

Prevalence of Anaemia among Children Attending Paediatrics Department of UDUTH, Sokoto, North-Western Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors KKI, NMJ, ASM and EUU designed the topic and provided fund. Authors OE, MLJ, MS, AG and AU did the data collection, compiled and analyzed the data using SPSS version 22. Authors LH, FJO, MD, ZB, LSS and SKM interpreters and concerned with logistics. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Anaemia is a global public health problem. It affects more than 56 million people globally, two thirds of them being from developing countries. This study was designed to investigate the prevalence and types of anaemia among the children attending the Paediatrics Department of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto North-Western Nigeria.

Method: Four hundred children between the ages of newborn to 15 years were recruited for this study. Haematological parameters tested include red cell indices, white cell total and differential, platelet counts and morphologies were studied with a Mythic™ 5-part autoanalyzer and manual techniques while morphological features were examined on blood film stained with Leishman's stain. Other investigations include serum iron, serum ferritin, serum transferrin, total iron binding capacity and haemoglobin electrophoresis using an alkaline pH 8.4.

Result: Out of the four hundred children tested, 139 (34.8%) were anaemic, revealing five aetiological types of anaemia among the children: Iron deficiency 62 (44.6%), sickle cell 43 (31.0%), normocytic normochromic 19 (13.7%), anaemia of chronic diseases 10 (7.1%), and megaloblastic 5 (3.6%) and three morphologic classification (i.e., normocytic anaemia 48 (34.5%), macrocytic anaemia 18 (13.0%), and microcytic anaemia 73 (52.5%)).

Conclusion: This cross-sectional non-interventional study found approximately one-third of a child cohort with anaemia in a single hospital in a North-Western Nigeria. These findings lead to the potential for the targeted provision of iron and other micro nutrients supplementation for anaemic children.

Keywords: Prevalence; paediatrics; iron deficiency anaemia; Nigeria.

1. INTRODUCTION

Anaemia is a global public health problem affecting more than 56 million people, two thirds of them being from developing countries [1]. It is associated with a decrease in haemoglobin (Hb) concentration with a concomitant decrease in the haematocrit (HCT) level. Anaemia is defined by the World Health Organization (WHO) as (Hb) < 12 g/dL in adult non-pregnant female, Hb < 11g/dL in pregnant females, Hb < 13g/dL in adult men, Hb < 12 g/dL in male children, Hb < 11 g/dL in female children, and Hb < 13 g/dL in newborns [2].

The aetiological factors of anaemia are multifactorial and include: Iron deficiency, other micronutrient deficiency, excessive blood loss, inheritance of the disorders of haemoglobin synthesis, malaria and other parasitic infections (i.e., hookworm and schistosomiasis infestations), HIV- infection and drug treatment-related complications [3]. Among the numerous factors, both nutritional and non-nutritional that contribute to the onset of anaemia, iron deficiency and malaria play the most critical role in developing contexts [4].

Anaemia is a common clinical problem encountered among the under-fives in everyday paediatric practice. A study done in the Paediatrics Department of Usmanu Danfodiyo

University Teaching Hospital, Sokoto, North-Western Nigeria revealed a high prevalence of anaemia (50%) due to severe malaria [5].

Anaemia is typically diagnosed on a complete blood count. Apart from reporting the number of red blood cells and Hb, the automated analysers also measures the size of the red blood cells by flow cytometry, which is an important tool in distinguishing between the causes of anaemia. Examination of a stained blood smear using a microscope can also be helpful, and it is sometimes a necessity in regions of the world where automated analysis is less accessible. In modern coulter counters, four parameters: red blood cells (RBC) count, Hb concentration, packed cells volume (PCV), and red cell distribution width (RDW) are measured, allowing others parameters (i.e., mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC)) to be calculated, and compared to values adjusted for age and gender. Other tests for proper differential diagnosis of anaemia include: malaria testing, haemoglobinopathies (using electrophoresis at alkaline pH), serum transferrin, serum iron, and total iron binding capacity [6].

Anaemia is a common blood disorder in children and imposes an economic burden on the parents/caregivers and the country as a whole.

