# Establishment of reference ranges and values for red cell distribution width amongst infants

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**ABSTRACT**

**Objective:** To determine the normal reference ranges and values for red cell distribution width (RDW) amongst various age groups of infants.

**Study Design:** Descriptive Cross Sectional Study

**Place and Duration:** At Haematology Department of Armed Forces Institute of Pathology (AFIP), Rawalpindi, from 25th March 2010 to 24th March 2011.

**Methodology:** Two thousand healthy infants visiting the vaccination centers were enrolled and the venous blood samples were taken to assess the values for red cell distribution width (RDW) by haematology analyzer. Percentages for reference ranges along with mean ± SD values for RDW were identified.

**Results:** The reference range for RDW value for less 27 days neonates was 65.1 – 80 fl (i.e66.05 ± 7.32 fl). In more than 27 days to less than 03 months aged infants, reference range was 35.1-50 fl (42.47 ± 5.61 fl).In more than 03 months to less than 06 months aged infants, reference range was 50.1-65fl (40.76 ± 4.59 fl).In more than 06months to less than 09 months aged infants, reference range was 50.1 - 65 fl(41.48 ± 4.29 fl). In more than 09 months to less than 01 year aged infants, reference range was 35.1 -50 fl (43.39 ± 7.54 fl).

**Conclusion:** Normal RDW reference values vary with age of growing infant.

**Keywords:** Neonates, Infants, Blood complete picture, Red cell distribution width, Reference ranges, Reference values

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## INTRODUCTION

Neonatal haematopathologies are an everyday encounter for the clinician and is always a challenging task for the clinicians. Therefore the implication of establishing accurate reference values of different hematological parameters and indices is direly required[1]. The values of hematological indices and parameters have a direct relation with age, gender, genetics, ethnic origin, altitude variation and environmental factors. Therefore studies should be carried out in specific regions to establish the reference values[2].

Red cell distribution width (RDW) is one of the important indices harboring significance to diagnose various haematopathologies in all age groups. The values of RDW can be obtained from complete blood count (CBC). It is considered as a quantitative measurement to detect the variation in size of red blood cells i.e anisocytosis[3,4]. It serves as a morphology index for red cells. The normal value for RDW is 13 ± 1.5%[5]. The value of RDW is obtained by dividing the mean + standard deviation of red blood cell (RBC) volume by mean corpuscular volume (MCV)[6]. The mean values can be identified easily by automated blood complete picture analyzers[7].

This simple and economical test can be used to establish differential diagnosis of anemia. The increased values of RDW even in presence of normal red cell indices can be due to iron deficiency anemia[8]. It can be an indicator for many other diseases e.g. venous thromboembolism, liver and kidney failure, diabetes, cancer, sepsis, chronic obstructive pulmonary disease and community-acquired pneumonia. It was concluded in one study that high values of RDW can even serve as a predictor for determining the prognostic outcome or the mortality rate of certain illness[3,9]. The RDW values also vary with neonatal gestational age. The values in preterm neonates were found

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higher as compared to the full term ones[10,11].

The literature review supports the fact, that red cell distribution width (RDW) values can be a predictor of many neonatal hematological pathologies. It was also extracted that there is a direct correlation amongst normal values of blood complete picture parameters with various factors i.e. geographical distribution, ethnicity, race etc. Currently the reference values used for RDW in our country are the ones derived from Western data. The National data is not available for accurate reference. The results of current study will assist in establishment of normal values for RDW in our country. This will facilitate accurate diagnosis and prompt management of infantile pathologies in our settings. The resultant effort will be a step forward to reduce infant morbidity and mortality rates. Therefore, the current study was planned with an objective to determine the normal reference ranges and values for red cell distribution width (RDW) amongst various age groups of infants.

## METHODOLOGY

This descriptive cross sectional study was carried out at the Department of Haematology, Armed Forces Institute of Pathology, Rawalpindi, Pakistan, from 25th March 2010 to 24th March 2011.The ethical approval was taken from the ethical review board of AFIP, prior study proceedings to vindicate all ethical concerns.

Apparently healthy, less 01 year aged males and females, of willing parents, were included in the study. The infants having pre mature birth, recent history of drug intake for any illness, i.e. in last 2 weeks, any diagnosed systemic illness, presence of any congenital disorder, and those with recent history of blood loss or transfusion were excluded from the study.

