Laboratory Reference Intervals for Routinely Analyzed Transferrin and Unsaturated Iron-Binding Capacity Parameters in the Adult Population of Uasin Gishu County, Kenya

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ABSTRACT

Reference intervals (RIs) are used in the interpretation of clinical laboratory data to help doctors reach a medical decision point. However, due to a variety of reasons, RIs varies significantly between various populations. This study aimed at establishing transferrin, and IUBC reference intervals that can be used locally for the interpretation of iron indices at MTRH. A cross sectional study was conducted at Moi Teaching and Referral Hospital, 290 healthy volunteers were enrolled in the study where their transferrin and IUBC were examined. The non-parametric approach was used to determine reference values with a 95% confidence interval. The Sigma diagnostics approach was used to verify the established Ris. IBM SPSS version 23.0 was used to conduct the statistical analysis. Mann-Whitney U tests were used to compare genders for significant differences. The established reference intervals for Transferrin: males: 2.13–4.01 g/L, females, 2.08–4.04 g/L; UIBC: males, 20.50–64.08 umol/L, females: 20.07–64.21 umol/L. Comparisons between genders for significant differences were done using Mann-Whitney U tests, revealing no significant gender-based differences between transferrin and UIBC exhibited. The established reference intervals in this study are age and sex-specific for routinely used transferrin and IUBC catering for the adult population of Uasin Gishu County aged 18–64 years. The result will assist the clinicians in reaching an informed medical decision.

Keywords: Healthy Population, Reference Intervals, Transferrin, Unsaturated Iron Binding Capacity, Uasin Gishu, Kenya

I. INTRODUCTION

Iron profile tests is an array of tests including transferrin and unsaturated iron binding capacity that offer useful details regarding the blood levels of many iron-related factors. These tests aid in the diagnosis and follow-up of illnesses involving iron metabolism and the body's capacity to carry and store iron, such as anemia and hereditary hemochromatosis, iron excess, iron deficiency, and other abnormalities of iron metabolism [1]. Iron profile tests are made to augment other laboratory tests, such as hematological tests and bone marrow biopsy, to offer accurate, scientific-based patient care. These tests are easily done, less invasive, and are more routinely used in the diagnosis and therapy monitoring of iron-related diseases compared to other diagnostic tests to assess iron such as bone marrow aspiration (BMA) [2].

Iron profile results as with any other clinical laboratory test results, will not be useful to both the clinician and the patients unless reported with and interpreted with reference intervals/normal ranges [3]. Reference intervals (RIs) are frequently employed in the process of interpreting and making medical diagnoses, therapeutic management choices, or other physiological evaluations. Reference intervals give medical healthcare professionals a baseline to evaluate a patient's health, identify potential illnesses, and reach a decision-making point between those with pathological conditions and those who are normal. Typically, the normal reference range for a given test is harboured on the results that are seen in 95% of the healthy reference population [4, 5, 6], and when applied to a broader population served by the laboratory, accurately comprises the majority of individuals sharing similar characteristics [7].

Reference interval points to the range limits of the results expected for a given condition, and when a patient's test results fall within the reference range, it signifies that they are within the range that would be expected for a healthy individual of the patient's age and sex. Conversely, results that fall outside the reference interval may indicate the presence of a medical issue or the need for further testing. While the term “reference range” is sometimes used, it is more common to refer to it as the “reference interval” because “range” implies the absolute maximum and minimum values, whereas “RI” encompasses [8]. Ideally, reference intervals are established based on data from a healthy reference

population; however, in certain situations, these intervals can be obtained from persons with other physiological or pathological conditions, and they can serve various purposes [9].

