

MID-UPPER ARM CIRCUMFERENCE CHARTS FOR LIBYAN PRESCHOOL CHILDREN

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ABSTRACT

Mid-upper arm circumference (MUAC) has been used as alternative indicator of nutritional status, if the collection of weight and height was difficult, such as during emergency, famine, or refuge crises. The aim of this study is to construction new arm circumferences charts for Libyan Preschool Children to use as screening tool in nutritional assessment. Data were taken from two cross-sectional studies carried out in 3 regions of western part of Libya (Tripoli, Al jafarh and Al-Jabel Al-Gharbi) between the years 2000 and 2010 by the principle author and his team following World Health Organization (WHO) methodology. A simple random sampling technique was used to obtain participants from MCH centers, kindergartens and the delivery section of obstetric hospitals. A sample of 2014 Libyan preschool children from both sexes were recruited from different places in Libya. Selected percentiles (P3, P10, P25, P50, P75, P90, and P97) are presented for boys and girls of under five years according to age. New MUAC charts were made for Libyan preschool children, to provide health workers in Libya with tool that should be useful in screening or as a clinical and research tool for adequacy of growth during the first five years of life in Libya.

KEY WORDS: Cross sectional studies, Mid upper arm circumference charts, Libyan preschool children, screening tool.

INTRODUCTION

For many years, mid-upper arm circumference (MUAC) has been used as alternative indicator of nutritional status of children, if the collection of weight and height was difficult, such as during emergency, famine, or refuge crises. In such cases, low MUAC, determined on the basis of a single cut-off value, has been used as a proxy for low-weight for height⁽¹⁻⁴⁾.

Moreover, in community-based studies, MUAC appears to be a better predictor of childhood mortality than height and weight based on anthropometrics indicators⁽⁵⁾.

Mid-upper arm circumference (MUAC) is an important tool in screening for under nutrition especially when weight and stature measurement are too demanding or are impossible, such as in emergency situation and when the precise age of the child is unknown, since it has been suggested that is relatively independent of age for children between 1 and 5 years⁽⁶⁾.

The relationship between weight change and MUAC change in children 6-59 months at each follow up visit during outpatient treatment for sever acute malnutrition, shows a strong correlation in all contexts irrespective of the treatment outcome⁽⁷⁾.

In Libya the first mid-upper arm circumference charts (MAUC) for Libyan preschool children was done in 1979 by Tajouri in Tripoli⁽⁸⁾.

The objective of this study was to develop update mid-upper arm circumference charts (MAUC) (local charts) for Libyan preschool children to use as a

rapid method for determining levels of nutrition status and as a screening tool for malnourished children. Local growth charts is very important due to genetic and environment factors that may be affected the growth of children and every country should be developed local growth charts.

SUBJECT AND METHODS

Data were taken from two cross-sectional studies carried out in 3 regions of western part of Libya to increase the sample size (Tripoli, Al jafarh and Al-Jabel Al-Gharbi) between 2000 and 2010 by the principle author and his team following World Health Organization (WHO) methodology⁽⁹⁾.

Tripoli is the capital city and the largest and most densely populated city in Libya. Aljafarh region is located 44 Km south-west from Tripoli.

Al-Jabel Al-Gharbi region is located 88 km south-west from Tripoli.

In general about 76% of the Libyan population lives in urban areas. Regarding basic needs, all regions of Libya are similar, with education and basic health care⁽¹⁰⁾.

Recruitment was from several selected areas in all regions (maternal child health centers, obstetrics hospitals, kindergartens). The sample comprised 2014 healthy children of both sexes, from different socioeconomic backgrounds, in all studied regions from Libya. Raw curves was smoothing according to Jelicoeur model. 1992⁽¹¹⁾.

Sample:

A multi-stage random sample was used to obtain participants from MCH centers, kindergartens and the delivery section of obstetric hospitals. A sample of 2014 healthy Libyan children (51.6 % boys and 48.4% girls) from preschool children from both

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sexes were recruited from different places in the studied area.