The majority of anaemic children (76.2%) are under the age of 5 years: The most frequently affected age is 2 years (23.8%) with a male to female ratio of 2:1 [7]. In various African settings about 12 to 29% of hospitalized children have severe anaemia with hospital case fatality rates ranging from 8 to 17% [8]. Severe anaemia is a major paediatric problem in Nigeria. It is associated with many untoward effects, such as congestive cardiac failure, chest pain, jaundice, splenomegaly, joints pain, fever, and swelling of the limbs [8]. Severe anaemia, which is a life threatening condition, is a common occurrence in paediatrics emergency units in hospitals in developing countries [9].

Conventional methods for the diagnosis of anaemia do not completely differentiate between some types of anaemia (i.e., iron deficiency anaemia (IDA) from anaemia of chronic diseases) especially in children leading to inappropriate treatment. Although many researchers have sought out the causes, types, prevention, and controls of anaemia in low income regions (Agi, 1997). The need to carry out this study was informed by the paucity of literature on the aetiological factors, types, and prevalence of anaemia among children in the vulnerable age groups of newborn to 15 years. This study may assist health care practitioners and health policy makers in curbing this preventable but potentially fatal disorder particularly among children: - The youngest members of the society.

2. MATERIALS AND METHODS

2.1 Study Area

This study was carried out in the Paediatrics Department of Usmanu Danfodiyo University Teaching (UDUTH) Sokoto, North-Western Nigeria. Sokoto State is located in the extreme north- west of Nigeria, near to the confluence of the Sokoto River and the Rima River. The State is located between longitude 11°30' and 13°50' East and latitude 4' to 6°0' North. It is bordered to the north by Niger Republic, Zamfara State to the east while Kebbi State borders most of the south and west parts [9]. The State falls within the savannah vegetation zone. Rainfall starts late and ends early with mean annual rainfall ranging from 500 to 1,300 mm, and annual average temperature of 28.3°C (82.9°F) [10]. The major indigenous tribes in the state are the Hausa and Fulani and other groups such as Gobirawa, Zabarmawa, Kabawa, Adarawa, Arawa, Nupes,

Yorubas, Ibos and others [10]. Occupation of city inhabitants include trading, commerce, with a reasonable proportion of the population working in private and public sectors. The majority of the Hausas' are farmers while Fulanis are nomadic and are engaged in animal rearing [10]. The population has experienced significant growth going from 3,696,999 in 2006 [11] to 4,806,098 in 2015 with an annual growth rate of 3% [12].

2.2 Study Population

The subjects were recruited from Paediatrics Department of UDUTH, Sokoto, North-Western Nigeria. The age of 15 years is considered as the upper age limit for paediatrics patients at UDUTH, Sokoto [8].

2.3 Study Design

This is a cross-sectional study designed to investigate the prevalence and the types of anaemia among 400 children attending Paediatrics Wards of UDUTH, Sokoto, North-Western Nigeria. Whole blood samples from the subjects were tested for full blood count, blood film reports, and Hb electrophoresis. Serum samples were tested for serum iron, total iron binding capacity, serum transferrin, and serum ferritin.

2.4 Sample Size Estimation

The sample was calculated using the following formula [13]:

$$n = Z^2pq/d^2$$

Where

n = minimum required sample size in population >10,000
Z = standard normal deviate set at 95% (1.96).
p = proportion of success or prevalence
q = proportion of failure (= 1- p)
d = precision, tolerable margin of error, expected difference set at 5%.

Attrition rate of 10% was added.

Prevalence of 50% of severe anaemia among children with malaria was recorded in Paediatrics Department of Usmanu Danfodiyo University Teaching Hospital Sokoto, North-Western Nigeria [14].

$$n = Z^2 pq/d^2$$

$$z = 95\% (1.96)$$

$$p = 50\% (0.5)$$

$$q = 1-0.5 = 0.5$$

$$d = 5\% (0.05)$$

$$n = Z^2 pq/d^2$$

$$n = (1.96)^2 (0.5) (0.5) / (0.05)^2$$

$$n = 384.16$$

Sample Size = 385

Attrition rate of 10% = $38.5 = 39 + 385 = 424$

Therefore, sample size = 424

2.5 Selection of Subjects

2.5.1 Inclusion criteria

The inclusion criteria for this study included: children aged (newborn-15.0 years), attendance to the Paediatrics Ward of Usmanu Danfodiyo University Teaching Sokoto, North-Western Nigeria, and written informed consent obtained from their parents/guardians.

