained from the urban areas.

A two-stage stratified random sampling design was adopted for respondent selection. The first stage was the selection of the villages/wards using a probability proportionate to size (PPS) systematic random sampling procedure, and the second stage was the selection of the segments/sectors from within the selected village/ward, using a simple random sampling procedure. From the selected segments/sectors, all the adolescent girls aged 15-19 years at the time of survey, irrespective of their marital status, were listed and selected for interview. Standardized bilingual questionnaires in Hindi and English were used for collecting information from the respondents.

A team of eight quality assurance officers was appointed by the Vistaar Project for monitoring and supervision throughout the training and fieldwork period, to ensure that correct survey procedures were followed and that data quality was maintained. In addition to the survey, baseline data were also collected on anaemia levels among the adolescent girls. A team of 15 health investigators (trained in pathological testing) were trained by a resource person in methods of blood collection, haemoglobin measurement using HemoCue Hb 201+ instrument, ethical requirements, and bio-hazard waste disposal. These health investigators measured the haemoglobin levels of adolescent girls while female investigators conducted the interviews. For the baseline survey 4824 interviews were completed, out of which 4465 (93%) of the adolescent girls agreed to have their haemoglobin measured as well. Only the data obtained from these 4465 adolescent girls was used for developing the screening criteria.

Screening tests are usually evaluated for their performance against some recognized standard called ‘gold standard’. The measures of performance are sensitivity (ability of the test to correctly identify those who have the disease, i.e. true positive individuals) and specificity (ability of test to correctly identify those who do not have the disease, i.e. true negative individuals). The lower the specificity, the higher the yield (which includes true positives and false positives), making it more difficult and costly to find the true positives and to provide focused attention or care or referral. Ideal screening criteria is the one with high sensitivity, high specificity and low yield (Morrison AS 1998).

In the present analysis, as per the international norms for non-pregnant women at sea level (WHO, UNICEF, UNU 1998), a haemoglobin level of <10.0 g/dl was used as the cut-off value to classify an adolescent girl or woman as severely or moderately anaemic.

The baseline survey also collected information about the occurrence of 18 anaemia related signs or symptoms which the adolescent girls may have experienced at any time during the past six months. This current study has used these 18 signs/symptoms, as indicators for the clinical diagnosis of severe or moderate anaemia. The association of each of these 18 signs with severe or moderate anaemia was estimated, first by preparing 2x2 contingency table and then by calculating odds ratio (OR) and the 95% confidence interval for the OR. Those signs with significant association (lower limit of CI, >1.0) were selected for further analysis.

Only nine of the 18 signs showed significant association with severe or moderate anaemia. For these nine signs sensitivity and specificity to predict severe or moderate anaemia were calculated, first individually and then for a 'prediction rule' of the presence of at least one or more of nine signs, the presence at least two or more of nine signs, the presence of at least three or more of nine signs, the presence of at least four or more of nine signs, and the presence of at least five or more of nine signs. A Receiver Operating Characteristic (ROC) curve was plotted in which the point closest to the upper left corner gives the best 'prediction rule' in the sense of balancing sensitivity and specificity (Bang AT et al. 2005).

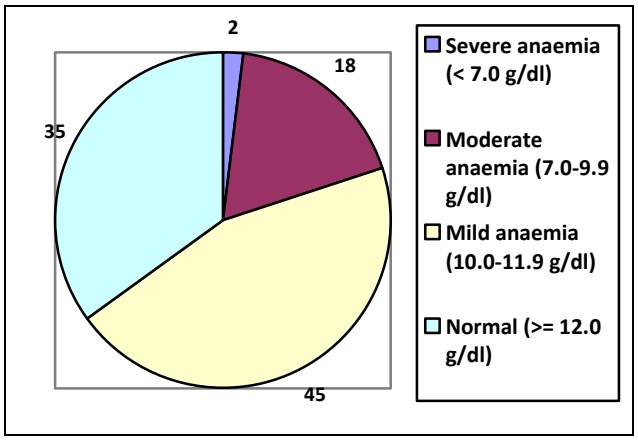
To reduce the number of criteria and to make the final set of criteria manageable for use in the field conditions and to focus on those signs that were independently associated with severe or moderate anaemia, we did logistic regression with backward elimination, using SPSS 11 version, and identified five 'core signs'. After estimating sensitivity, specificity and yield for the presence of at least one or more of those 'five core signs' and its association with severe or moderate anaemia, we tried to improve the criteria further by individually adding the other four signs, one at a time, and evaluated the performance of the rule 'presence of at least one or more of five core signs plus another sign' with severe or moderate anaemia, as the best screening criteria for identifying severe or moderate anaemia in the field conditions.