Arm circumference is measured with a tape measure extending. A plastic tape was used to measure the MUAC. The mid-point of the left upper arm was determined by measuring the length from the tip of the shoulder to the tip of the elbow and the length was divided by two. The tape was wrapped around the straightened arm at the midpoint and the tape inspected to ensure it was neither too tight nor too loose. The measurement was recorded to the nearest 0.1 cm.

Statistical analysis:

Adjusted mean for arm circumference were calculated for each sex separately. The t- test was used in assessment of sex differences.

Arm circumferences at 3rd, 10th, 25th, 50th, 75th, 90th, and 97th percentiles were determined for each sex and were graphically smoothed.

Statistical analyses were done with SAS Software.

RESULTS

(Table 1) presents the adjusted mean between boys and girls for arm circumferences for Libyan preschool children. There were no difference regarding the adjusted mean between both sexes (p > 0.05).

(Table 1) Test of adjusted mean of arm circumferences according to sexes

Sex	Adjusted mean	P- value
Boys	14.96	
Girls	14.84	0.0631

(Table 2) shows the distribution of arm circumferences in cm for both sexes. The percent of children from one to four years with arm circumferences more than 13.5 cm is 88.7% for both sexes and 11.3% between 12.5 and 13.5 cm.

(Table 2) Distribution of arm circumferences in cm for both sexes

Arm	All		Boys				Girls					
	<12 months	≥12 months	<12 months	≥12 months	<12 months	≥12 months	<12 months	≥12 months	<12 months	≥12 months		
Circumferences	n	%	n	%	n	%	n	%	n	%	n	%
<12.5	158	21.4	0	0	71	18.8	0	0	87	24.1	0	0
12.5-13.5	278	37.7	144	11.3	141	37.3	69	10.4	137	38.1	75	12.2
>13.5	302	40.9	1132	88.7	1664	43.9	592	89.6	1363	37.8	540	87.8
Total	738	100	1276	100	378	100	661	100	360	100	615	100

(Table 3) shows the comparison between new percentiles for Libyan preschool children and the old percentiles (1979) for both sexes.

(Table 3) Distribution of new percentiles of arm circumferences for Libyan preschool children according to old percentiles (1979)

Age(months)	New percentiles			Old percentiles (1979)		
	3 rd	50 th	97 th	3 rd	50 th	97 th
[0-<0.2]	9.0	10.5	11.6	8.2	9.9	11.2
[0.2-<2]	9.5	12.5	15.5	8.3	10.3	12.4
[2-<5]	11.0	13.5	16.5	9.7	12.1	14.1
[5-<9]	12.5	14.0	16.0	11.2	13.4	15.4
[9-<15]	12.5	15.0	16.5	11.3	13.7	15.6
[15-<21]	13.0	15.0	17.0	12.6	14.5	17.2
[21-<30]	13.5	15.5	17.5	13.2	14.8	17.4
[30-<40]	14.0	15.5	18.0	13.4	15.6	17.2
[40-<50]	14.5	16.0	18.0	13.5	15.8	18.7
[50-<60]	14.5	16.0	18.5	14.0	16.4	18.9

(Table 4) shows the Libyan percentiles in comparison with WHO percentiles for both sexes. For preschool children regarding mid-upper arm circumferences.

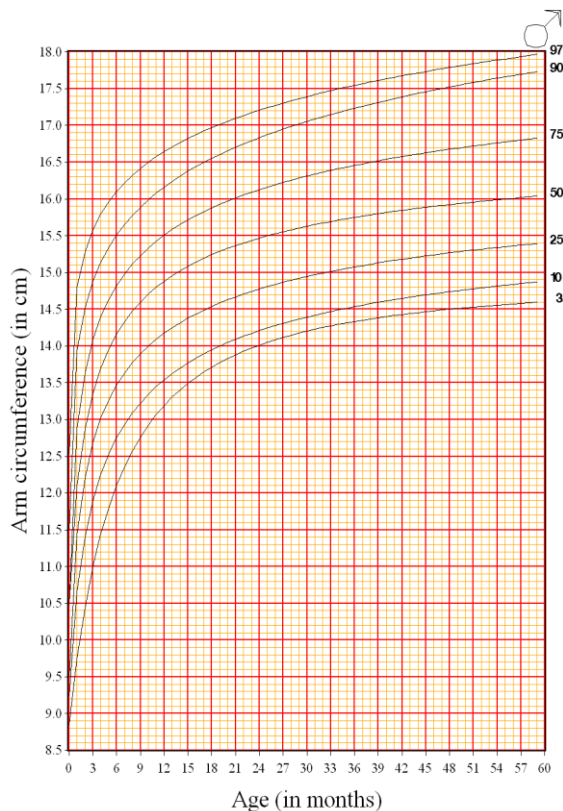
(Table 4) Comparison between Libyan percentiles and WHO percentiles for preschool children(MUAC)