Reference intervals vary significantly between different population groups due to factors such as heredity, age, sex, race, nutrition, climate, and altitude [10]. Reference intervals for clinical laboratory tests and parameters can be directly impacted by genetic variations in populations since these changes might result in variances in the distribution of certain results within a given group. Consequently, using reference intervals from books or other sources can be unreliable, as they may not accurately reflect the local population's characteristics. Therefore, each laboratory should establish its own reference intervals tailored to its specific context, aligning with the local population it serves [11]. The International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) and the Clinical and Laboratory Standards Institute (CLSI), leading organizations in clinical laboratory medicine, recommend that laboratories follow standardized procedures to determine local reference intervals for clinical chemistry tests [12]. This guidance discourages sole reliance on manufacturer-supplied reference interval values or those from the literature [13]. Of note, studies around the globe, including Africa and some parts of Kenya, have shown disparity in reference values between the manufacturers'-provided values and those obtained from the local population. Studies that have been done currently in different parts of the world, Kenyan regions included, have shown these differences in reference values. For instance, in Rwanda, the North Rift Valley, Taita Taveta, and Kisumu in Kenya, some clinical chemistry parameters have shown a significant difference between reference values provided by reagent manufacturing companies and those obtained from the local populations served in these regions [14, 15, 16, 17]. Locally established reference intervals are considered to represent of the local population medical ranges, which can be relied on as this relies on the central 95% of the local healthy population.

II. MATERIALS & METHODS

2.1 Study area and Study population

The study was conducted at Moi Teaching and Referral Hospital Clinical Chemistry laboratory located in Uasin Gishu County, North rift Kenya. The laboratory analysis was conducted at the Moi Teaching and Referral Hospital Clinical Chemistry Laboratory. The hospital is located along Nandi Road in Eldoret Town, Uasin Gishu County, Kenya.

2.2 Study Design

The study design was a cross-sectional study. The study was carried out at a one-time point over a short period of time.

2.3 Inclusion criteria

Subjects who participated in the study were healthy males and females aged 18 to 64 years who had lived in Uasin Gishu County for not less than 6 months and who were free from chronic illnesses such as hypertension, chronic renal failure, tuberculosis, diabetes mellitus, HIV, hepatitis B, hepatitis C, and syphilis. The participants had to have Hb levels of 12.5 to 17.2 g/dL and 12.1 to 15.1 g/dL for males and females, respectively.

2.4 Exclusion criteria

Subjects that never met the inclusion criteria were excluded; these included pregnant females and individuals who were on any form of medication, such as those on iron supplements, oral contraceptives, and iron chelators. Individuals who had recently donated blood in the previous 3 months, smokers and alcoholics were excluded from the study as well.

2.5 Sample size determination

Sample size was calculated using the G power 3.1.9.7 sample size calculator at a two-tail error probability of 0.05 and a power of 0.95 for the two groups giving a total of 298 (Figure 3.1). A total of 321 volunteers were recruited, and out of these 290 samples met inclusion criteria for the study. The number met the CLSI procedure guidelines, which recommends a minimum of 120 people per group (male and female) as per CLSI C28-A3C [18].

