BIRTH WEIGHT AND LENGTH OF NEW-BORN INFANTS
DELIVERED AT OXFORD MATERNITY HOSPITAL

By

HODIDA ESSA EL HADI
(T. Sc., Home Science & Education)
University of Khartoum, 1987

A Thesis submitted for the Degree of Master of Science
in Nutrition

Faculty of Education,
University of Khartoum.

1987
DEDICATION

To: My Family and Friends with
Love and Gratitude
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<td>Weight (kg) for Length of 520 Sudanese New-Borns/Males Compared with International Standards</td>
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<td>Weight (Kg) for Length of 1,000 Indian New-Born/Adoles Combined Compared with International Standards</td>
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<td>Weight for Length Distribution by Standard Deviation for 1,000 Indian New-Born/Adoles Combined Compared with International Standards</td>
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The objective of the present study is to collect information regarding birth weight and length and other anthropometric measurements of new-born infants delivered at Ceduwan Maternity Hospital. One thousand new-born infants are included.

The literature review of this study concentrates on informations about growth and development of infants and factors affecting birth weight and length, the birth weight and length in different parts of the world as well as birth weight and length of new-borns previously studied in the Sudan were reviewed.

Weight, length, head, chest and arm upper-arm circumference and skin fold thickness measurements are taken by the author for all infants included in the study. Weight for age centiles are done and compared with international standards, for each sex separately as well as sexes combined. Length for age and weight for length are also done.

Results of this study when compared with international standard show that the Sudanese new-born weight for age for males, females and sexes combined is higher at the 3rd, 5th, and 10th centiles and lower regarding the 25th, 50th, 75th, 90th, 95th and 97th centiles.

The Sudanese new-borns length for age for males, females, and sexes combined is higher at the 3rd and 5th centiles and
lower regarding the 10th, 25th, 50th, 75th, 90th, 95th, and 97th centiles.

The Sudanese neonates weight for length for males, females and sexes combined is higher than the international standards.

The study recommends provision of adequate equipments for anthropometric measurements as well as trained staff in all hospitals and health centres. The need for nutrition and health programmes is emphasized.
المؤاهلة

تهدف هذه الدراسة إلى جمع معلومات عن أحوال
والزواج وتبادل المعلومات الإضافية للاطفال
التزمت وتزيد على الوصول الاستيعابي للولاية
من حيث هذه الدراسة إتاحة طرق صحيحة

الولاية.

الأعمال الإدارية لهذا السياق يوضح على بعض
المعلومات الأولية والعادات التي تتعلق على أحوال
والزواج لدى شابي الولاية في بعض المناطق المختلفة
من البلد، وهي السودان.

الخضوع إلى القانون، ومحبة النساء، ومحبة الإمراء
وتحريض واسع النطاق على إنشاء نظام علم
بسبب واستشرافات الدولة للإفتاء الذين يضيفون
النظام - يعود جدير بوضعه على هذه المهمة

النظام.

فهو الوطين، بالنسبة للنظام والقانون، بالنسبة
للمجتمع، وكتاب الوطين، بالنسبة للقانون، ونظام
النظامية، ونظام، كل من الدواكر، وانت، والחסنين
المجتمعي.

عند مقارنة نتائج هذه الدراسة مع المعلومات
العامة، يتباح لنا أن الوطين بالنسبة للنظام والأطفال
السودانيين خصائص الوطين لكل من الدواكر، الحاكيم,
والخصائيين، تعبير عن ضرورة اتخاذ قرارات علمية
لتحسين التزامات الخدمات وال服务质量، وتقديم
خدمات، التزامات الاستقلال، الخاصة والخصوص
الرسمية، والخصوص، الخاصة، والخصوص، الخصائص، والخصوص
(الخصوص، الخصائص، الخاص، الخاص، الخصائص، والخصوص،
الخصوص، الخاص، الخصائص، الخاص، الخاص)
من أهم النتائج التي قدتم في نهاية الدراسة:

- تغيرات المناخ والمعايير البيئية المطلوبة للحفاظ على التوازن والطاقة النزبية وال рыб.
- المرتكز للتحقيق في هذا المجال في كل المستشفيات، والمراكز الصحية.
- السكان على البرامج النظائية والمحلية في مجال الإنتاج والطاقة.

نهاية الورقة بخصوص النتائج السودانية في مجال الولادة ذكراً واناثًا والمسميات المتصلة بمشيرة مرض النرويج.
I am greatly indebted to my Supervisor, Professor Faiha Yousif Zamaawi - Head Department of Home Science - for her valuable advice, guidance, continuous encouragement and patience throughout the process of this study.

Thanks are also extended to Grandma Maternity Hospital staff for their valuable help and utmost spirit of cooperation.

My thanks must be extended to Ustaz Ibrahim Dassen - Mathemetic Department - for his valuable assistance.