Arm circumferences percentiles for Libyan (boys)				WHO Arm circumferences percentiles (boys)		
Months	3 rd	Median	97 th	3 rd	Median	97 th
6	12.0	14.3	16.5	12.3	14.2	16.4
12	15.0	15.0	16.5	12.7	14.6	16.9
18	13.0	15.0	16.5	12.8	14/8	17.2
24	14.5	16.3	17.0	13.1	15.2	17.5
30	14.0	15.0	17.0	13.4	15.5	18.0
36	13.5	15.8	18.5	13.6	15.7	18.3
42	15.0	16.5	19.0	13.7	15.9	18.6
48	14.5	15.5	17.5	13.9	16.1	18.9
54	14.5	16.0	18.5	14.0	16.3	19.2
59	14.5	15.5	17.5	14.1	16.5	19.5

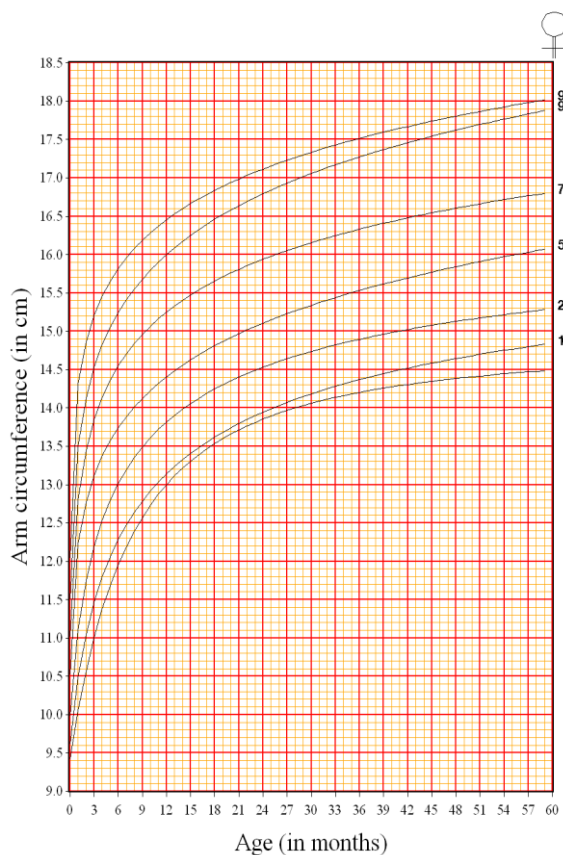
Arm circumferences percentiles for Libyan (girls)				WHO Arm circumferences percentiles (girls)		
Months	3 rd	Median	97 th	3 rd	Median	97 th
6	12.0	15.8	16.0	11.8	13.8	16.2
12	12.5	13.5	15.5	12.2	14.2	16.6
18	13.0	15.5	17.5	12.4	14.5	16.9
24	13.5	15.5	17.0	12.8	14.9	17.4
30	14.0	16.0	17.5	13.2	15.3	17.9
36	14.0	15.5	17.0	13.4	15.6	18.3
42	15.0	16.2	18.5	13.6	16.0	18.8
48	14.5	16.0	16.5	13.8	16.2	19.2
54	14.0	16.0	18.5	14.0	16.6	19.7
59	15.0	15.5	17.5	14.1	16.8	20.1

Arm circumferences percentiles presented in (figures 1 and 2) for both sexes for Libyan preschool children. (Figure 1) shows the arm circumference percentiles for the age for the boys, and (figure 2) shows arm circumference percentiles for the age for the girls.