3. Results

The Vistaar baseline survey covered a total of 4465 adolescent girls aged 15-19 years with information on 18 anaemia related signs or symptoms as well as Hb measurement, from five districts of Jharkhand. The mean haemoglobin level of the 4465 adolescent girls was 11.2 g/dl, substantially less than the cut-off of 12.0 g/dl used to define anaemia in non-pregnant women living at sea level (WHO, UNICEF, UNU 1998). Severity of anaemia in adolescent girls was classified at three levels: mild anaemia (Hb 10.0-11.9 g/dl), moderate anaemia (Hb 7.0-9.9 g/dl), and severe anaemia (Hb less than 7.0 g/dl). According to this classification, 65% of the girls in the sample were anaemic, 45% being mildly anaemic while 2% were severely anaemic and 18% were moderately anaemic (Figure 1). The 20% with severe or moderate anaemia were in need of immediate treatment to reverse their condition.

Percent prevalence of anaemia in adolescent girls in this baseline survey matched with the NFHS-3 (2005-06) survey in Jharkhand state among the girls aged 15-19 years, in which two-thirds were found to be anaemic and 19% had severe/moderate anaemia.

Figure 1: Percent prevalence of anaemia among adolescent girls aged 15-19 years



Percent prevalence of severe or moderate anaemia among adolescent girls varied significantly by different socio-economic and educational groups (Table 1). The prevalence of anaemia was significantly higher among the adolescent girls from the rural areas and those belonging to the scheduled caste and tribes compared to the girls from the urban areas and those from the forward castes. Among the socio-economic factors impacting on prevalence, illiteracy of the adolescent girl had significantly strong association with severe/moderate anaemia, while the association of household standard of living on anaemia was marginal.

Table 1: Association of severe/moderate anaemia with background characteristics of adolescent girls

Equity characteristic	Severe or moderate anaemia	
	% Girls	Odds Ratio
Place of residence		
Rural	20.7	1.00
Urban	17.7	0.65**
Caste		
Scheduled caste/tribe	29.1	1.00
Other backward caste	18.1	0.79
Others (Forward caste)	17.5	0.70**
Standard of living index		
Low	22.4	1.00
Medium	19.1	0.70*
High	19.9	0.84
Literacy of adolescent		
Illiterate	25.1	1.00
Dropout	20.5	0.73*
Currently studying	18.6	0.65**
Total	**20.4**	--

Significance of Odds Ratio in Logistic Regression: * p value < 0.05, ** p value < 0.005

Table 2 presents the inter-relationship between occurrence of a symptom and presence of severe or moderate anaemia (Hb <10.0 g/dl as measured on the day of the survey) for each of the 18 anaemia signs/symptoms experienced by the girls in the past six months. Of the 18 signs/symptoms whose association with severe/moderate anaemia was estimated, only nine signs showed significant association (lower limit of 95% CI of OR > 1.0). These nine significant anaemia signs/symptoms were selected for further analysis. Table 2 also indirectly shows the sensitivity (percent among severe/moderate anaemia cases) and the specificity (100% among non-cases) of each sign with severe or moderate anaemia. If 'presence of any one or more of the nine significant signs' is to be used as clinical criteria for diagnosing severe/moderate anaemia, this criteria has a sensitivity of 71% (ability to correctly diagnose true cases, i.e. with severe/moderate anaemia) and specificity of 38% (ability to correctly diagnose true negatives, i.e. without severe/moderate anaemia), with a yield of 64% (percent of adolescents identified as severe or moderate anaemic cases). By adopting these diagnostic criteria, two out of three adolescent girls will be diagnosed as severely/moderately anaemic. Even though sensitivity is good (71%), this criteria is picking up too many false positives resulting in higher yield. In order to improve specificity further and to reduce the yield, we did further analysis of the data.