I would like to thank my friends for their encouragement throughout the period of the study.

Finally, thanks are also extended to all those who have rendered any service or help for me towards the preparation of this research.
CHAPTER I

INTRODUCTION
CHAPTER 1

INTRODUCTION

Growth is influenced by biological determinants including sex, intra-uterine environment, birth order, birth weight in single and multiple pregnancies, parental size and genetic constitution and by environmental factors including climate, season and socio-economic level.

Growth is due to increase in total cell number (hyperplasia), in cell size (hyper-trophy) and in the amount of inter-cellular materials. The rate and timing of each of this growth process is controlled by heredity, hormonal action, environmental impact and quality of nutrition of the mother during pregnancy, all of which interact to produce identifiable pattern of growth (Fremler, 1980).

The nutritional assessment of human communities can be undertaken by various ways including anthropometry which appears to be of greatest value in assessment of nutritional status and health, (Heede and Falkner, 1974).

Nutritional anthropometry is concerned with the measurement of the variations of the physical dimensions and the gross composition of the human body at different age levels and degrees of nutrition. In general recent work tend to support that environmental influences especially nutrition are of greater importance than genetic
background or other biological factors. Certainly the physical dimensions of the body are much influenced by nutrition particularly in the rapidly growing period of early childhood.

Appropriate reference standard can be used to measure changes in nutrition and health status in a given population, so local anthropometric standards need to be prepared and used wherever possible (Hicks and Falkner, 1974).

Measurements of weight and height are the most simple methods for assessment of growth in children, which gives a better index of actual growth and growth failure. In developing countries problems faced in anthropometric measurements are lack of local standards. There are present no satisfactory standards for birth weight and height, in the Sudan as well as many other countries. Usually these countries use the European and American standards. All statistical evidence suggest that birth weight and height differ in different races (Mokadi, 1962). The use of standardized birth weight and length allows for international comparisons of health and nutritional status. (Martin and Paul, 1976).

Standards can be prepared by measuring cross-sectionally a statistically adequate sample of a healthy well-fed section of the community whose ages are known (Jelliffe, 1956).

It has been observed by many workers that measurements of the well-fed section of different ethnic groups tend to
appropriate to those of Consciamia in Europe and U.S.A. (Ford, 1966; and Jelliffe, 1966).

The present study deals with measurements of birth weight and length of new-born infants belonging to well-nourished mothers delivered at Komunum Maternity Hospital.

This study, the first of its kind to be done in the Sudan, is an attempt to cover the following objectives:

1) To collect information regarding measurements of birth weight and length of new-born infants of mothers delivered at Komunum Maternity Hospital.

2) To obtain anthropometric information of the other measurements of the same new-born infants that are important for determination of nutritional status and health.
CHAPTER IX

LITERATURE REVIEW
CHAPTER II

LITERATURE REVIEW

Since the purpose of the study is to collect information regarding birth weight and length and other anthropometric measurements of newborn infants delivered at Colombo Maternity Hospital, the literature review will give information with emphasis on the following:

1) Growth and development of infants and factors affecting birth weight and length.

2) Birth weight and length in some countries in different parts of the world.

3) Birth weight and length in the Sultan.

II.2. Growth and Development of Infants and Factors Affecting Birth Weight and Length

Gestation is 280 days or 40 weeks as measured from the first day of the last menstrual period, but there is an individual variation. Full-term babies are those born between 37 to 42 Weeks. The duration of gestation is sometimes difficult to ascertain accurately. Birth weight and length in relation to duration of gestation is one of the main indices of foetal development, (Roat and Tschachen, 1970).
Data collected by a WHO study on birth weight from 37 centres showed that the average duration of gestation is the same in developed and developing countries (G rosa and Tarplen, 1970).

An adequate birth weight and length of an infant is important because it will determine the ability to adapt to the new environment and develop normally (Cameron and Novander, 1976).

Each infant's physical growth and development are determined by the characteristics acquired from his ancestors, and the quality of nutrition of his mother during pregnancy (Robinson, 1976).

The average weight of an infant born at term is approximately 3.400 Kg, and the usual length of full-term infants is 51 cm with an average of 45-57 cm (Schaffer and Avery, 1960).

Tehran and Vachon (1967), reported that an average newborn infant weighs about 3.4 Kg, 90% of full-term newborn infants weigh about 2.5-4.5 Kg. Length average is about 50 cm, approximately 9% of infants are within the range of 44-55 cm.

Birth weight of the healthy newborn varies from community to another, and differ in different races, and that they are influenced by racial, structural and socio-economic factors (Mesawi, 1963). For example, babies of
American Negroes are on average smaller than those of
whites, despite the fact that the adult stature of both
groups is roughly the same. Among North American Indians
the distribution of birth weight is similar to that found
in whites, although adult Indians are on average four one-
shorter than adult whites. Birth weight and length are
also closely correlated with maternal stature. Short
mothers have babies of lower birth weight and length than
taller mothers. (Montazem, 1965). Also association between
birth weight and weight gain during pregnancy was found to
be high. (Sandra et al., 1980).