The charts include the following percentiles (3rd, 10th, 25th, 50th, 75th, 90th and 97th). (Tables 4 and 5) present the percentiles tables for both sexes for Libyan preschool children.



(Figure1) Arm circumference charts for Libyan preschool children(boys)



(Figure2) Arm circumference charts for Libyan preschool children (girls)

(Table 5) Arm circumference percentiles table for Libyan preschool children(boys)

Age(mois)	3 ^{ème}	10 ^{ème}	25 ^{ème}	50 ^{ème}	75 ^{ème}	90 ^{ème}	97 ^{ème}
0	9.0	9.3	9.5	10.5	10.5	11.5	12.5
1	9.5	10.5	11.5	12.0	12.5	13.5	15.5
2	10.0	11.0	12.0	13.0	14.0	15.0	16.5
3	11.0	12.3	13.0	13.8	14.5	15.5	16.5
4	12.0	12.5	13.0	13.5	14.0	14.0	14.0
5	12.5	13.0	13.0	13.5	14.0	15.5	15.5
6	12.0	12.5	13.5	14.3	15.5	16.0	16.5
7	13.0	13.0	13.5	14.0	15.5	16.0	16.0
8	12.5	13.0	13.5	14.5	15.0	16.0	16.0
9	12.0	13.5	14.5	15.0	15.0	16.0	17.5
10	12.5	13.0	13.5	14.5	15.0	15.5	16.0
11	13.0	13.5	14.5	15.0	16.0	16.5	16.5
12	12.5	13.5	14.5	15.0	15.5	16.5	16.5
13	13.0	13.3	14.0	15.3	15.5	16.0	16.0
14	13.5	13.5	14.3	15.0	15.1	15.2	15.2
15	13.0	13.5	14.0	15.0	16.5	16.5	17.0
16	14.0	14.0	14.3	15.0	15.5	16.5	17.5
17	13.5	13.5	14.5	15.0	15.8	16.5	16.5
18	13.0	13.5	14.5	15.0	16.0	16.5	17.0
19	15.0	15.0	15.0	15.5	15.5	16.0	16.0
20	14.5	14.5	15.5	15.5	16.0	16.5	16.5
21	14.0	14.5	14.8	15.5	15.8	17.0	17.5
22	14.5	14.5	15.0	15.8	17.0	17.3	17.5
23	13.0	13.0	14.0	14.5	15.0	16.5	16.5
24	14.5	14.5	15.5	16.3	16.5	17.0	17.0
25	13.5	13.8	15.0	15.5	16.0	17.0	17.0
26	14.0	14.0	14.0	14.8	15.5	17.0	17.0
27	14.5	15.0	15.0	15.5	16.5	17.0	17.0
28	13.5	14.0	14.3	15.8	16.5	16.5	18.0
29	15.0	15.0	15.0	15.5	16.0	16.5	17.0
30	14.0	14.0	14.5	15.0	15.5	17.0	17.0
31	14.0	14.0	15.0	15.5	16.5	18.0	18.0
32	14.0	14.0	14.5	15.5	16.0	16.0	18.0
33	14.5	14.5	15.0	16.0	16.5	16.5	16.5
34	14.5	14.5	15.0	16.0	17.0	18.0	18.0
35	15.0	15.0	16.0	16.8	17.5	18.0	18.0
36	13.5	15.0	15.0	15.8	16.5	17.0	18.5
37	14.5	14.5	15.5	16.0	16.5	16.5	16.5
38	14.5	14.5	15.0	15.8	16.5	17.5	19.0
39	15.0	15.0	15.0	15.5	17.0	17.0	17.0
40	14.5	14.8	15.0	15.5	16.0	17.3	18.0
41	14.5	14.5	15.0	15.8	17.0	18.0	18.0
42	15.0	15.0	16.0	16.5	17.0	19.0	19.0
43	14.5	14.5	14.5	15.5	16.0	17.5	17.5
44	14.5	14.5	15.0	15.5	16.0	17.0	17.0
45	14.0	14.5	15.0	16.0	16.0	16.5	16.5
46	14.5	15.0	15.0	16.0	17.5	18.5	19.5
47	13.5	14.0	15.0	16.0	16.0	17.5	17.5
48	14.5	14.5	15.5	15.5	16.5	17.5	17.5
49	14.5	15.0	16.0	16.5	17.2	17.5	18.0
50	15.0	15.0	15.5	16.5	17.0	18.5	19.0
51	15.0	15.0	15.5	15.8	16.5	17.0	17.0
52	14.5	15.0	15.0	16.0	17.0	17.0	17.5
53	14.5	15.0	15.5	16.0	17.0	17.5	18.0
54	14.5	15.0	15.5	16.0	16.5	17.5	18.5
55	13.5	14.0	15.0	16.5	17.5	18.5	19.5
56	15.0	15.0	15.5	16.0	16.0	17.0	17.0
57	14.0	15.0	15.5	16.0	17.0	17.5	17.5
58	15.0	15.0	15.0	15.5	17.5	18.0	18.0
59	14.5	14.5	15.5	15.5	16.0	17.5	17.5