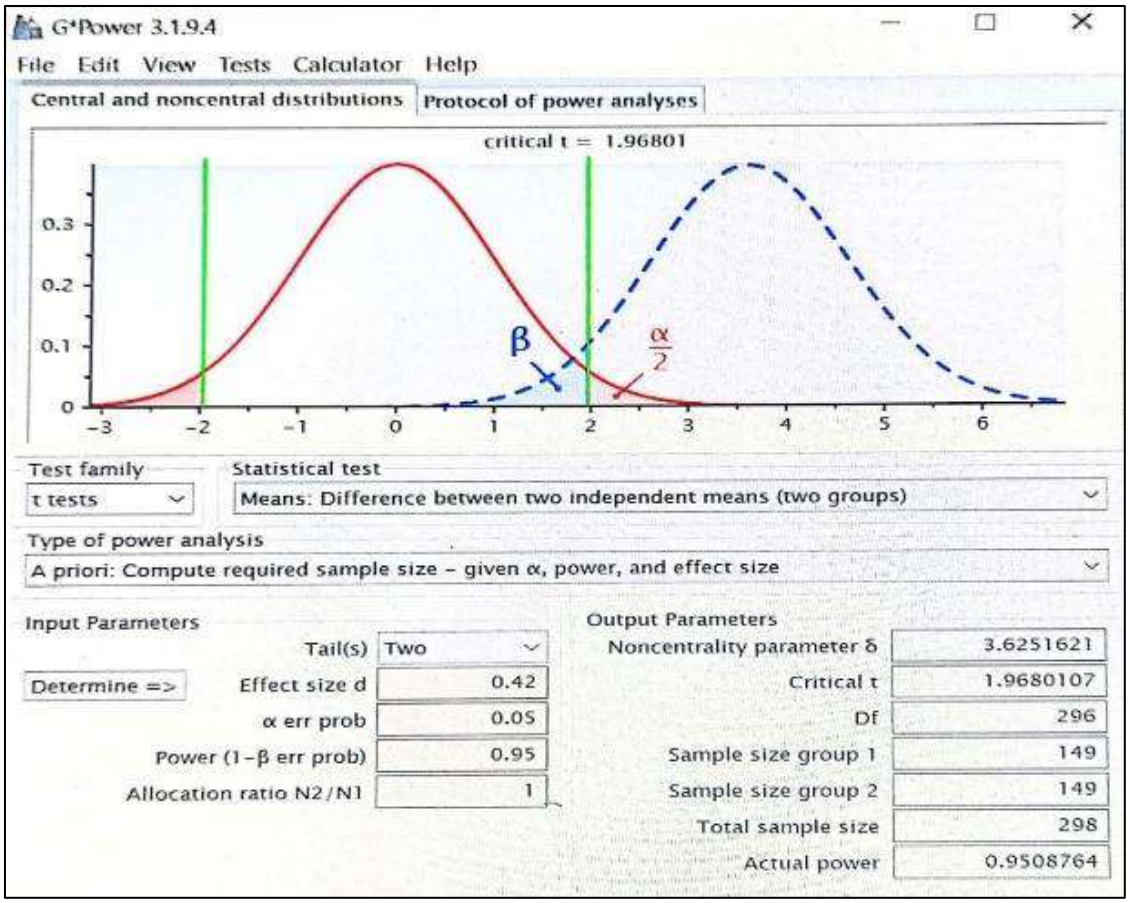

Figure 1
G Power Sample Calculation

2.6 Sampling design

The participants were selected based on a multistage cluster sampling technique. These entailed the selection of the participants geographically from the six sub-counties of Uasin Gishu. Since the county's social and economic activities are almost evenly distributed, in every subcounty, 2–3 wards were randomly picked to represent the subcounty, depending on the subcounty's population. A total of 15 wards were picked out of the 30 wards in the county, and participants were selected in the hierarchy of population within the wards. Turbo, which had the highest population, had 3 wards selected, followed by Soy Subcounty with 3 wards, Kapseret Subcounty participants from 3 wards, Moiben Subcounty participants were drawn from 2 wards, Kesses Subcounty participants were from 2 wards, and lastly, Ainabkoi Subcounty was represented by participants from 2 wards. In the wards after mobilization, the participants were placed in strata according to their sex. In the clusters, systematic random sampling was done to choose the participants. The selection of the participants here was at a regular interval after randomly selecting the starting point.

2.7 Collection of blood samples

Samples for the tests were collected by a trained phlebotomist, approximately 4mls of venous blood collected and transferred into labeled plain vacutainers with the participants' unique code number, sex of the participant, and age. Blood was left to clot, and the clotted samples were centrifuged at 3000 rpm for five minutes at room temperature (20°C–28°C) to get the serum. Using a Pasteur pipette, the serum was aliquoted into well-labeled cryovials. At the analytical center, the samples that were not analyzed immediately were stored at 4–8°C for 7 days maximum, or at -20 °C for those that were to take longer periods. The samples were analyzed on a Cobas® 6000 series chemistry analyzer, which is a fully automated clinical chemistry analyzer by Roche Diagnostics.