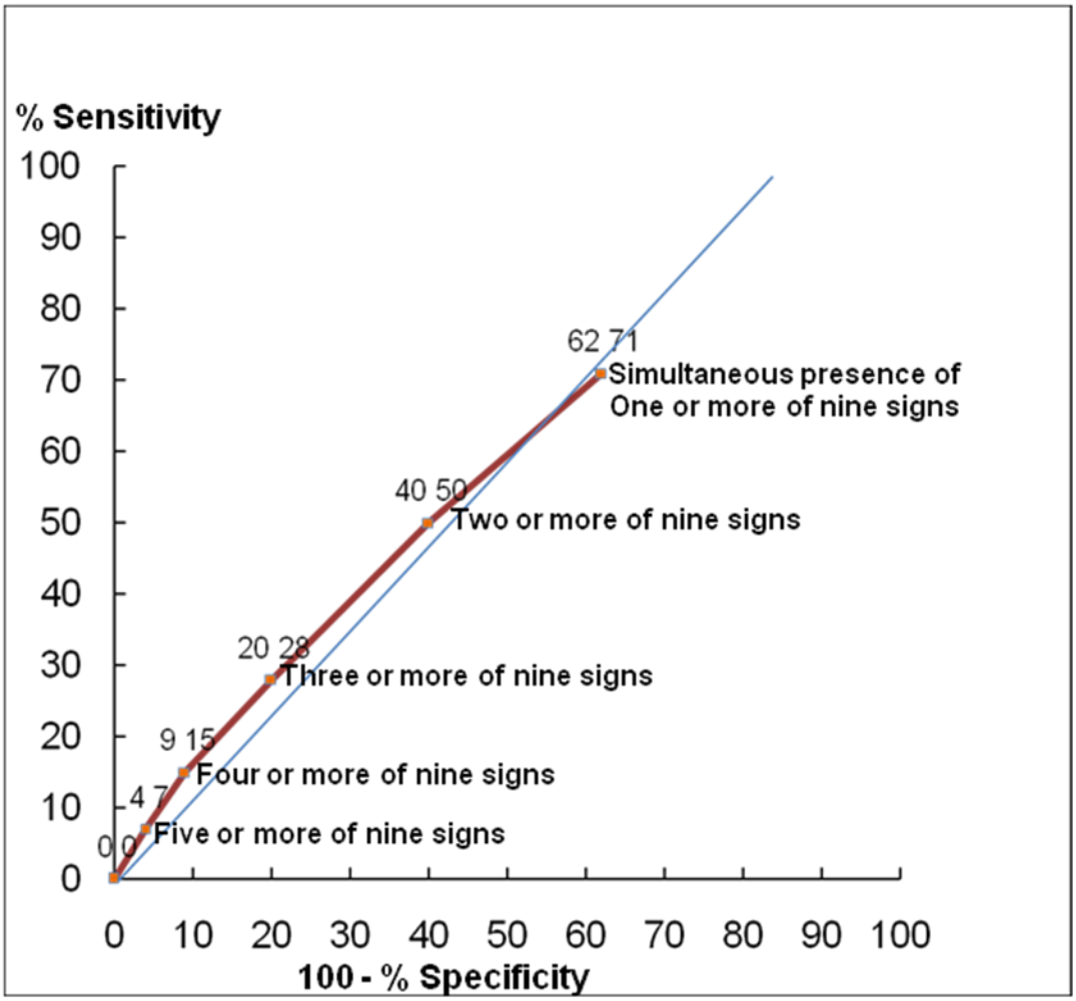
Table 2: Frequency of clinical signs and symptoms and their association with severe or moderate anaemia