(Table 6) Arm circumference percentiles table for Libyan preschool children (girls)

Age (mois)	3 ^{ème}	10 ^{ème}	25 ^{ème}	50 ^{ème}	75 ^{ème}	90 ^{ème}	97 ^{ème}
0	9.5	9.5	10.0	10.5	11.0	11.5	12.0
1	9.5	10.5	11.0	12.5	13.0	13.5	14.5
2	11.0	11.8	12.0	13.0	13.5	14.5	16.5
3	11.5	11.5	12.3	13.0	13.8	14.5	15.5
4	11.0	11.0	12.5	13.5	14.5	15.0	15.5
5	12.0	12.0	12.5	13.5	13.8	14.0	14.0
6	12.0	12.3	12.5	12.8	14.0	15.0	16.0
7	12.0	12.0	13.2	14.0	14.5	15.5	16.0
8	12.5	14.0	14.0	14.5	15.5	16.5	18.5
9	12.0	12.0	13.3	13.5	14.5	15.5	15.5
10	13.0	13.0	14.0	14.5	15.3	15.5	15.5
11	13.0	13.0	14.0	14.5	15.0	15.5	15.5
12	12.5	12.5	13.0	13.5	14.5	15.5	15.5
13	12.5	13.0	14.0	15.0	16.0	16.5	16.5
14	13.0	13.0	14.0	14.5	15.5	16.0	16.0
15	12.5	12.5	13.3	14.5	16.3	17.0	17.0
16	15.0	15.0	15.3	16.0	16.5	16.5	16.5
17	14.0	14.0	14.5	15.0	16.5	17.0	17.0
18	13.0	14.0	14.5	15.5	16.0	16.5	17.5
19	14.0	14.0	14.5	14.5	15.0	16.0	16.0
20	13.5	13.5	14.0	15.0	15.5	17.5	18.0
21	14.0	14.0	14.5	14.5	15.0	17.0	17.0
22	13.1	13.1	14.0	14.0	15.0	18.5	18.5
23	14.5	14.5	14.5	15.0	15.5	15.7	15.8
24	13.5	14.0	15.0	15.0	15.5	16.0	17.0
25	14.0	14.0	15.5	16.0	17.0	17.0	17.0
26	14.5	14.5	14.5	15.0	16.0	16.5	16.5
27	14.0	14.0	14.0	15.3	16.0	16.5	16.5
28	14.5	14.5	14.5	14.5	14.8	15.0	15.0
29	14.0	14.5	14.5	15.0	16.5	17.0	17.5
30	14.0	14.0	14.5	16.0	16.5	17.5	17.5
31	14.0	14.0	14.3	15.0	15.8	17.0	17.0
32	14.0	14.0	14.5	15.0	16.0	16.5	16.5
33	14.0	14.0	14.5	15.0	16.0	16.5	16.5
34	13.5	13.5	15.5	16.5	17.0	18.5	18.5
35	14.5	14.5	15.0	15.5	16.0	16.5	16.5
36	14.0	14.0	14.5	15.5	16.0	17.0	17.0
37	14.5	14.5	15.5	15.5	16.5	18.0	18.0
38	13.5	14.0	14.5	15.5	17.5	18.0	19.5
39	14.0	14.5	15.0	16.0	17.0	19.0	19.0
40	15.0	15.0	15.0	15.5	17.0	17.0	17.0
41	14.5	14.5	15.0	15.4	16.5	17.5	17.5
42	15.0	15.0	15.5	16.2	16.5	18.5	18.5
43	14.5	14.5	14.5	15.5	16.5	17.0	17.0
44	13.0	14.0	15.0	15.5	16.5	17.3	17.5
45	14.5	15.0	15.0	15.5	16.0	16.0	16.5
46	13.5	14.0	15.0	15.5	17.0	18.5	20.0
47	15.5	15.5	15.5	16.0	16.5	17.0	17.0
48	14.5	15.0	15.5	16.0	16.5	16.5	16.5
49	14.5	14.5	15.0	16.0	16.0	17.0	18.5
50	14.5	14.5	15.0	16.5	16.5	17.0	17.5
51	14.0	14.5	15.0	16.0	18.0	19.5	19.5
52	14.0	15.0	15.5	16.5	17.0	18.5	18.5
53	14.5	14.5	15.0	16.0	17.0	18.0	19.0
54	14.0	14.0	15.5	16.0	16.0	18.5	18.5
55	14.0	15.0	15.0	16.3	17.0	17.5	17.5
56	14.5	14.5	15.0	16.0	16.5	17.8	18.5
57	14.5	14.5	15.3	15.8	16.3	17.5	17.5
58	15.0	15.0	15.5	16.0	16.5	18.5	18.5
59	15.0	15.5	15.5	15.5	16.5	17.0	17.5