2.8 Serum unsaturated iron binding capacity determination

Serum UIBC was analyzed based the ferrozine method, with absorbance measured photometrically.

2.9 SerumTransferrin determination

Serum transferrin levels were analyzed based on the immunoturbidimetric assay method.

2.10 Data analysis

Data from the study was input into MS-Excel® 2013 by Microsoft Corporation and analyzed with Statistical Package for Social Sciences (IBM SPSS) version 23.0. The normality test was computed using the Kolmogorov-Smirnoff (KS). Descriptive statistics for the continuous variables was established and recorded in terms of median and median range. Mann-Whitney U test and Kruskal wallis for inferential statistics to compare the differences between the various groups, with $p \leq 0.05$ considered a significant difference.

III. RESULTS

3.1 Demographic and Anthropometric Characteristics of Study Participants

The study enrolled 290 healthy adults, which consisted of 157 males who accounted for 54.14% and 133 females representing 45.87%. The participants were grouped into three age groups, namely; - early adulthood (18–34 years), early middle age (35–44 years), and late middle age (45–64 years). The age of the study participants was comparable across the three age groups (P =0.902); height for both males and females was comparable across the three age groups (P = 0.955) and (P = 0.808), respectively. The age of the study participants was comparable across the three age groups (P =0.902); height for both males and females was comparable across the three age groups (P = 0.955) and (P = 0.808), respectively. On the comparison of weight and BMI across the age groups and among the sexes, it was found that there were no significant differences. For males, the weight and BMI values were (P = 0.633) and (P = 0.543), respectively; for females, the values were (P = 0.357) and (P = 0.227) for the weight and BMI, respectively. BMI categorization on the basis of underweight, normal, and overweight was done, and this showed that there were no significant variations in their distribution among the participants in the three age groups (P = 0.193). The majority of the participants among the groups were normal, amounting to 75.4%, with those who were underweight accounting for 2.4% and those who were overweight accounting for BMI (22.2%) as indicated in Table 4.1 below

Table 1

Demographic and Anthropometric Characteristics of All the Study Participants per Age Group

Characteristic Age group. n (%)		**18-34 years n=112 (38.6)**	**35-44 years n=90 (31.0)**	**45-64 years n=88 (30.4)**	***Age gps (P)***	***Gender (P)***
Gender	Male. n (%)	62 (21.4)	47 (16.2)	48 (16.6)	0.902	-
	Female. n (%)	50 (17.2)	43 (14.8)	40 (13.8)		
Height. cm	Male. H (%)	173.4 (33.3)	174.2 (33.4)	173.8 (33.3)	0.955	**<0.0001***
	Female. H (%)	164.5 (33.4)	164.2 (33.3)	163.8 (33.3)	0.808	
Weight, Kg	Male. W (%)	67.3 (32.4)	69.2 (33.3)	71.2 (34.3)	0.633	**<0.0001***
	Female. W (%)	56.5 (31.4)	61.2 (34.0)	62.4 (34.6)	0.357	
BMI, Kg/m^2	Male. B (%)	21.5 (28.1)	24.8(35.0)	24.6(36.9)	0.892	**<0.0001***
	Female. B (%)	22.4 (31.4)	24.2 (33.9)	24.8 (34.7)	0.239	
BMI category, n (%)						
Underweight (<18.5kg/m^2)		4 (1.4)	2 (0.7)	1 (0.3)	0.193	-
Normal (18.5 – 24.9 kg/m^2		90 (31.0)	68 (23.4)	61 (21.0)		
Overweight (>25.0 kg/m^2)		18 (6.2)	20(7.0)	26(9.0)		
Education level, n (%)						
None		8 (2.8)	4 (1.4)	6 (2.1)	0.874	-
Primary		41 (14.1)	35 (12.1)	37 (12.7)		
Secondary & above		63 (21.7)	51 (17.6)	45 (15.5)		
Marital status, n (%)						
Single		32 (11.0)	9 (3.1)	8 (2.8)	**0.001***	**-**
Married		74 (25.5)	71 (24.5)	69 (23.7)		
Separated		6 (2.1)	10 (3.7)	11 (3.7)		
Religion, n (%)						
Catholic		19 (6.6)	15 (5.2)	15 (5.2)	0.914	-
Protestant		81 (27.8)	66 (22.8)	67 (23.1)		
Muslim		12 (4.1)	9 (3.1)	6 (2.1)		
Occupation, n (%)						
None		24 (8.1)	3 (1.0)	7 (2.4)	**0.001***	**-**
Self		63 (21.8)	63 (21.8)	60 (20.7)		
Formal		25 (8.6)	24 (8.4)	21 (7.2)		