Sign/symptom present at least once during the past six months	Present in Severe/ Mild anaemia cases (n=911)		Present in non-Severe/ Mild anaemia cases (n=3554)		Odds Ratio (95% CI)
	No.	%	No.	%	
Dizziness	363	39.8	1152	32.4	1.4 (1.2-1.6)*
Fatigue	447	49.1	1529	43.0	1.3 (1.1-1.5)*
Feverish	439	48.2	1780	50.1	0.9 (0.8-1.1)
Breathlessness	116	12.7	286	8.0	1.7 (1.3-2.1)*
Swelling of legs	69	7.6	277	7.8	1.0 (0.7-1.3)
Less appetite	213	23.4	709	20.0	1.2 (1.1-1.5)*
Pallor skin	49	5.4	96	2.7	2.0 (1.4-2.9)*
Scores in the corner of the mouth	105	11.5	263	7.4	1.6 (1.3-2.1)*
Smooth/shiny/dry tongue	30	3.3	103	2.9	1.2 (0.8-1.7)
Spontaneous bleeding	38	4.2	121	3.4	1.2 (0.9-1.8)
Abdominal pain due to ulcer/worms	80	8.8	369	10.4	0.8 (0.6-1.1)
Piles	11	1.2	64	1.8	0.7 (0.4-1.3)
Gastric problem	115	12.6	447	12.6	1.0 (0.8-1.3)
Fever with cold	171	18.8	692	19.5	1.0 (0.8-1.2)
Frequent headache	228	25.0	810	22.8	1.1 (1.0-1.4)
Frequent vomiting	104	11.4	326	9.2	1.3 (1.1-1.6)*
Feel unconscious	79	8.7	178	5.0	1.8 (1.4-2.4)*
Fever with cough	127	13.9	358	10.1	1.5 (1.2-1.8)*
Any one or more of above signs present	**760**	**83.4**	**2813**	**79.2**	**1.3 (1.1-1.6)***
Any one or more of nine significant signs	**649**	**71.2**	**2214**	**62.2**	**1.5 (1.3-1.8)***

* Signs with significant association with severe/moderate anaemia.

By measuring sensitivity and specificity for presence/occurrence of one or more of the nine significant signs in Table 2 presence of two or more of nine signs; presence of three or more of nine signs; presence of four or more of nine signs; and presence of five or more of nine signs, a receiver operating characteristic (ROC) curve was plotted (Figure 2) as the evaluation criteria for balancing sensitivity and specificity for the nine significant signs of Table 2. From Figure 2 it is evident that 'presence of any two or more of the nine signs' gives the best performance in terms of balancing sensitivity and specificity, as this point is closest to the upper left corner of the figure. Thus, on the basis of ROC curve we selected 'presence of two or more of the nine signs' as the 'prediction rule'.

Figure 2: Receiver Operator Characteristic (ROC) curve to decide the number of signs needed to clinically diagnose severe/moderate anaemia in adolescent girls



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In order to reduce the number of criteria and to make final diagnostic criteria manageable for use in the field conditions and also to focus on those signs that were independently associated with severe or moderate anaemia, we did logistic regression with backward elimination by using the nine signs that showed significant association with severe/moderate anaemia as predictors and presence or absence of severe/moderate anaemia as dependent variable. The results of logistic regression analysis are in Table 3, and the analysis identified five signs/symptoms (Table 3) that independently showed significant association with severe/moderate anaemia.