DISCUSSION

The first mid upper circumferences charts for Libyan preschool children were done In Tripoli since 1979

from cross sectional study of growth in urban preschool children in Libya⁽⁸⁾.

The present mid upper arm circumferences (MUAC) charts developed in our study differ from previous study in 2 ways. Firstly, the data were drawn from 3 regions rather than 1 region as reported in 1979⁽⁸⁾. Our study also represents groups from various socio-economic categories, whereas the 1979 study was in urban preschool children from Tripoli. Secondly, our charts were fitted with the most recent mathematical models, whereas those produced in 1979 were hand-smoothed⁽¹¹⁾. This smoothing has the advantage of making the curves more accurate and also allows for comparisons.

Comparisons with national and international references are necessary, although local references are preferable because of potential variations in the genetic or environmental factors that may affect the growth patterns of infants and children⁽¹²⁾.

A simple measurement, like mid-arm circumferences can be used as an alternative to the weight recording in certain situation for identifying newborns with low birth weight or very low birth weight.

A water proof, flexible tape with appropriate cut-off points marking in separate colors, is easy to use, quick, reliable ,practical and cost effective alternative to weighing newborn babies⁽¹³⁾.

Another study recommended to use arm circumferences for age as an alternative indicator of nutritional status when the collection of length/height and weight measurement is difficult as happens in emergency humanitarian situation due to famine or refugee crises⁽¹⁴⁾.

Many other studies confirm that MUAC measurement allow differentiation between normal and under weight and normal and wasted children⁽¹⁵⁻¹⁸⁾.

This study shows improvement in nutritional status for Libyan preschool children as indicated by the percent of children from one year to less than five years with arm circumferences more than 13.5 cm (88.7%).

In comparison, the old and new tables of percentiles for Libyan preschool children, we see certain improvement in nutritional status Libyan preschool children in most percentiles. Others published studies confirmed the same finding regarding the improvement of nutritional status of Libyan preschool children during the last decades⁽¹⁹⁻²¹⁾.

