Normal values of Hemoglobin A_{1c} (Hb A_{1c}) in non-diabetic adults

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***Abstract*- Background:**At present, there are no studies done to investigate the normal values of Hb A_{1c} in Sudanese population. The level of Hb A_{1c} for Sudanese population is borrowed from international references.

Objectives: The objective of this article is to investigate the normallevels of Hb $A_{1c,}$ and the factors that may affect its value.

Methods: Extensive internet search has been done on research regarding the normal values of Hemoglobin A_{1c} and factors affecting themin non-diabetic Adults.

Result: Normal level of Hb A_{1c}obtained from all previous studies showed a value of 3.6% as minimum and 6.5 % as maximum value**.** Significant racial/ethnic differences in Hb A_{1c}levelswere observed;these differences are significantly higher in people fromAfrican descent than inCaucasians.

Discussion: Hb $A_{1c}$is influenced by many risk factors; these include BMI,physical activity, age, ethnicity, diet and smoking.

Conclusion: Normal level of Hb A_{1c} from all previous studies showed a value of 3.6% as minimum and 6.5 % as maximum value and seemed to be affected by many risk factors.

Index Terms- Hb A_{1c}, Normal value,non-diabetic Adults

I. Introduction

Currently, there are no known studies conducted to investigate the normal reference range of Hb A_{1c} in Sudanese population.These normal reference ranges of Hb $A_{1c}$for our population in the clinical practice aretaken from non-Sudanese subjects depending on the international American and British Guidelines.

Most of the studies about the normalHb A_{1c} were done in Western countries.For these countries the different environment, ethnic groups, nutritional habits and body mass indices, play a significant role in determining the Hb A_{1c}levels compared to Sudan.

II. Methods

An extensive internet search regarding the normal values as well as the factors affecting Hemoglobin A_{1c} in non-diabetic Adults, has been conducted.

Consulting the following Web site: National Center for Biotechnology Information NCBI, PubMed, Google Scholar and using the following key words: Normal Hb A_{1c} , Normal Hb A_{1c} in non-diabetics , physiological factors affecting Hb A_{1c} .

The search covered the past 28years and 13papers were located and retrieved.

III. Results

IV.

First author	Type of study – country	Sample size	Date	Results and main conclusion
Modan[1]	Cross section – Israel	648	1988	Correlation of Hb $A_{1c}$with daily caloric intake and physical exercise was not established. No significant correlation between BMI and Hb A_{1c} was observed. A small, yet significant elevation in Hb A_{1c} was related with smoking (7.1 vs. 6.8%, P< .01)
Simon[2]	Cross section - United Kingdom	3240	1989	Mean of normal distribution of Hb A_{1c} in men is 5.03% with mean (SD) of (0.53) Obese persons (defined as BMI > 28 kmg/m^2) were found to have higher level of Hb A_{1c};however after adjustment for age, the correlation between the two values (BMI and Hb A_{1c}) was no longer significant.
K. Wiener [3]	Cross section - Liverpool, UK	399	1999	No significant correlation between HbA_{1c} and age;hence, they cannot see the need for age-specific reference ranges for Hb A_{1c}.

Boltri[4]	Cross section - USA	4880	1999 - 2000	Hb A_{1c}level showed significant racial/ethnic dependency where it was significantly higher in Blacks and Hispanics.
Boeing [5]	cross section – Germany	1773	2000	There is a direct relationship between risk of increasedHb A_{1c} andthe intake ofhigh energy and energy-adjusted saturated fats. Hb A_{1c} levels did not correlate with physical activity. Obesity was related with higher Hb A_{1c} levels.
Sargeanta[6]	Cross section – Cambridge - UK	2704	2000	A dose-response relationship between HbA_{1C} levels and the daily smoked cigarettes was observed. A positive association with total smoking exposure as measured by pack-years was detected as well.
Gulliford[7]	Cross section – England	9772	2001	The study detected a Hb A_{1c} mean of normal distributionin general population to be 6.34 % with mean (SD) of (0.85). Found a 0.180% lower Hb A_{1c} in participants who exercise compared to those with no or little physical activity;Hb A_{1c} seemed to be correlating with the level of physical activity Smokinghad a direct association with higher Hb A_{1c} levels.
Pani[8]	Cross section – UK	2473	200-2004	They stated that the results established clearlyan Hb A_{1c} increment in correlation with age, despite the multivariate adjustments for sex, fasting, and 2-hour post-load glucose; and suggested that other factors not related to glycaemia may weigh in the relationship of Hb A_{1c} with age.
International Expert Committee[9]	cross section	-	2009	Hb A_{1c} is helpful diagnostic value in diabetes the diagnose can be established when theHb A_{1c} level is 6.5% and more.
International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) [10]	Cross section		2009	The non-diabetic 'normal' range being 4-6%.
Ziemer[11]	Cross section – USA	1581	2010	Hb A_{1c} levels were found to be higher in people from African descend than in Caucasian people across the full spectrum of glycaemia after adjustments for plasma glucose and other factors known to correlate with Hb A_{1c} levels.
Nathan[12]	Cross section – London – UK	78	2011	Normal range of Hb A_{1c} test for non-diabetic people is between 3.6 – 5.5 %.
WHO report[13]	-	-	2011	Hb $A_{1c}$of 6.5%was recommended as the diagnostic cut-off point for diabetes.

V. Discussion

From all the studies done about normal level of Hb A_{1c} the minimum value was 3.6 % and the maximum value was 6.5 %.[2,7,10,12]

There are significant racial/ethnic differences in Hb A_{1c}levels, which are significantly higher in Blacks than white.[4,11]

Hb A_{1c}increased with all the known risk factors for diabetes (e,g obesity) [2,5] and decrease with increase in physicalactivity[7], but the age, diet and smoking appeared as a factor influencing Hb A_{1c}independently. [1,2,3,5,6,7,8]

VI. Conclusion

By reviewing all the previous studies,blood levels of Hb A_{1c}demonstrated values of 3.6% asminimumand 6.5 % as maximum value. [2,7,10,12]

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