Table 3: Clinical signs/symptoms selected by Logistic Regression for their significant association with severe and moderate anaemia

Presence of Sign/Symptom in last six months	Beta	Odds ratio	95% CI	P value
Dizziness	0.204	1.23	1.05 - 1.44	<0.012
Breathlessness	0.288	1.33	1.04 - 1.70	<0.022
Pallor of skin	0.452	1.57	1.09 - 2.27	<0.017
Sores in the corner of the mouth	0.346	1.41	1.10 - 1.81	<0.007
Feel unconscious	0.383	1.47	1.10 - 1.96	<0.010

The five signs/symptoms identified by the logistic regression analysis are considered as ‘core signs’ and the presence of any one or more of the five core signs to predict severe or moderate anaemia gave a sensitivity of 51% and specificity of 60% with a yield of 43% (Table 4). As the prediction rule identified simultaneous presence of two or more signs, which gives the best balance between sensitivity and specificity, we tried to strengthen the diagnostic criteria further by measuring sensitivity, specificity and yield for the simultaneous presence of any one or more of five ‘core signs’ plus the presence of fatigue; any one or more of five ‘core signs’ plus the presence of less appetite; any one or more of five ‘core signs’ plus the presence of frequent vomiting; and any one or more of five ‘core signs’ plus the presence of fever with cough (Table 4).

From Table 4 it may be noted that, when the other four signs rejected by the logistic regression analysis were added to the core criteria, one at a time, the performance of the criteria improved in terms of increase in sensitivity, even though there was marginal drop in the specificity, in comparison to the performance based only on one or more of five core criteria. Based on this analysis we selected the presence of “any one or more core criteria signs (Dizziness, Breathlessness, Pallor of skin, Sores in the corner of the mouth, Feel unconscious) plus Fever with Cough” as the best clinical criteria for diagnosing severe or moderate anaemia in adolescent girls aged 15-19 years in community where haemoglobin

testing is not readily available. The criteria selected by us provide a sensitivity of 55%, specificity of 56% and a yield of only 46%. It implies that the criteria selected by us will select less than half of the adolescents as severely or moderately anaemic, out of which almost three in five are true cases and the criteria also rejects 60% true negatives.

Table 4: Evaluation of various sets of clinical criteria to predict severe/moderate anaemia in adolescent girls, N=4465, severe/moderate anaemia cases: 911.

Clinical criteria	True Positive	False Negative	False Positive	True Negative	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)	Yield (% adolescent girls selected as severe / moderate anaemic)
Clinical Core Criteria (One or more of the following signs) • Dizziness • Breathlessness • Pallor of skin • Sores in the corner of the mouth • Feel unconscious	463	448	1440	2113	50.8	59.5	24.3	82.5	42.6
Core criteria and Fatigue	596	315	1973	1580	65.4	44.5	23.2	83.4	57.5
Core Criteria and Less Appetite	523	388	1726	1827	57.4	51.4	23.3	82.5	50.4
Core Criteria and Frequent vomiting	483	428	1529	2024	53.0	57.0	24.0	82.5	45.1
Core Criteria and Fever with cough	**498**	**413**	**1558**	**1995**	**54.7**	**56.1**	**24.2**	**82.8**	**46.1**

Table 5: Evaluation of various sets of clinical criteria to predict anaemia in adolescent girls, N=4465, anaemia cases: 2917.

Clinical criteria	True Positive	False Negative	False Positive	True Negative	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)	Yield (% adolescent girls selected as severe / moderate anaemic)
Clinical Core Criteria (One or more of the following signs) • Dizziness • Breathlessness • Pallor of skin • Sores in the corner of the mouth • Feel unconscious	1306	1611	598	950	44.8	61.4	68.6	37.1	42.6
Core criteria and Fatigue	1731	1186	839	709	59.3	45.8	67.4	37.4	57.6
Core Criteria and Less Appetite	1535	1382	715	832	52.6	53.8	68.2	37.6	50.4
Core Criteria and Frequent vomiting	1378	1540	636	912	47.2	58.9	68.4	37.2	45.1
Core Criteria and Fever with cough	1419	1498	638	910	48.6	58.8	69.0	37.8	46.1

We further tested the performance of five core signs/symptoms identified by the logistic regression analysis to predict any anaemia (Hb < 12.0 g/dl). We got a sensitivity of 45% and specificity of 61% with a yield of 43% (Table 5). When the other four signs rejected by the logistic regression analysis were added to the core criteria in the diagnosis of any anaemia, one at a time, the performance of the criteria improved in terms of increase in sensitivity and drop in the specificity.