In comparison the Libyan percentiles with WHO percentiles, the Libyan percentiles run very close from WHO percentiles(MUAC) mainly for the median.

CONCLUSION

This study provides medical and paramedical staff with update local MUAC charts, use as a reference for clinical, epidemiological , research purposes and as a screening tool to detect children at risk of health or nutritional disorders.

The references provided from this study have the advantage of operational simplicity and mothers can use them with minimal training to monitor their babies using a very simple graduated inexpensive strip.

Local growth charts are of particular value due to variations in environment or genetic factors that may affect the physical growth of children.

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REFERENCES

- 1- Jelliffe D B, Jelliffe EFP. The arm circumferences as a public health index of protein –calorie malnutrition in early childhood. *Journal of tropical pediatirc*, 1969, 15; 177-260.
- 2- Velzeboer MI et al. Evaluation of arm circumferences as a public health index of protein –calorie malnutrition in early childhood. *Journal of tropical pediatircs*, 1993, 29; 135-44.
- 3- Shakir A. Arm circumferences in the surveillance of protein – energy malnutrition in Baghdad. *American journal of clinical nutrition*, 1975, 26:661-65.
- 4- McDowell I, King FS. Interpretation of arm circumferences as an indicator of nutritional status. *Archives of disease in childhood*, 1982, 57:292-96.
- 5- Vella V et al . Anthropometry and childhood mortality in Northwest and Southwest Uganda. *American journal of public health*, 1993, 83:1616-18.
- 6- Le Thi et al. Mid-upper arm circumferences development and it's validity in assessment of under-nutrition. *Asia Pacific J Clin Nutr* (1998)7(1):65-69.
- 7- Binns P et al. Relationship between mid upper arm circumference and weight changes in children aged 6-59 months. *Archives of Public Health*, 2015, 73; 54.
- 8- Tajouri R F. Cross section study of growth in urban preschool children in Libya 1979.
- 9- Measuring change in nutritional status. Guidelines for assessing the nutritional impact of supplementary feeding programme. Geneva, World Health Organization, 1983.
- 10- Population census, 1995. Tripoli, Libyan, Information and Documentation Centre, 1995.
- 11- Jolicoeur P, Pontier J, Abidi H. Asymptotic models for the longitudinal growth of human stature. *American journal of human biology*, 1992, 4:461–8.
- 12- Frongillo EJ, de Onis M, Hanson KM. Socio-economic and demographic factors are associated with worldwide patterns of stunting and wasting of children. *Journal of nutrition*, 1997, 127:2302–9.
- 13- Das Jet al. Mid-Arm circumferences :An alternative measure for screening low birth weight babies. *Bangladesh .Med.Res.counc.Bull.*, 2005; 31(1)1-6.
- 14- De Onis. M et al. World child growth standards. Department of nutrition for Health and Development. World health organization 2007.
- 15- Shakir A, Morley D. Measuring malnutrition. *Lancet*1974. 1:758 -759.
- 16- Shakir A. Arm circumferences in the surveillance of protein – calorie malnutrition in Baghdad. *Am J Clin Nutr*1975; 28; 661-5.
- 17- McDowell I, Savage F. Interpretation of arm circumference as an indicator of nutritional status. *Arch Dis childhood* 1982; 57:292 -6
- 18- De Onis M et al. The development of MUAC for age reference data recommended by WHO expert committee. *Bulletin of the Woeld Health Organization*,1997; 75(1);11-18
- 19- Pan Arab project for child developemnt. Arab Libyan maternal and child health survey. 1998, Tripoli Libya.
- 20- Hameida J, Billot L, Deschamps J P. Growth of preschool children in Libya: regional and sociodemographic differences. *Eastern Mediterranean health journal*, 2002, 8(4/5): 458-69.
- 21- Bordom J.et al .New growth charts for Libyan preschool children. *Eastern Mediterranean health journal*, vol14 N°6, 2008, 8: 1400-12.