Tripathi et al., (1987) reported that the birth weight
increased with increasing maternal height and pregnancy
weight. Birth weight was significantly related to maternal
weight gain during pregnancy.

In mothers who came from the higher socio-economic
croups, who had adequate antenatal care, whose diet is
good, and who did not suffer from chronic ill-health, the
new-born tended to weigh more than in the case of mothers
who came from the lower socio-economic level and who lived
on a poor diet. In most developing countries the average
birth weight is much less than in the developed countries
except in very few who enjoy a good standard of living.
Generally the average birth weight is 3.4 Kg, even these
small babies are capable of normal growth and development,
(Ibrahim, 1976).
Campbell and Hevander (1976) reported that birth weight according to socio-economic status was as follows:

- Upper socio-economic level: 3.290 Kg
- Upper middle socio-economic level: 2.950 Kg
- Lower middle socio-economic level: 2.600 Kg
- Lower socio-economic level: 2.180 Kg

Fehrenbach and Vaughan (1965) found birth weight in high social class to be 3.200 Kg and in low social class to be 2.940 Kg.

The effect that the nutritional experience has on stature was shown by Greulich, 1957 who studied the physical and development of 698 American-born Japanese children and compared his findings with the anthropometric data of the same age and sex born in Japan published by the Japanese Ministry of Education. The California Japanese children were found to be taller, heavier and more advanced skeletal. The study showed that favourable environmental factors, particularly good nutrition can affect the stature, which usually considered to be a racial characteristic, (WHO, 1970).

Jean (1955) reported that the percentage of mothers of pre-mature deliveries was twice as high among those with poor dietary habits than among those with better nutrition. However, these studies did not separate nutrition from associated economic factors, prenatal care or other influences that might be involved.
Bagchi and Bose (1962) found that infants born to poorly nourished mothers in Calcutta weighed an average of 281 g. less than those born to well-nourished mothers in the higher socio-economic strata.

Intra-uterine nutrition may also be involved in the effect; that is, parity and interval between successive pregnancies have on birth weight. For example babies of very young mothers have lower birth weights than those of older mothers. These differences may be the result of the nutritional demands of pregnancy being added to increased requirements of the mother herself to meet the acceleration of growth and development that follows puberty (Joint FAO/WHO Expert Committee on Nutrition, 1967).

Parity is also a factor in birth weight and length. First-born babies being, on an average, lower birth weight and length than subsequent ones. When maternal age and parity analyzed together, it is clear that parity has the greater effect. Parity and birth interval may also influence postnatal nutrition, but it is difficult to isolate these factors since high parity and short birth intervals are frequently associated with poverty (FAO, 1970).

Most studies in Africa have confirmed the positive relationship between parity and birth weight. The evidence from these studies indicates that later-born children may have an advantage of relatively higher birth weight over
earlier born children, although there is some indication that birth weight may decrease again for very high birth order. In Africa, most African primiparas are teenagers and the low birth weight may be a reflection of young maternal age rather than parity, (Owens, 1985).

It is often useful to make comparison with stated norms, such as weight and length. It is also dangerous to expect every infant to conform exactly to such norms, no single criterion of physical status is indicative of the quality of nutrition, but a series of measurements is likely to be a reliable indicator, (Robinson, 1976).

It has been widely observed that the new-born is mature relative to birth weight and although under weight by International Standards, i.e. weighing 2.500 g or less, the respiratory and feeding problems encountered in an infant of the same birth weight in developed countries do not occur. Many professional workers have therefore suggested that the WHO criterion for low birth weight should be modified in these areas (Rosa and Tauscher, 1970).

It was observed that the African babies weighing 5 pounds were clinically mature and thrived better with a minimal medical care than European babies with an equivalent weight, (Modasi, 1965).
11.2. Birth Weight and Length in Some Countries in Different Parts of the World

Under optimal conditions in Europe and North America, the normal birth weight for infants of either sex average between 3.3 and 3.5 Kg. Among other well to do ethnic groups birth weight are reported slightly low 2.9 Kg. (Cameron and Novander, 1976).

Simpkins (1968) reported the mean birth weight among the African population of Uganda as 2.963 Kg. One factor affecting the mean birth is large number of high parity which gives birth to relatively large babies.