2.5.2 Exclusion criteria

Individuals who did not meet the inclusion criteria included: Individuals above 15 years, and children whose parents/guardians refused to provide a written informed consent for their wards to participate in the study.

2.6 Methods

Between three to five mL of blood was collected from the subjects (about 2.5 mL in K₂EDTA containers). The anti-coagulated samples were used for full blood counts using a Mythic™ (22 CT, 2008) 5-part automated haematological analyser; blood films were stained with Leishman's stain for blood morphology, and haemoglobin electrophoresis was carried out at pH 8.4 using the procedure described by Helena Biosciences [15]. Samples in coagulated containers were allowed to clot and serum was separated for the investigations of serum iron, serum ferritin, serum transferrin, and total iron binding capacity.

2.7 Ethical Consideration

This study was approved by the Ethical Committee of Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria.

2.8 Statistical Analysis

The data collected were entered into the data editor of the Statistical Package for Social Sciences (SPSS™ Version 20) software. Analysis was based on simple percentages, proportions, and values were expressed in a standard form (i.e., mean ± std). A Chi-square test at a 95% confidence level was used to test for association between aged groups, anaemia, and gender. A p-value of < 0.05 was considered as significant in all statistical analysis.

3. RESULTS

Four hundred subjects including 224 (56.0%) males and 176 (44.0%) females aged newborn to 15 years participated in this study. The children included: Pre-primary school (newborn to 5.0 years), primary school (5.01- 10.0 years) and post-primary school (10.01- 15.0 years).

Of the four hundred children tested, 139 (34.8%) children were anaemic while 261 (65.2%) were not anaemic (normal) as shown in Table 1. Children aged newborn to 5.0 years were more affected with anaemia compared to those above 5.0 years: however, the difference was not significant ($p > 0.05$).

Children with Hb ≥ 13 g/dl were considered not anaemic: Mild anaemic children had reading of 9.0-10.9 g/dl: moderately anaemic children had Hb of 7.0-8.9 g/dl: While severe anaemic children had Hb < 7.0 g/dl. According to Table 2, which reflects the severity of anaemia in the total population, children aged newborn to 5.0 years were more likely to exhibit severe anaemia than those above 5.0 years.

Table 1. Age specific prevalence of anaemia among the study population

Age (years)	Not anaemic	Anaemic	Total
Newborn to 5.0	154(38.5%)	74(18.5)	228(57.0%)
5.01 – 10.0	59(14.8%)	38(9.5%)	97(24.2%)
10.01 – 15.0	48(12.0%)	27(6.8%)	75(18.8%)
Total	261(65.2%)	139(34.8%)	400(100%)

$\chi^2 = 1.42$; $df = 2$ p -value = 0.500. Linear by linear association ($\chi^2 = 0.684$; $df = 1$, p -value = 0.038, $df =$ degree of freedom)

Of the 139 anaemic children recorded, 87 (62.6%) were male while 52 (37.4%) were female indicating that male incidence was higher than their female counterparts: However the difference was not significant ($p>0.05$).

These results revealed that iron deficiency anaemia is the most common type of anaemia among the presenting children, but no statistical significant difference ($p>0.05$) was revealed.

Table 5 shows that microcytic anaemia is the most common (52.5%) type of anaemia among

the presenting children, but this finding was not statistically significant ($p>0.05$).

4. DISCUSSION

Anaemia, in this study, was defined based on the WHO criteria of Hb values of less than 11 g/dl; mild anaemia (9.0–10.9 g/dl), moderate anaemia (7.0–8.9 g/dl) and < severe anaemia (7.0 g/dl) [16]. The global prevalence of anaemia in school-age and preschool-age children is 25.4% and 47.4% respectively. It affects 293 million children globally with the highest prevalence (67.6%) found in Africa [16].