Data shown are median values for continuous variables and numbers (n) and proportion (%) of study subjects for categorical variables. Data analysis was conducted using chi-square tests for categorical data and Kruskal wallis test for continuous data. Significance was set at a *P* value <0.05 and significant *P*-values **bolded***

3.2 Establishment of Reference Intervals for Males and Females

The establishment of the reference intervals was done in accordance with the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) and the Clinical and Laboratory Standards Institute (CLSI) guidelines. The reference sample population for the two groups (male and female) met the recommendation of CLSI, of at least a minimum of 120 individuals per group (CLSI C28-A3). The reference intervals were created using the 2.5^{th} and 97.5^{th} percentiles as lower and upper bounds, respectively, at 95% confidence intervals as per the CLSI recommendations. The Mann-Whitney U test was used to compare the medians for the two sexes statistically. Statistics were deemed different if $P \leq 0.05$. The established iron profile reference intervals and the reagent manufacturer (Cobas) provided reference ranges, traditionally in use were verified, using the sigma diagnostic method.

3.3 Established normal Transferrin and UIBC RIs for adults aged 18-64 years

Transferrin and unsaturated iron binding capacity (UIBC) reference intervals were established based on the IFCC/CLSI guidelines. The following values for the reference intervals were established for Transferrin: 2.13–4.01 g/L and 2.08–4.04 g/L for males and females, respectively; combined males and females: 2.11–4.02 g/L. For UIBC, the established reference intervals were: 20.50–64.08 umol/L and 20.07–64.21 umol/L for males and females, respectively, and 20.33–64.05 umol/L for combined males and females. As shown in Table 4.7, a comparison between genders for the two analytes was done; transferrin had a *P*~0.829 and UIBC had a *P*~1.00. These *P* values were an indication that there were no significant statistical differences between genders for the two analytes.

Table 2

Established Normal Transferrin and UIBC RIs for Adults Aged 18-64 years, Uasin Gishu County, Kenya

	Sex	N	Mean	Median	Percentiles		Refence value	Tolerance limit (% Dev.)
					2.5	97.5		
	M	157	2.83	2.78	2.13	4.01	2.13 - 4.01	-7.82
	F	133	2.82	2.75	2.08	4.04	2.08 - 4.04	-7.84
Transferrin (g/L)	M/F	290	2.83	2.76	2.11	4.02	2.11 - 4.02	-7.67
	M	157	39.61	40.20	20.50	64.08	20.50 - 64.08	-6.34
UIBC	F	133	44.29	40.3	20.07	64.21	20.07 - 64.21	5.10
(umol/L)	F/M	290	41.76	40.25	20.33	64.05	20.33 - 64.05	6.09

Comparison of the established Transferrin and UIBC RIs for male and female

	Sex	N	Mean	Median	Refence value	Z- score	*p*-value
	M	157	2.83	2.78	2.13 - 4.01		
Transferrin (g/L)	F	133	2.82	2.75	2.08 - 4.04	-0.113	0.829
	M	157	39.61	40.20	20.50 - 64.08		1.00
UIBC (umol/L)	F	133	44.29	40.3	20.07 - 64.21	-4.435	

*umol/L - micromole per litre; g/L – grams/Litre, N- number of samples analyzed; Sig.- significance; M/F=Male & Female. *p≤0.05; RIs – Reference interval, *Tolerance limit= ≤ +/-20*

3.4 Verification of the established Transferrin and UIBC RIs & manufacturer's RIs per age groups

The established Uasin Gishu reference intervals and the manufacturer's (Cobas) provided reference intervals were verified using the sigma diagnostic method, based on age groups. The observed tolerance limits were all within the permissible range of ≤ +/-20%, as shown in Table 3.