4. Discussion

This retrospective analysis based on 4465 adolescent girls from five districts of Jharkhand state, India, identified a decision rule and a set of six clinical signs for detecting adolescent girls who are at risk of developing severe or moderate anaemia, in the community settings where haemoglobin testing is not readily available. This detection methodology had 55% sensitivity, 56% specificity and 24% predictive value (Table 4). Using these criteria, 46% of the adolescent girls from the community would be identified as suspected cases of severe or moderate anaemia instead of the 20% identified by the baseline survey. As will be seen shortly hereafter, the augmented diagnosis of moderate and severe cases of anaemia could have positive aspects for the adolescent girls in the community. The criteria did not perform so well for any anaemia (Hb < 12.0 g/dl) in adolescent girls (Table 5), with slight drop in sensitivity (49%) and marginal improvement in specificity (59%), even though yield remained the same at 46%.

Is the criteria developed by us to detect severe or moderate anaemia in adolescent girls performing poorly because of only 55% sensitivity and 56% specificity? Are the clinical signs/symptoms used by us to detect severe/moderate anaemia appropriate? Or did we miss any important signs/symptoms? Stoltzfus et al. (1999) used clinical pallor of the conjunctiva, palm and nail beds in 5760 pregnant and post partum women in Nepal and Zanzibar to detect severe anaemia by non-physician health workers and haemoglobin cut-off value for severe anaemia as <7.0 g/dl. Pallor at any of the three study sites detected severe anaemia with >84% specificity, while sensitivity varied from 81% in Nepalese post-partum women to 29% in Zanzibari preschoolers. The authors concluded that use of pallor to screen and treat severe anaemia by primary care providers is feasible and worthwhile, where severe anaemia is common. In another clinical based study in Denmark (Gjorup T et al. 1986), three physicians independently assessed whether 180 medical or surgical inpatients were anaemic. The assessments were based on inspection of skin, nail beds, and conjunctivae. The overall

accuracy of the clinical diagnoses was determined with the blood haemoglobin concentration as the "true" standard. For the three observers, the overall accuracy ranged from 0.78–0.79, the predictive value of a positive diagnosis ranged from 0.51–0.61, the predictive value of a negative diagnosis ranged from 0.81– 0.84, the sensitivity ranged from 0.27–0.44, and the specificity ranged from 0.88– 0.95.

In a study among Mexican adolescent men and women aged 12 years or above (Sanchez-Carrillo, et al. 1989) colour shades resembling the conjunctiva showed 58% sensitivity and 86% specificity for Hb of 7-11 g/dl. While, Khan et al. (1990) in their urban community study in India found sensitivity for clinical pallor was 32%. On the other hand Ghosh and Mohan (1978) found field workers were able to correctly identify 100% with severe anaemia (6 g/dl), 66% with moderate anaemia (6-9 g/dl), and 50% with mild anaemia (9-11 g/dl) using anaemia recognition card. Thus, most of the literature confirms that pallor is a useful sign to detect severe anaemia, but is insensitive to detect mild anaemia (Stoltzfus R J et al. 1999). In a meta analysis of 13 clinical studies from developing countries using clinical pallor as the clinical sign for detecting anaemia at different cut off points the sensitivity ranged from 16%-100% and specificity ranged from 41%-96% (Erin Dusch et al. 1996). The criteria developed by us are performing reasonably well in comparison to other similar clinical studies in developing counties, in terms of sensitivity and specificity.

Our analysis had an additional advantage as the clinical diagnostic criteria include other than pallor and are providing reasonably good diagnostic criteria to detect not only severe anaemia and also moderate anaemia. Thus the modest sensitivity (55%) and specificity (56%) for the criteria developed by us are acceptable even though they identify augmented numbers, 1558 (34%), of the girls in the community, with moderate or severe anaemia. Firstly, the outcome of the diagnosis is not fatal and secondly, the additional numbers diagnosed with moderate or severe anaemia actually benefit the adolescents, as the treatment they will receive for the condition will only be beneficial for their general health status. Thus, the costs of this over diagnosis are low compared to the benefits the adolescents will receive. Hence the moderate specificity (56%) of our criteria is feasible and worthwhile for adoption in field conditions.