According to WHO Bulletin, 1970 the median birth weight of all live born infants are as follows:

<table>
<thead>
<tr>
<th>Country</th>
<th>Median Birth Weight (Kg.)</th>
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<tbody>
<tr>
<td>Ireland</td>
<td>3.478</td>
</tr>
<tr>
<td>Finland</td>
<td>3.380</td>
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<tr>
<td>Lebanon</td>
<td>3.294</td>
</tr>
<tr>
<td>South Africa</td>
<td>3.199</td>
</tr>
<tr>
<td>Venezuela</td>
<td>3.206</td>
</tr>
<tr>
<td>Greece</td>
<td>3.287</td>
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<tr>
<td>Greece</td>
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</tr>
<tr>
<td>Japan</td>
<td>3.029</td>
</tr>
<tr>
<td>Guatemala</td>
<td>3.078</td>
</tr>
<tr>
<td>Iran</td>
<td>3.031</td>
</tr>
<tr>
<td>Malaysia</td>
<td>2.985</td>
</tr>
<tr>
<td>Sudan</td>
<td>3.057</td>
</tr>
<tr>
<td>Syria</td>
<td>3.067</td>
</tr>
<tr>
<td>India</td>
<td>2.771</td>
</tr>
<tr>
<td>China</td>
<td>1.136</td>
</tr>
</tbody>
</table>
Mean Crown-heel length (cm) ± SD

- Males: 48.950 ± 1.682
- Females: 48.700 ± 1.145
- Both: 48.668 ± 1.687

The percentile lines displayed on growth charts show the chances of a normal child falling above or below that line. Children whose weight is below the third percentile deserve additional attention and possible evaluation. (Coss, et al., 1983).

Behnken and Vaughan (1983) and Pipes (1981) listed the PCSS percentile as follows:

**Males**

<table>
<thead>
<tr>
<th>Centiles</th>
<th>5th</th>
<th>10th</th>
<th>25th</th>
<th>50th</th>
<th>75th</th>
<th>90th</th>
<th>95th</th>
</tr>
</thead>
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<tr>
<td>Length(cm.)</td>
<td>46.4</td>
<td>47.5</td>
<td>48.0</td>
<td>50.5</td>
<td>51.8</td>
<td>53.4</td>
<td>54.4</td>
</tr>
<tr>
<td>Weight(Kg.)</td>
<td>2.54</td>
<td>2.78</td>
<td>3.0</td>
<td>3.27</td>
<td>3.62</td>
<td>3.82</td>
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**Females**

<table>
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<th>Centiles</th>
<th>5th</th>
<th>10th</th>
<th>25th</th>
<th>50th</th>
<th>75th</th>
<th>90th</th>
<th>95th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length(cm.)</td>
<td>45.4</td>
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<td>3.52</td>
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Williams (1967) reported the following centiles of weight and length of American new-borns:
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<th>10th</th>
<th>25th</th>
<th>50th</th>
<th>75th</th>
<th>90th</th>
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<td>49.3</td>
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<td>Weight(kg)</td>
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<td>3.76</td>
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<td>4.26</td>
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<td>51.0</td>
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Schröen and Vaughan (1983) reported the following centiles of British children:

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<td>48.5</td>
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<td>52.0</td>
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<td>Weight(kg)</td>
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<td>55.0</td>
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II.3. Birth weight and Length in the Sudan:

At present there are no satisfactory reference standards for birth weight and length in the Sudan. Most of the studies done concentrated on birth weight only while few of these studies addressed both birth weight and length together.

Mohawi (1963) conducted studies of birth weight in Juba and Khartoum hospitals. The result of these studies pointed out that the mean birth weight in Juba Hospital is 6.14 pounds (2.772 Kg) and in Khartoum Hospital is 6.7 pounds (3.045 Kg) with a mean of 6.6 pounds (2.99 Kg) for both hospitals.

Ahmad, et al. (1967) conducted another study on Sudanese newborn birth weight. Results showed that the mean birth weight in both Omdurman and Khartoum hospitals is 3.456 Kg.

According to the local standards reported down by the Sudan National Formulary (1974) the mean birth weight is 3.4 Kg and length is 50.0 cm.

Zurawi (1975) reported the findings of her study of birth weight and height of well-nourished Sudanese children. She found that the mean birth weight in Khartoum Province as a whole is 3.6 Kg and the mean length is 51.13 cm, and that the mean birth weight and length of these
well-nourished Sudanese children giving 10th, 50th and 90th centiles were as follows:

**Males**

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<td>Weight(Kg.)</td>
<td>3.35</td>
<td>3.5</td>
<td>3.80</td>
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<td>Length(cm.)</td>
<td>50.5</td>
<td>52.0</td>
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**Females**

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<td>Weight(Kg.)</td>
<td>3.20</td>
<td>3.55</td>
<td>4.45</td>
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<td>Length(cm.)</td>
<td>50.0</td>
<td>51.0</td>
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</table>

Thorshin (1977) conducted a study on birth weight and reported that the mean birth weight in Omdurman is 3.185 Kg.

Taha (1978) made a study on normal foetal growth in the Sudan and he found that the mean birth weight in Khartoum, Omdurman and Khartoum North hospitals is 3.125 Kg.