Table 2. Severity of anaemia among the study population

Age (years)	Degree of anaemia				Total
	Not Anaemic	Mild	Moderate	Severe	
Newborn to 5.0	154(38.5%)	32(8.0%)	34(8.5%)	8(2.0%)	228(57.0%)
5.01 – 10.0	59(14.8%)	8(2.0%)	22(5.5%)	8(2.0%)	97(24.3%)
10.01 – 15.0	48(12.0%)	6(1.5%)	17(4.2%)	4(1.0%)	75(18.7%)
Total	261(65.3%)	46(11.5%)	73(18.2%)	20(5.0%)	400(100%)

$\chi^2 = 9.7$; $df = 6$, p -value = 0.133, $df =$ degree of freedom. Mild = Mild anaemia, Moderate = Moderate anaemia, Severe = Severe anaemia

Table 3. Gender specific grading of anaemia among the anaemic children

Gender	Degree of anaemia			Total
	Mild	Moderate	Severe	
Male	36(25.9%)	36(25.9%)	15(10.8%)	87(62.6%)
Female	19(13.7%)	28(20.1%)	5(3.6%)	52(37.4%)
Total	55(39.6%)	64(46.0%)	20(14.4%)	139(100%)

Proportion M/F = 2:1; M = male, F = female, $\chi^2 = 2.07$; $df = 2$, p -value = 0.27

Table 4. Aetiological classification of anaemia among the anaemic children based on age groups

Age (years)	Aetiological classification of anaemia					Total
	IDA	SCA	NNA	ACD	MBA	
Newborn to 5.0	40(28.8%)	19(13.7%)	8(5.7%)	6(4.3%)	1(0.7%)	74(53.2%)
5.01 – 10.0	11(7.9%)	13(9.4%)	7(5.0%)	3(2.1%)	4(2.9%)	38(27.3%)
10.01 – 15.0	11(7.9%)	11(7.9%)	4(3.0%)	1(0.7%)	0	27(19.5%)
Total	62(44.6%)	43(31.0%)	19(13.7%)	10(7.1%)	5(3.6%)	139(100%)

$\chi^2 = 14.04$; $df = 8$, p -value = 0.076, IDA = iron deficiency anaemia, SCA = sickle cell anaemia, NNA = normocytic normochromic anaemia, ACD = anaemia of chronic diseases, MBA = megaloblastic anaemia

Table 5. Age specific morphologic classification of anaemia among the anaemic children

Age(years)	Morphologic classification of anaemia			Total
	NA	MACA	MICA	
Newborn – 5.0	27(19.4%)	6(4.3%)	42(30.2%)	75(54.0%)
5.01 – 10.0	11(7.9%)	11(7.9%)	16(11.5%)	38(27.3%)
10.01 – 15.0	10(7.2%)	1(0.7%)	15(10.8%)	26(18.7%)
Total	48(34.5%)	18(13.0%)	73(52.5%)	139(100%)

$\chi^2 = 2.7$; $df = 2$, p -value = 0.291, NA = normocytic anaemia, MACA = macrocytic anaemia, MICA = microcytic anaemia

Four hundred subjects comprised of 224 (56.0%) males and 176 (44.0%) females between the ages of newborn and 15 years of age participated in this study. The red cell indices observed in this study were consistent with the average MCV in IDA of 66.81 fl, the mean value of MCH of 23.97 pg, the mean value of MCHC of 34.81%, and mean haemoglobin of 10.41 gm/dl in IDA recorded by Abu-syed et al. [17].