The Ministry of Health and Family Welfare, Government of India has set different sets of guidelines for suspecting, recognizing and confirming cases of iron deficiency anaemia, depending on the level of the health facility at which the case appears. At level one facilities the health personnel suspect that a patient has iron deficiency anaemia based solely on the

grounds of pallor of the eyes (palpebral conjunctiva)/tongue/nail beds and/or palms accompanied or unaccompanied by weakness, tiredness and breathlessness even while at rest. At levels two to four facilities, in addition to the above, a haemoglobin level < 12.0 g/dl for non-pregnant women aged more than 15 years is required to diagnose a patient as having iron deficiency anaemia. (NRHM 2005). Compared to the NRHM guidelines, which attempt to identify all levels of anaemia, our criteria focuses on severe or moderate anaemia cases that need immediate attention. Additionally, our criteria involve more signs as predictors of severe/moderate anaemia.

There are certain limitations of our study. The 18 clinical signs/symptoms used in this analysis came from responses by the adolescent girls to questions posed by the female investigators during the baseline survey. As most of the female investigators were non-clinical personnel, the investigators might or might not have correctly explained the signs/symptoms to the adolescent girls, leaving scope for under-reporting of these signs/symptoms. Aditionally, as the baseline survey collected information about the girl having experienced the signs/symptoms within the six months prior to the interview, there was scope for re-call bias by the respondents. As the primary purpose of baseline survey was not to record the prevalence of clinical signs associated with anaemia in adolescent girls, the survey may have missed other important signs of anaemia such as 'tiredness', 'weakness' while at rest and at work etc. In order to improve specificity of the final diagnostic criteria developed by us, we recommend another similar study, identifying and including the clinical signs missed by the baseline. If the investigators for this new study have a clinical background, the results will provide more accurate information on the prevalence of signs/symptoms and their association with severe/moderate anaemia. As the problem of anaemia is equally prevalent in pregnant and lactating women in India, such a clinical anaemia diagnostic study with multiple target groups will provide client based diagnostic criteria tools to detect anaemia in general, and severe/moderate anaemia in particular.

5. Significance

In conclusion, in the community (village, health sub centre etc.,) settings where haemoglobin measurement is not readily available, feasible or affordable, it is possible for the adolescents themselves or for the grassroots workers such as the Accredited Social Health Activists and/or the Anganwadi workers to detect cases of moderate or severe anaemia by using the criteria developed by us. Since the prevalence of severe and moderate anaemia in adolescent

girls was measured to be around 20% and prevalence of mild anaemia was 45%, the limitation of our criteria which over diagnosed 1558 (35%) cases as severe/moderate anaemia, will only benefit the adolescents, as they will be alerted to the possibility of their problem becoming more serious and this may result in their doing something to improve their haemoglobin levels. Thus in communities where more than 65% women are anaemic, screening and treating severe or moderate anaemia cases, using the final diagnostic criteria developed by us, represents a modest but important first step in reducing morbidity and mortality from anaemia.

Acknowledgement:

The authors acknowledge USAID support to the Vistaar Project of IntraHealth International. We are thankful to the 4465 adolescent girls for providing information for this analysis. We thank Ms Laurie Nato Parker, Project Director, The Vistaar Project for providing opportunity to first author to present the results of the paper in Indian Association for the Study of Population (IASP) XXXI annual conference at Tirupati. We thank Ms Aditi Bam for editing the paper. We also thank Ms Madhuri Narayanan, Mr Laxmikant Palo, Mr Manish Kumar of the Vistaar Project for critically reviewing the paper. We are grateful to Dr U V Somayajulu (Sigma Consultancy Pvt. Ltd.) for reviewing the paper. The baseline data for this study was collected by the social wing of ACNielsen ORG-MARG. The authors are thankful to them for the baseline data.

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