Mohamed (1988) conducted a study in Omdurman Maternity Hospital, he found that the mean birth weight of 270 newborn babies is 3.2 Kg ± 0.5. The mean birth weight for boys is 3.3 Kg ± 0.5 while the mean birth weight for girls is significantly less at 3.0 Kg ± 0.65.
Elhadi (1989) reported that the birth weight of
new-born infants included in her study is 3.05 Kg and
birth length is 50 cm.

This short summary reflected the factors affecting
birth weight and length as well as some of the studies
done on birth weight and length in different parts of the
world and in the Sudan.
CHAPTER II

ADUCTIONS OF NEUROMUSCULAR AND
HISTOLOGY OF STUDY
1. Mean:
2. Standard deviation.
3. Centiles.
4. Correlation coefficient.
5. Normal curve distribution.

1) Mean:
It is defined as the sum of values in the series divided by the number. The definition may be written as follows:

\[ \bar{x} = \frac{\sum x}{n} \]

In which \( \sum x \) is the sum and \( n \) is the number of items in the series. The symbol \( \sum \) always refers to sum in statistics.

2) Standard Deviation:
There is no satisfactory way to describing the standard deviation other than by stating the operation by which it is calculated.

The operation in finding the standard deviation of a series thus include:

a) Finding the deviation of each value from the mean.
b) Squaring the deviation.
c) Summing the squares.
d) Dividing the sum by \( n \).
e) Extracting the square root of the quotient.
4) Coefficient of Correlation:

It is merely a sensitive measure of the amount of correlation of relationship between the sets of scores, i.e., between two variables since it is independent of the number in the scores and the unit of the measurement. A coefficient of +1.00 indicates perfect positive correlation.

The basic formula may be written as follows:

\[ r = \frac{\sum xy - (\sum x)(\sum y)}{\sqrt{[\sum x^2 - (\sum x)^2][\sum y^2 - (\sum y)^2]}} \]

Normal Curve Distribution:

In order to construct a normal curve distribution the following steps should be considered:

1. Find out the Z score using the following formula:
   \[ Z = \frac{X - \mu}{\sigma} \]

2. Make the corresponding reading from the statistical table (see Appendix 1, Table 3).

3. Add 0.5 if the reading is positive.

4. Subtract the reading from 0.5 if the reading is negative.

5. Convert the result to percentage. (Rosa, 1955).
CHAPTER IV

RESULTS AND DISCUSSION
CHAPTER IV

RESULTS AND DISCUSSION

The main objective of this study is to collect information regarding anthropometric measurements with emphasis on birth weight and length of new-born infants of mothers delivered at Cotonou Maternity Hospital.

This chapter includes two sections:

Section One is for presentation of results and Section Two for discussion of the findings.

**Section One**

Table 1 and Fig. 1 show weight (kg) for age centiles for Beninese New-Borns/Males compared with international standards.

Table 2 and Fig. 2 present weight (kg) for age distribution by standard deviation for Beninese New-Borns/Males compared with international standards.

Table 3 and Fig. 3 show weight (kp) for age centiles for Beninese New-Borns/Females compared with international standards.

Table 4 and Fig. 4 show weight (kp) for age distribution by standard deviation for Beninese New-Borns/Females compared with international standards.
Table 5 and Fig. 5 show weight (kg) for age centiles for 1,000 Sudanese New-Borns/SEXES combined compared with international standards.

Table 6 and Fig. 6 show weight (kg) for age distribution by standard deviation for 1,000 Sudanese New-Borns/SEXES combined compared with international standards.

Table 7 and Fig. 7 show length (cm) for age centiles for Sudanese New-Borns/Males compared with international standards.

Table 8 and Fig. 8 show length (cm) for age distribution by standard deviation for Sudanese New-Borns/Males compared with international standards.

Table 9 and Fig. 9 show length (cm) for age centiles for Sudanese New-Borns/Females compared with international standards.

Table 10 and Fig. 10 show length (cm) for age distribution by standard deviation for Sudanese New-Borns/Females compared with international standards.

Table 11 and Fig. 11 show length (cm) for age centiles for 1,000 Sudanese New-Borns/SEXES combined compared with international standards.

Table 12 and Fig. 12 show length (cm) for age distribution by standard deviation for 1,000 Sudanese New-Borns/SEXES combined compared with international standards.
Table 13 and Fig. 13 show weight (Kg) for length of 500 Balinese New-Born/Males compared with international standards.

Table 14 and Fig. 14 show weight (Kg) for length distribution by standard deviation for 520 Balinese New-Born/Males compared with international standards.

Table 15 and Fig. 15 show weight (Kg) for length for 560 Balinese New-Born/Females compared with international standards.

Table 16 and Fig. 16 show weight (Kg) for length distribution by standard deviation for 620 Balinese New-Born/Females compared with international standards.