In this study, we recorded an overall prevalence of anaemia of 34.8% among our cohort of children in Sokoto, North-Western Nigeria. This finding is consistent with the global prevalence of 33% [18]. The observed prevalence is lower compared to the high prevalence rate of 49.6% anaemia recorded in children in South-Eastern Nigeria [19]. Similarly, the observed prevalence in Sokoto is also lower compared to the prevalence of 82%, 62%, 66.7% and 57.1% reported in Abia State [20]; Ibadan [21]; Anambra [22] and Enugu State [23] respectively. The low prevalence observed in our study may be due to the present study being carried out in UDUTH where a significant number of patients are from a higher economic class and may have access to better nutrition. They are also more likely to be able to afford insecticide-treated mosquito bed nets, thus less likely to be exposed to malaria and malaria-related anaemia. This finding may also be linked to the study's timeline between March to June, 2015 (dry session) when there is climatic changes and the environment is not conducive for the breeding of female anopheles mosquitoes (vectors for malaria). However, our observed prevalence is higher than a 29% prevalence of anaemia reported in Katsina [24]. Several factors may be responsible for the high prevalence of anaemia among children recorded in this study and in other studies from other parts of Nigeria. These include: Malaria, poor nutrition, frequent bacterial infections, poor hygiene, and high parasitic infections, as well as other local challenges [25].

In this present study, we observed prevalence of severe anaemia, mild anaemia and moderate anaemia of 20 (14.4%), 64 (46.0%) and 55 (39.6%) respectively in our cohort of children in Sokoto, Nigeria. Our observed prevalence varied significantly from the prevalence of severe anaemia, mild anaemia and moderate anaemia of 16.7-22.2%, 13.9% and 8.3% respectively observed in a previous report in North Western Nigeria [26].

Our findings revealed that, of 139 anaemic children, 74 (53.3%) were pre-school aged (Newborn to 5.0 years), 38 (27.3%) were school aged (5.01-10.0) and 27 (19.4%) were post-primary school children (10.01-15.0). These findings indicate that children under the age of five are more vulnerable to anaemia than those above five years. This finding is consistent with the global findings of 47.4% and 27.4% in pre-school and schooled children respectively [15]. Our study is also consistent with the prevalence level for developing countries recorded to be 42% for pre-school children but inconsistent with 53% of anaemia recorded previously for school children in developing countries [1].

This study also indicates that, of the 139 anaemic children tested, anaemia was higher among male children 87 (62.6%) compared to female children 52 (37.4%) representing a male to female ratio of 2:1 approximately. This finding is consistent with the previous report [7]. In this present study, we observed a low prevalence of severe anaemia of 5% among our cohort of children in Sokoto, Nigeria. Our findings align with the previous studies by other Nigerian researchers which indicated prevalence rates ranging from 2.7% to 12.5% [27]. Our observed prevalence for severe anaemia is however lower than a prevalence rate of 9.7% reported in under-5 children in Abakaliki South Eastern Nigeria [8]. Similarly, previous reports in various African settings indicated that about 12 to 29% of hospitalized children had severe anaemia [6]. Again we might speculate that the socio-economic status in Sokoto users of the UDUTH might have resulted in a differing profile of anaemia sufferers.

In this study, we observed a prevalence rate of 44.6% of IDA among the anaemic children. According to WHO criteria, the accepted cut-off point for IDA screening in children is set at 11 gm/dl, 70fl, and 20pg for haemoglobin, MCV and MCH respectively. Following these criteria, the most common type of anaemia recorded among the children in this present study is IDA, followed by sickle cell anaemia (31.0%), normocytic normochromic anaemia (13.7%), anaemia of chronic diseases (7.1%) and macrocytic/megaloblastic anaemia (3.6%). Our finding for IDA is higher than the prevalence rate of 34.3% reported in Enugu, South-East Nigeria [22]. The higher prevalence recorded in our study, may be linked to malnourishment; however, other factors may include; inadequate

intake of iron containing food, mal-absorption from the gastro-intestinal tract and excessive loss through circulation [28]. Also, prevalence of IDA was higher in male compared to female. In another study, it was found that the prevalence of IDA declined sharply in males after 15 years of age coinciding with the end of a growth spurt while the prevalence among females stated to rise after the age 18 years as they proceed to marriage and childbearing [29].