Table 1

Verification of the Established Transferrin and UIBC RIs & Manufacturer's RIs per Age Groups

		Sex	N	Mean	Median	UG RIs	Cobas RIs	Cobas RIs Tolerance limit	UG RIs Tolerance limit
18–34 years.	Tran (g/L)	M	62	2.90	2.80	2.13 - 4.01	2.0 -3.6	3.57	-5.54
		F	50	2.89	2.75	2.08 - 4.04	2.0 -3.6	3.21	-5.86
		M/F	112	2.89	2.76	2.11 - 4.02	2.0 -3.6	3.21	-5.71
	UIB (umol/ L)	M	62	39.23	40.40	20.50 - 64.08	20 - 62.0	-4.32	-7.23
		F	50	42.05	40.20	20.07 - 64.21	20 - 62.0	2.56	-0.21
		M/F	112	40.49	40.25	20.33 - 64.05	20 - 62.0	-1.2	-4.03
35-44 years.	Tran (g/L)	M	47	2.75	2.70	2.13 - 4.01	2.0 - 3.6	-1.79	-10.42
		F	43	2.78	2.76	2.08 - 4.04	2.0 - 3.6	-0.71	-9.12
		M/F	90	2.77	2.76	2.11 - 4.02	2.0 - 3.6	-1.07	-9.62
	UIBC (umol/ L)	M	47	40.26	40.80	20.50 - 64.08	20 - 62.0	-1.80	-4.80
		F	43	44.47	39.90	20.07 - 64.21	20 - 62.0	8.46	5.53
		M/F	90	42.28	40.75	20.33 - 64.05	20 - 62.0	3.12	0.21
45-64 years.	Tran (g/L)	M	48	2.82	2.80	2.13 - 4.01	2.0 - 3.6	0.71	-8.14
		F	40	2.78	2.71	2.08 - 4.04	2.0 - 3.6	-0.71	-9.45
		M/F	88	2.80	2.77	2.11 - 4.02	2.0 - 3.6	0.0	-8.65
	UIBC (umol/ L)	M	48	39.07	39.65	20.50 - 64.08	20 - 62.0	-4.70	-6.67
		F	40	46.89	45.60	20.07 - 64.21	20 - 62.0	14.37	11.27
		M/F	88	42.84	40.00	20.33 - 64.05	20 - 62.0	4.49	1.54

*Tran=transferrin, UIBC=unsaturated iron binding capacity, M=male, F=female, M/F=male & female, RIs= reference intervals, UG=Uasin Gishu, *Tolerance limit= ≤ +/-20%*

3.5 Verification of the established Transferrin and UIBC RIs & manufacturer's RIs per location

Based on the sigma diagnostic method, the established transferrin and unsaturated iron binding capacity reference intervals and the provided manufacturer's (Cobas) reference interval were verified as per the study participant's location of origin. The observed tolerance limits for both the established and provided reference intervals were within the permissible range of ≤ +/-20% in all the locations, as shown in Table 4.