Table 17 and Fig. 17 show weight (Kg) for length of 1,000 Balinese New-Born/Sexes combined compared with international standards.

Table 18 and Fig. 18 show weight (Kg) for length distribution by standard deviation for 1,000 Balinese New-Born/Sexes combined compared with international standards.
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*Note: For any discussion or standard deviation for 1.000*
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**Note:**

The table above provides data for various temperatures in degrees Celsius. Each row represents a different temperature, and the values indicate some form of measurement or calculation related to those temperatures.
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**Note:**
- The table represents data for length distribution of Sudanese corn. The values listed are likely indicative of length measurements in millimeters or another unit of measurement.
Fig. 2. Weight (kg) for age distribution. Neoreborns/males compared with international standards.

SDS
Fig. (8) Length (cm) For Age Distribution By Standard Deviation For Sudanese New Born Males compared with International Standards.
New-born, Boys, Females, compared with International Standards.

Length (cm) for Age Distribution by Standards Deviation for Standard.
Fig. (12)

Length (cm) for Age Distribution By Standard Deviation For 1000

Sudanese Newborn/Severes combined compared with International Standards

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0.5 International standards

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R. Spirted Population mean
Fig. 13. Weight (kg) for length of 520 Sudanese New-Born males compared with international standards.

Length (cm)
FIG. 15. Weight (kg) for length (cm) Newborns, Females
Comparison with International Standards.
Section 2

Table 1 shows that the Sudanese New-Born/Male weight is higher than the international standards regarding the 3rd, 5th and 10th centiles and lower than it at the 25th, 50th, 75th, 90th, 95th and 97th centiles, (See Fig.1). The correlation coefficient between the two is 0.99 which shows that there is a significant difference.

When comparing the weight of Sudanese newborns/males with WHO centiles it is observed that the Sudanese newborns/males have higher weights than WHO regarding 5th and 10th centiles, and have lower weight centiles with reference to the 25th, 50th, 75th, 90th, 95th and 97th centiles (Fehrenb and Vaughan (1983) and Phipps, (1981).

The Sudanese newborns/males weight centiles (10th, 25th, 50th, 75th, 90th, 95th and 97th) are lower than the American newborns/males centiles with exception to the 5th centiles.

According to report of Fehrenb and Vaughan (1981), the British newborn centiles were lower than the Sudanese newborn centiles, (3rd, 5th, 10th, 25th, 50th, 90th, 95th and 75th).

Results of this study regarding newborn/males are in contrast with results of a study done by Zrancal (1975) which reported that the newborn/male had higher weights than the newborn males included in the present study.
Table 2 shows weight for age distribution by standard deviation for Sudanese new-born/males compared with international standards. The mean weight of Sudanese new-born/males is 3.3 kg, which is equal to the international standards and higher than the Spartan new-born/males. It is lower than the Lebanese new-born/males and at the same time equal to Jordan new-born/males (Darby and Patwardhan, 1972). Comparing the Sudanese new-born males with the Indian new-born/males (Purchit et al., 1977), it was observed that the Sudanese new-born/males have higher weights than the Indians.

Regarding results of birth weight of the Sudanese new-born/males of this study, it was found that they are in agreement with those of a survey done by Mohamed (1986).

As shown in Fig. (2), it is observed that the weight for age distribution by + 3σ for Sudanese new-born/males is nearly the same as the international standard, while by - 3σ the Sudanese new-born are less than the international standards.

From Table 3, the Sudanese new-born/males have higher weight than the international standards regarding the 3rd, 5th, 10th and 97th centiles, while they have the same weight with reference to 25th, 50th, 75th, 90th and 95th centiles. The correlation coefficient between the two is 0.99 which shows that there is no significant
difference. The comparison between the Sudanese neonates and the international standard is shown in Fig. (3).

When comparing the Sudanese neonates with WHO weight centiles it is observed that the Sudanese neonates have higher weights regarding the 5th, and 10th centiles. At the same time they have similar weights at the 25th, 50th and 75th centiles. It is observed that they have lower weights at 90th, and 95th centiles.

Results of a study done by Pillai (1967) are in agreement with results of weight measurement of Sudanese neonates regarding 3rd and 10th centiles.

According to Ahmad and Yaqub (1963) report of British neonates weight centiles it is observed that the Sudanese neonates have higher weights regarding 5th, 10th, 25th, 50th, 75th, 90th, and 95th centiles.

Tab. 4 shows the weight (kg) for age distribution by standard deviation for Sudanese neonates compared with international standards.

The Sudanese neonates mean weight is 3.2 kg which is in agreement with international standards.

According to results of a study done by Farah and Alon (1973) it is observed that the Sudanese neonates have lower weights than the Lebanese neonates. At the same time they have higher weights than the Egyptian and Indian neonates.
According to results of a study done by Foschini et al. (1977), and another study done by Bhawed (1988), it is observed that the Sudanese newborn/sexes is higher than the Indian and Subslices.