Two thousand healthy infants (1000 males and 1000 females) were enrolled in the study by non probability convenience sampling technique. The infants visiting the vaccination centers of Military Hospital (MH), Holy Family Hospital and Benazir Bhutto Hospital, Rawalpindi were enrolled for study. The infants were further divided into 05 subgroups with a division of 400 subjects in each subgroup. Group I included less than 27 days of age, group II included more than 27 daysuptil03 months of age, group III included more than 03 months uptil 06 months of age, group IV included more than 06 months uptil 09 months of age and group V included more than 09 months uptil 01 years of age. A written and informed consent was taken from the parents/ guardians prior study proceedings. The demographic details (name, age, gender), birth history, history of any current or past illness, blood loss and medication, were recorded in a proforma. A 03ml of venous blood samples were taken aseptically from cubital fossa of all selected infants. The collected blood was preserved in EDTA bottle. The estimation of RDW values was done by analyzing blood complete picture (CP) through Sysmex KX-21 (Japan). The extracted values from CP card were recorded on laboratory evaluation form.

**Data Analysis:** Data analysis was done on SPSS version 17. For quantitative variables, mean values along with standard deviation were identified for all groups separately. While for qualitative variables and to establish reference ranges, frequencies were calculated in terms of percentages for all groups separately.

## RESULTS

The blood samples for RDW estimation was processed for 2000 infants. The extracted values for RDW in infants of various age group is shown in tables I and II.

The qualitative analysis indicated that in group I neonates, reference range of 65.1 – 80 fl was present in 52.8% (n = 211) neonates. This was followed by 50.1 – 65 fl in 43% (n = 172). In group II a reference range of 35.1-50 fl, was present in 91.25% (n= 365) infants. While in group III, reference range of 50.1-65fl, was present in 90.8% (n=363) infants. In case of group IV, reference range of 50.1 - 65 fl was observed in 92.2% (n=369) infants. Whereas analysis for group V showed that, reference range of 35.1 -50 fl was present in 87% (n = 348) infants. This is shown in Table - I.

In group I, the average RDW value was 66.05 $\pm$ 7.32 fl. In males the mean value for RDW was 65.80 $\pm$ 7.32 fl. While in females it was 65.95 $\pm$ 8.33 fl. The values are highest in this group, as compared to remaining 04 groups. In group II, the average mean RDW value was 42.47 $\pm$ 5.61 fl. In males the mean value was 43.03, $\pm$ 4.90 fl. However, in females it was 41.91 $\pm$ 6.21 fl. In group III, the mean RDW value was 40.76 $\pm$ 4.59 fl. In males the value of RDW was 40.29 $\pm$ 4.20 fl and in females it was 41.22 $\pm$ 4.91 fl. The mean RDW value of group IV was 41.48 $\pm$ 4.29 fl. The mean value in males was 41.71 $\pm$ 4.59 fl. While in females it was 41.22 $\pm$ 3.99 fl. In case of group V, the mean RDW value was 43.39 $\pm$ 7.54 fl. It was found to be lower than Group I and higher than Groups III and IV. The males had an average value of 42.15$\pm$ 5.78 fl. While in females it was 46.47 $\pm$ 22.85 fl. This is shown in Table-II.

**Table-I: Frequencies of RDW reference ranges in 05 age groups (N= 2000)**

| Reference Ranges of RDW | Group I (< 27 Days) | Group II (>27Days to 3 Months) | Group III (>3 Months to 6 Months) | Group IV (>6 Months to 9 Months) | Group V (>9 Months to 01 Year) |
|---|---|---|---|---|---|
| 24-35fl | 0.8 (n=03) | 2.25 (n= 09) | 4.5(n=18) | 2.8(n=11) | 0.75(n=03) |
| 35.1-50fl | 0.5 (n=02) | **91.25 (n=365)** | - | - | **87.0**(n=348) |
| 50.1-65fl | 43.0 (n=172) | 5.75 (n=23) | **90.8**(n=363) | **92.2**(n=369) | 9.25(n=37) |
| 65.1-80fl | **52.8 (n=211)** | 0.75 (n=03) | 4.8(n=19) | 5.0(n=20) | 1.25(n=05) |
| 80.1-100fl | 3.0 (n=12) | - | - | - | - |