Table 4

Verification of the Established Transferrin and UIBC RIs & manufacturer's RIs per Location

		Sex	N	Mean	Median	UG RIs	Cobas RIs	Cobas RIs Tolerance limit (%)	UG RIs Tolerance limit (%)
Turbo	Tran	M	32	2.83	2.87	2.13 - 4.01	2.0 -3.6	1.07	-7.82
		F	25	2.84	2.87	2.08 - 4.04	2.0 - 3.6	1.43	-7.19
		M/F	57	2.83	2.87	2.11 - 4.02	2.0 - 3.6	1.07	-7.67
	UIBC	M	32	40.70	40.75	20.50 - 64.08	20 - 62.0	-073	-3.76
		F	25	48.02	49.70	20.07 - 64.21	20 - 62.0	17.12	13.55
		M/F	57	43.91	42.70	20.33 - 64.05	20 - 62.0	7.10	4.08
Soy	Tran	M	30	2.82	2.78	2.13 - 4.01	2.0 - 3.6	0.71	-8.14
		F	24	2.92	2.90	2.08 - 4.04	2.0 - 3.6	4.29	-4.89
		M/F	54	2.87	2.85	2.11 - 4.02	2.0 - 3.6	2.5	-6.36
	UIBC	M	30	39.53	40.35	20.50 - 64.08	20 - 62.0	-3.58	-6.53
		F	24	44.32	40.35	20.07 - 64.21	20 - 62.0	8.10	4.80
		M/F	54	41.66	42.70	20.33 - 64.05	20 - 62.0	1.61	-1.26
Kapseret	Tran	M	26	2.78	2.69	2.13 - 4.01	2.0 - 3.6	-0.71	-9.45
		F	22	2.72	2.68	2.08 - 4.04	2.0 - 3.6	-2.86	-11.40
		M/F	48	2.75	2.68	2.11 - 4.02	2.0 - 3.6	-1.79	-10.27
	UIBC	M	26	39.10	39.00	20.50 - 64.08	20 - 62.0	-4.63	-7.54
		F	22	46.15	39.95	20.07 - 64.21	20 - 62.0	12.56	9.13
		M/F	48	42.33	39.65	20.33 - 64.05	20 - 62.0	3.24	0.33
Moiben	Tran	M	24	2.74	2.65	2.13 - 4.01	2.0 - 3.6	-2.14	-10.75
		F	21	2.78	2.70	2.08 - 4.04	2.0 - 3.6	-0.71	-9.45
		M/F	45	2.76	2.68	2.11 - 4.02	2.0 - 3.6	-1.43	-11.58

	UIBC	M	24	38.57	39.40	20.50 - 64.08	20 - 62.0	-5.93	-8.80
		F	21	43.13	40.2	20.07 - 64.21	20 - 62.0	5.20	1.99
		M/F	45	40.93	39.80	20.33 - 64.05	20 - 62.0	-0.17	-2.99
Kesses	Tran	M	23	2.87	2.94	2.13 - 4.01	2.0 - 3.6	2.50	-6.51
		F	21	2.50	2.67	2.08 - 4.04	2.0 - 3.6	-10.70	-8.79
		M/F	44	2.84	2.73	2.11 - 4.02	2.0 -3.6	1.43	-7.3
	UIBC	M	23	39.18	39.96	20.50 - 64.08	20 - 62.0	-4.44	-7.35
		F	21	43.51	44.60	20.07 - 64.21	20 - 62.0	6.12	2.88
		M/F	44	41.02	39.96	20.33 - 64.05	20 - 62.0	0.05	-2.77
Ainabkoi	Tran	M	22	2.94	2.84	2.13 - 4.01	2.0 - 3.6	5.00	-4.23
		F	20	2.85	2.71	2.08 - 4.04	2.0 - 3.6	1.79	-6.19
		M/F	42	2.90	2.78	2.11 - 4.02	2.0 - 3.6	3.57	-5.38
	UIBC	M	22	40.28	41.15	20.50 - 64.08	20 - 62.0	-1.76	-4.75
		F	20	39.59	37.90	20.07 - 64.21	20 - 62.0	-3.44	-6.38
		M/F	42	39.95	40.40	20.33 - 64.05	20 - 62.0	-2.56	-5.31

*N – Number of samples analyzed, % Dev. - Percentage deviation, M=male, F=female, M/F=male & female, RIs= reference intervals, UG=Uasin Gishu, *Tolerance limit= ≤ +/-20*