5. CONCLUSION

Generally, there is high prevalence of anaemia among the children seen at the UDUTH in Sokoto (34.8%). IDA is the most prevalent type, follow by sickle cell, normocytic normochromic, anaemia of chronic diseases while megaloblastic anaemia is the least prevalent. This findings leads to potential for the targeted provision of iron and other micronutrient supplementation for anaemic children.

COMPETING INTERESTS

Authors have declared that no competing interests exist.


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APPENDIX I

USMANU DANFODIYO UNIVERSITY TEACHING HOSPITAL, SOKOTO.
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Chairman Board Rt. Hon. Inusa Simon Dogari		Chief Medical Director Dr. Y. Ahmed MBBS, FWACS
Director of Administration Alh. Bala Hassan B.Sc (Pol.Sc.)MPA		Chairman M.A.C Dr. S. A. Saidu, MBBS, FWACS, FMCR

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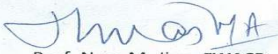
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Department of Haematology & Blood Transfusion Sciences,
Faculty of Medical Laboratory Sciences,
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RE: APPLICATION FOR ETHICAL CLEARANCE

With reference to application on the above subject dated 31st December, 2014 on a research topic titled: **"Aetiology and types of Anaemia among Children visiting Paediatrics Department of Usmanu Danfodiyo University Teaching Hospital, Sokoto, North-western Nigeria"**, I write to acknowledge its receipt and to convey Ethical Committee's approval to you. The approval is given with the understanding that the data obtained would be used to substantiate the above topic.

Please ensure that the study is guided by the methodology presented in the proposal.

Thank you.


Prof. Nma M. Jiya, **FWACP**
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APPENDIX II

RESEARCH QUESTIONNAIRE

Study Title: Prevalence and Types of Anaemia among Children Attending Paediatric Departments (CLINIC 1, EPU, PSW, PMW, PNSW,SCBU, A&E) of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto, North-Western, Nigeria.

I give consent for myself/child to be a participant in this study. I have been fully informed what participation will involve and had all my questions answered. I understand that I can withdraw from this study at any time without giving reason and without penalty.

- Age (Years).....
- Gender: Male [] Female []
- Occupation of the parent: Farming [] Business [] Civil Servant [] others [] Specify.....
- Level of educational attainment of the parent: No formal [] Primary [] Secondary [] Tertiary []
- Area of resident.....
- Number of children/sibling.....
- Number of wife(s).....
- Any medication: Haematinic [] others [] Specify.....
- Sign and symptoms of disease(s).....
- Hereditary disease(s) sickle cells anaemia [] others [] Specify.....

APPENDIX III

Example of Reference Values (Mythic 22CT, 2008)

Parameter	1st Week	8 Days-3 Months	3 Months to 3 Years	3-6 Years	6-15 Years	Adult
RBC 106/ μ L (1012/L)	5,0 to 6,0	3,8 to 4,8	3,6 to 5,2	4,1 to 5,3	4,0 to 5,4	M : 4,5 to 5,8 F : 3,8 to 5,4
HGB g/dL	14,5 to 22,5	10 to 16	10,5 to 13,5	10,5 to 13,5	11,5 to 14,5	M : 13,5 to 17,5 F : 12,5 to 15,5
HCT %	44 to 58	38 to 44	36 to 44	36 to 44	37 to 45	M : 40 to 50 F : 37 to 47
MCV fl	100 to 120	85 to 96	70 to 86	73 to 89	77 to 91	82 to 98
MCH pg	34 to 38	24 to 34	23 to 31	24 to 30	24 to 30	> or = 27
MCHC g/dL	32 to 36	32 to 36	32 to 36	32 to 36	32 to 36	32 to 36
PLT 10 ³ / μ L (109/L)	150 to 400	150 to 400	150 to 400	150 to 400	150 to 400	150-400

M = male, F = female. OTHER REFERENCES: Serum ferritin: 15-120 ng/MI for adolescence and children, 30-300 ng/mL for Men and 10-160 ng/mL (up to 300ng/mL generally) for women. Serum Transferrin: 170-360 mg/dL. Serum Iron: Male = 55-175 μ g/dL, Female = 40-145 μ g/dL. Total Iron Binding Capacity: Newborn = 100-400

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