**Table-II- A: Mean values of RDW in 05 age groups (N= 2000)**

| Quantitative Statistical Variables | Gender | Group I < 27 Days | Group II >27 Days to 3 Months | Group III >3 Months to 6 Months | Group IV >6 Months to 9 Months | Group V >9 Months to 01 Year |
|---|---|---|---|---|---|---|
| Mean RDW fl | Female (n=1000) | 65.95 | 41.91 | 44.22 | 41.22 | 46.47 |
| | Male(n=1000) | 65.80 | 43.03 | 40.29 | 41.71 | 42.15 |
| | Average | **66.05** | **42.47** | **40.76** | **41.48** | **43.39** |
| Standard Deviation | Female | 8.33 | 6.21 | 4.91 | 3.99 | 22.85 |
| | Male | 7.32 | 4.90 | 4.20 | 4.59 | 5.78 |
| | Average | **7.32** | **5.61** | **4.59** | **4.29** | **7.54** |

## DISCUSSION

The RDW imparts a great diagnostic and prognostic significance for many neonatal and infantile disorders like haematological pathologies, cardio vascular disorders, cerebrovascular diseases (CVDs) and severe sepsis[12,13]. Özdoğan HK et al, concluded that increase in value of RDW has significant correlation with high mortality in intensive care unit (ICU) patients[3]. The findings were further strengthened by another study which showed severe inflammation is the pathogenic factor for raised RDW values, ultimately predicting high mortality in ICU[14].

The results of current study revealed a significant variation in mean values of RDW amongst all 05 groups of infants. For less than 27 days mean values of RDW was 66.05± 7.32fl, more than 27 days to 03 months it was 42.47 ± 5.61 fl, more than 03 months to 06 months it was 40.76 ± 4.59 fl, more than 06 months to 09 months it was 41.48 ± 4.29fl and more than 09 months 01 year of age group infants it was 43.39 ± 7.54fl. The current study results are in accordance with study results by Li N et al (2017), which concluded that the values of RDW varies with age[15]. The available Western data from literature review showed that the values uptil 01 year of age group infants remains constant i.e. 42.5±3.5fl[5]. While the RDW mean value of current study in all five age groups have shown higher values i.e. more than 40fl, when compared to less than 33fl reported by Choi et al, in less than 01 year age healthy babies[16]. The mean RDW value were higher in case of less than 27 years of age i. e 66.05 ± 7.32fl and 1 year age group i.e. 43.39 ± 7.54fl when compared to that in western populations. The reported values by western literature, which are currently used in our country for less than 27 days and 01 year of age is 42.5 ± 3.5fl[5].

Regarding the reasons for this variation, included genetic predisposition, environmental factors, altitude variation, ethnicity and racial differences. One Pakistani study concluded different RDW levels in Karachi, when compared to the published studies of Italy, Malaysia, New Delhi, Russia and even Nigerian population indicating the demographic changes affecting the Pakistani population[17]. Another published study identified that the variation in RDW values is significantly associated with maternal gestational ages. The values of RDW in neonates of mothers with ≤34 weeks gestational age was higher as compared to ≥35 weeks gestational age[10]. Tonbul et al showed the same findings that maternal ages influence neonatal RDW values[18].

The published data by Lolowa et al, revealed that in order to label a neonate as a case of iron deficiency anemia, the values of RDW should be more than 14.5% (normal value in %)[19]. Buchetal, identified the same findings in line with previous study, but the details regarding classification of microcytic anemia were in correlation with RDW values[7]. Hoffmann et al in 2015 showed different opinion by identifying low sensitivity and specificity of RDW for the diagnosis of iron deficiency anemia[20]. In view of all available literature, it is clinched that establishment and implementation of accurate reference value/ranges for RDW is necessary to identify underlying pathology. So that in light of available literature, the values valid for the regional population can be implemented. Hence timely management can reduce the infant morbidity and mortality rates.

## CONCLUSION

Normal RDW reference values vary with age of growing infant.

## RECOMMENDATIONS

1. Reference ranges and values for RDW should be reviewed and established for specific regions.
2. For various age groups, different reference ranges/values should be established and implemented accordingly.
3. Besides RDW, establishment of regional reference values/ ranges should be done for hematological parameters and indices.

## CONTRIBUTION OF AUTHORS

Bukhari KT: Conceived idea, Manuscript writing, Sample collection, Sample processing, Data collection, Final formatting of manuscript.

Zahid M: Data interpretation, Manuscript writing, Literature search.

Zafar H: Manuscript writing, Data tabulation

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