The weight distribution by standard deviation for Sudanese newborn/sexes combined is below the international standard reported in Table 4. Table 5 shows that the Sudanese newborn/sexes is similar to the international standard in +3σ and are less in -3σ.

Table 5 shows that the Sudanese newborn/sexes combined have higher weight centiles than the international standards, ranging 3rd, 5th, and 10th, and have lower weight centiles at 25th, 50th, 75th, 90th, 95th, and 97.5th centiles. The correlation coefficient of the Sudanese newborn/sexes combined and the international standard is 0.99. This shows that there is no significant difference between the two (see Fig. 2).

Table 6 shows that the mean weight for Sudanese newborn/sexes combined is 3.5 kg which is similar to the international standards, while they are higher than the Indian newborn/sexes combined as reported by Foschini et al. (1977).

Comparing results of the weight of the Sudanese newborn/sexes combined included in this study with results of studies done in the Sudan, it is observed that the Sudanese newborn/sexes combined under study have
higher weight than the weight results of studies done by
and Alhadi (1983). This is in contrast to results done by
Ahmed (1967), the Sudan National Councilery (1974), Zannawi
(1973) and Bashir (1977).

Fig. 6 explains that the weight (kg) for age distribution by
standard deviation for 1,000 Sudanese newborns/sexes
combined compared with international standards, which shows
that the Sudanese are less in <3SD and they are almost the
same in >3SD.

Table 7 shows that length (cm) for age for Sudanese
newborns/sexes is higher than the international standard
regarding the 3rd, 5th, centiles and are lower than it at 10th,
25th, 50th, 75th, 90th, 95th and 97th centiles. (See Fig. 7).
The correlation coefficient is 0.92 which shows no signifi-
cant difference.

According to reports of different studies done by
Pipes (1961) and D’Aubry and Vaughan (1963) regarding the
NHIS newborn/males, Nahum and Vaughan (1983) with reference
to British newborn/males and Williams (1967) concerning the
American newborn/males and Zannawi (1975) regarding the Sudanese
newborn/males. When newborns included in the above studies
compared with the Sudanese newborns/males included in this
study, it is observed that the Sudanese newborn/males have
lower length centiles regarding the 10th, 25th, 50th, 75th,
90th, 95th and 97th.
Table 6 tells that the mean length of the Sudanese new-born/males is less than the international standard.

According to results of a study done by Derby and Forwardian (1972) when compared with Sudanese new-born length, it is observed that the Sudanese new-born males are shorter than them, and taller than the Indian new-born/males as reported by Puchhit et al. (1977).

Looking at Fig. 8, it tells that the length (cm) for are distribution by standard deviation for Sudanese new-born males compared with international standard are almost the same regarding +SD and -SD.

Table 9 presents the length (cm) for the centiles for Sudanese new-born/males who have higher length than the international standards regarding the 3rd, 5th, and 10th centiles, and have lower length than it at the 25th, 50th, 75th, 90th, 95th and 97th centiles.

The correlation coefficient is 1.00 which explain that there is no significant difference (See Fig.9). When comparing the Sudanese new-born/males length with WHO centiles it is observed that the Sudanese new-born/males have higher length regarding the 5th, 10th centiles and lower length at 25th, 50th, 75th, 90th, 95th and 97th centiles.

According to results of studies done by Williams (1967), Behemen and Vaughan (1967), when compared with Sudanese new-born/males included in this study, it is observed
that the Sudanese new-born females are shorter than the American, Egyptian, British new-born females.

The mean length for Sudanese females is 45.4 cm and it is lower than the international standard. (See Table 10).

The length of Sudanese new-born females is lower than Egyptian, Jordan, Lebanon females as reported by Derby and Patton (1972) and have higher length than the Indian new-born females (Purshit et al. 1977).

From the length (cm) for age distribution by standard deviation it is observed that the Sudanese new-born females and the international standard are almost the same regarding -SD and the Sudanese new-born females are less regarding +SD (See Fig. 10).

Table 11 shows that the length (cm) for age centiles for Sudanese new-born sexes combined compared with international standards. Their lengths is lower regarding the 25th, 50th, 75th, 95th, 99th and 97th centiles and higher at the 3rd and 6th centiles. The correlation coefficient is 0.76 which shows no significant difference. (See Fig. 11).

Looking at Table 12 it is observed that the mean length for Sudanese new-born sexes combined is 49.4 cm which is lower than the international standards. The Sudanese new-born sexes combined length for age is higher than the Indian new-born sexes combined length for age as reported by Purshit et al. (1977).
study have lower lengths than the Sudanese children included in studies done by Sudan National Forensics (1974),
Sawadi (1975) and Elkadi (1989).

The length for age distribution by standard deviation for Sudanese new-borns/sexes combined when compared with
international standards shows that there is a difference.