IV. DISCUSSION

The establishment of transferrin and unsaturated iron binding capacity (UIBC) reference intervals for the healthy population aged 18–64 years, for both males and females, was conducted in accordance with CLSI guidelines. The reference intervals obtained for transferrin were as follows: for males, 2.13–4.01 g/L; for females, 2.08–4.04 g/L; and for combined males and females, 2.11–4.02 g/L. For unsaturated iron binding capacity (UIBC), it was 20.50–64.08 umol/L, 20.07–64.21 umol/L, and 20.33–64.05 umol/L for males, females, and combined males and females, respectively. The established reference intervals were then verified using the sigma method to test their suitability for use in the various categories and groups. Comparisons for gender-specific reference interval differences for each analyte were done using the Mann-Whitney U tests.

On the verification of the established reference intervals for both transferrin and unsaturated iron binding capacity (UIBC) under the age group and location categories, the results realized were within the acceptable tolerance limits of ± ≤ 20%, as shown in Tables 4.7, 4.8, and 4.9. These results indicated that the established transferrin and unsaturated iron binding capacity reference intervals were suitable and could be safely used for all age groups and in all the locations within Uasin Gishu County. It was also realized that the combined male and female reference intervals for the two analytes can be safely employed for both sexes. This scenario is in tandem with the reagent manufacturer, Cobas, which supplies shared reference intervals for both males and females for each analyte (transferrin and UIBC).

Gender-specific reference interval differences were determined using the Mann-Whitney U tests for each analyte, and a *P* value of 0.829 was realized for transferrin and a *P* value of 1.00 for UIBC. These values were greater than 0.05, which indicated that there were no statistically significant differences between the genders for both transferrin and UIBC. This scenario is in agreement with similar studies done by other researchers, such as [19, 20, 21]. The balance depicted by transferrin can be attributed to the fact that, from a biological perspective, transferrin's' basic function remains constant across the sexes. Transferrin is an iron transporter, and this elementary physiological function does not significantly differ between sexes. This occurrence can be attributed to the fact that transferrin, as a transport protein for iron in the blood, is not hormonally dependent, and its levels can fluctuate according to individual physiological demands rather than sex differences. Transferrin reference intervals depend on population demography, age, genetics, and the general health condition of individuals (Riege*et et al.,* 2016). The established unsaturated iron binding capacity reference interval showed no statistically significant differences between the genders. The phenomenon can be attributed to the fact that the UIBC's purpose is to measure transferrin's ability to transport iron. The fact that transferrin and unsaturated iron binding capacity reference intervals show no statistically significant differences between genders is thought to be the reason for the reagent manufacturer providing a shared male and female reference interval for each of the two analytes.

The manufacturer's provided transferrin and UIBC reference intervals were validated, and the Sigma diagnostic procedure was used to verify the stated transferrin and UIBC reference intervals from the manufacturer (Cobas). The provided manufacturer's transferrin and UIBC reference intervals are 2.0–3.6 g/L and 20–62.0 umol/L, respectively. The two analytes were verified based on their age groups and origin regions. The study findings revealed that the manufacturer's specified reference ranges for the two analytes were appropriate for usage in Uasin Gishu County. This eventuality can be attributed to the fact that transferrin, an iron transport protein, is tightly controlled by biological mechanisms that are generally consistent across groups and are not hormone- or diet-dependent. This may also be due to both using the same process to construct the reference intervals.

The established transferrin and unsaturated iron binding capacity (UIBC) reference intervals were found to have no gender statistically significant differences. The combined male and female reference intervals on verification for the two analytes were found to be suitable for both sexes and can be safely applied for both males and females.

V. CONCLUSION & RECOMMENDATIONS

The sex-specific reference intervals for transferrin and unsaturated iron-binding capacity established in this study are tailored for adults aged 18–64 years in Uasin Gishu County. Given the noticeable variations observed between these locally derived reference intervals and those provided by manufacturers, it is important for medical laboratories to adopt locally established and validated reference intervals or verify reference intervals supplied from other regions to ensure accurate health assessments.

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