Table 13 presents the weight (kg) for length of
Sudanese new-borns/sexes compared with international
standards. It shows that the Sudanese new-borns/sexes have
higher lengths than the international standards (See Fig.13).

Table 14 shows weight (kg) for length distribution by
standard deviation compared with international standards,
in which the mean weight for length is higher in Sudanese
new-borns/sexes than the international standards (See Fig.
14).

Table 15 shows that the mean weight for length for
Sudanese new-borns/sexes when compared with international
standards is higher at the following lengths: 50.0, 51.0,
52.0 and 53.0 cm and is lower at 49.0 cm (See Fig.15).

Table 16 presents the mean weight for length by 8.0 for
Sudanese new-borns/sexes compared with international
standards. It shows that the Sudanese new-borns/sexes have
higher length at the following lengths: 50.0, 51.0,
52.0 and 53.0 and is lower at 49.0 cm (See Fig.16).
Table 17 shows that the length for 1,000 Sudanese newborns/sexes combined, when compared with international standards is higher (see Fig.17).

Comparing the mean weight for length for Sudanese newborns/sexes combined with international standards, it is observed that the Sudanese newborns/sexes combined have higher weight for length than the international standards (see Table 18 and Fig.18).

Results of this study regarding weight for length is in agreement with results of weight for length studies done by Ibrahim (1979), at 46.0 and 47.0 lengths.

When comparing weight for age of Sudanese newborns/males, females and sexes combined, it is observed that the Sudanese newborns, males, females and sexes combined, have higher weights regarding the 3rd, 5th, and 10th centiles and lower weights at 25th, 50th, 75th, 90th, 95th, and 97th centiles. The Sudanese newborns/females, males, sexes combined, have higher length for age than the international standard at the 3rd and 5th centiles and lower length for age regarding the 10th, 25th, 50th, 75th, 90th, 95th and 97th centiles. The Sudanese weight for length for males, females and sexes combined is higher than the international standards.
CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS
Indian new-born infants/sexes combined is 2.8 kg and the length is 48.9 cm. The Sambharo new-born infants birth weight as reported by many research workers is between 3.0-3.6 kg and the length is between 50-52.13 cm.

The present study consists of a sample of 1,000 infants belonging to well-nourished mothers. Measurements done in this study include: weight, length, mid-upper arm, head and chest circumferences and skin fold thickness.

Weight for age, length for age and weight for length percentiles are done and compared with international standards.

Conclusions:

The findings of this study regarding new-borns of well-nourished mothers have revealed data that can permit the following conclusions:

Weight for age of Sambharo new-born/sexes, females and sexes combined than compared with international standards, it is observed that the Sambharo new-born/sexes, females and sexes combined have higher weights at the 3rd, 5th, and 10th percentiles, and have lower weights remaining the 25th, 50th, 75th, 90th, 95th and 97th percentiles.

The mean weight for age for Sambharo new-born/sexes is 3.5 kg and females is 3.2 kg. The mean weight for sexes combined is 3.3 kg. These mean weights correspond with international standard mean weight.

Comparing length for age for Sambharo new-born/sexes, females and sexes combined with international standards, it
1. Mass media.
2. School curricula.
3. Social organizations for women.
4. Village level workers.

The programmes should include the following aspects:

1. Nutritional needs of non-pregnant females, pregnant and lactating mothers.
2. Importance of ante-natal care.
3. Family Planning.
4. Development of a program to promote female literacy through adult education.
5. Nutrition education using food supplements for pregnant women as a teaching tool to evaluate degree of knowledge, attitude and behavioral change in order to have a well-sized new-born infants with a normal weight.

Plans for future studies:

1. Development of national standards for Indonesian children under five years of age.
2. Continuous research to develop standards of growth of children up to adolescence.
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APPENDIX
APPENDIX 1

Appendix 1 Table (a): Mean ± SD of Weight, Length, Mid-Upper Arm Circumference, Head, Chest Circumference, and Triceps Skin-fold Thickness of 520 Sudanese New-Borns/Males.

Appendix 1 Table (b): Mean ± SD of Weight, Length, Mid-Upper Arm, Head and Chest Circumference and Triceps Skin-fold Thickness of 480 Sudanese New-Borns/Males.

Appendix 1 Table (c): Mean ± SD of Weight, Length, Mid-Upper Arm, Head and Chest Circumference and Triceps Skin-fold Thickness of 1,600 Sudanese New-Borns/Sexes Combined.

Appendix 1 Table (d): Normal Curve Area.
<table>
<thead>
<tr>
<th>Year</th>
<th>7-9-84</th>
<th>5-14-84</th>
<th>12-8-84</th>
<th>11-15-84</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>75</td>
<td>73</td>
<td>78</td>
<td>79</td>
</tr>
</tbody>
</table>

- 25-50

- 75-100

- 100-125

- 125-150

- 150+