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RESEARCH ARTICLE

NEONATAL MEASUREMENTS AND MATERNAL FACTORS IN KHARTOUM STATE, SUDAN

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Abstract

Introduction: Anthropometric measurements of Neonatal serve as a vital clinical tool for identifying small or large newborns.These measur ements also playa crucial role in assessing the potentialoutcomes of newborns,helping to predict future risksof morbidity or mortality. The purpose of this study was to determine the average anthropometric measurements representative of Khartoum State, Sudan's newborn population and to examine the relationship between these measurement s and maternal factors.

Methodology: This study employed a descriptive observational design acrossthree hospitals located in Khartoum: Omdurman Maternity Hospital, Bahri Teaching Hospital, and Saad Abo Aila Hospital. The study included 794 mothers and their newbornsafter meetingthe inclusion and exclusion criteria within the first 72 hours postdelivery. Neonatal measurements, including birth weight, crownheel length, and head and chest circumference, were taken for those who met the criteria.Statistical Package for Social Science (SPSS) version 20 to present means and generate tables and figures. Chi-square test used to assess the significant of relationship between different maternal and neonatal variables. All ethical considerations were maintained.

Results: newborn Males made up 51.5% (409), while females represented 48.5% (385). Maternalagefalls within the 20 to under 31 years range, representing 52% of the total. The most prevalent Body Mass Index (BMI) category in the sample was overweight, making up 41.7%, whereas18.9%of the mothers were classified as obese. Head circumference demonstrated a statistically significant correlation with maternal BMI (P-value= 0.017). Maternal parity showed a statistically significant correlation with both newborn weight (P-value = 0.006) and head circumference (P-value = 0.008). Pregnancy complications were identified in 14% of cases and demonstrated a statistically significant correlation with weight, length, head circumference, and chest circumference (all P-values < 0.05). The most frequent health issue encountered during pregnancy was hypertension,affecting41% of cases, followed by malaria at22% and diabetes at 13%. The occurrence of morbidities during pregnancy showed a

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statistically significant relationship with weight, length, head circumference, and chest circumference,withall P-values beinglessthan 0.05.

Conclusion: The study observed that maternal complications in Sudan such as overweight, hypertension, malaria, and diabetes has significant association withneonatal measurements, including height, weight, head circumference, and chest circumference. Urgent intervention needed at the national level.

Introduction:-

Anthropometric measurements are noninvasive, quantitative methods used to evaluate the physical dimensions, proportions, and composition of the human body (Casadei & Kiel, 2022). These include metrics such as height, weight, Body Mass Index (BMI), and skinfold thickness. Widely employed in pediatrics to monitor growth and in adults for assessing health risks like obesity or informing ergonomic design, these measurements offer essential and cost efficient data for various applications (Carrión-Martínez et al, 2022).

Between 1997 and 2003, the World Health Organization (WHO) developed new global standards for evaluating the growth and development of children aged 0 to 5 years. This initiative included approximately 8,500 children from Brazil, Ghana, India, Norway, Oman, and the United States of America (USA) who were raised under optimal conditions. The standards emphasized breastfeeding as the benchmark for healthy growth (WHO, 2026). This is what is nowadays known as Multicenter Growth Reference Study (MGRS).

A neonate, or newborn, refers to an infant during the first 28 days of life, a crucial period marked by rapid physiological adjustments, the development of early bonds, and the initiation of feeding. This phase is associated with heightened risks of illness and mortality often necessitating specialized care for preterm or medically compromised infants (Anthony & McKinlay, 2023). Primary concerns during this time include susceptibility to infections, respiratory challenges, and maintaining proper temperature regulation. In 2023, around 2.3 million newborns worldwide lost their lives within the first 28 days, a period known as the neonatal stage. This continues to be the most critical and fragile phase for child survival, representing 47% of all deaths among children under the age of five Cao et al, 2022).

Maternal factors refer to the physical, social, and genetic conditions of a pregnant individual that play a crucial role in shaping pregnancy, childbirth, and the long term health of the child. Important and manageable aspects include maternal age, pre pregnancy weight, existing medical conditions such as diabetes or hypertension, infections, and mental well being (Muglia et al, 2022). Abnormal maternity conditions considerably heighten the likelihood of disabilities and developmental challenges in children (Alkazaleh et al, 2025).Global maternal health and mortality, reflected in a rate of 197 deaths per 100,000 live births in 2023, are largely influenced by stark inequities. Notably, 94% of these deaths occur in low resource settings (Shanto et al, 2023).

Sudan, situated in East North Africa, is classified as a developing country (Satti et al, 2026: Abdalrhman et al, 2025). Ongoing conflict has significantly harmed the nation's healthcare system, leaving many pregnant women without access to essential maternal care services (Abdelnour et al, 2026: Satti et al, 2025). Therefore, Maternal mortality remains a significant issue in Sudan, accounting for approximately 78.7% to 80.25% of deaths between 2000 and 2019 (Taha et al, 2025). The primary cause is obstetric hemorrhage, responsible for 45.45% to 45.5% of fatalities, followed by hypertensive disorders at 16.1%, and sepsis (Taha et al, 2025). In 2023, the national maternal mortality ratio was estimated at 256 per 100,000 live births (Elhassan et al, 2025).

Methodology:-

The study was a descriptive observational hospital-based investigation conducted in Khartoum State across three hospitals: Omdurman Maternity Hospital, Bahri Teaching Hospital, and Saad Abo Ailla Teaching Hospital. The study population comprised Sudanese women who had recently given birth in these hospitals, along with their neonates within the first 72 hours post-delivery. A total of 794 mothers and their newborns participated. Data for the study were collected using a straightforward questionnaire designed to gather demographic information from the mothers. The author was actively involved in screening all mothers and babies (n=794) and conducted clinical neonatal examinations to rule out any congenital abnormalities. Additionally, the author performed anthropometric

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measurements following standard methodologies. The mothers' body weight and height were measured using a stadiometer. Neonatal anthropometric parameters were recorded with measuring tapes, pre-calibrated weighing scales, and an infantometer for length measurements. The collected data was summarized and presented through tables and graphs. Pearson's chi-square test was employed to evaluate the significance of the suggested relationships among various maternal and neonatal variables with 95% confidence intervals and less than 0.05 level of significance. Additionally, the chi-square test and the Statistical Package for the Social Sciences (SPSS) version 20 were utilized for generating tables, figures, and processing the results. All ethical considerations been maintained. Ethical approval obtained from Sudan Medical Specialization Board (S.M.S.B.) Council of Pediatrics and Child Health. A written consent form hospitals administration. Confidentiality and secrecy were maintained. Informed written and verbal consent was obtained from parents. The mothers are informed about the purpose of the study and a verbal consent was obtained for both examination and measuring them and their neonates. Data was kept only for the purpose of the study.

Results:-

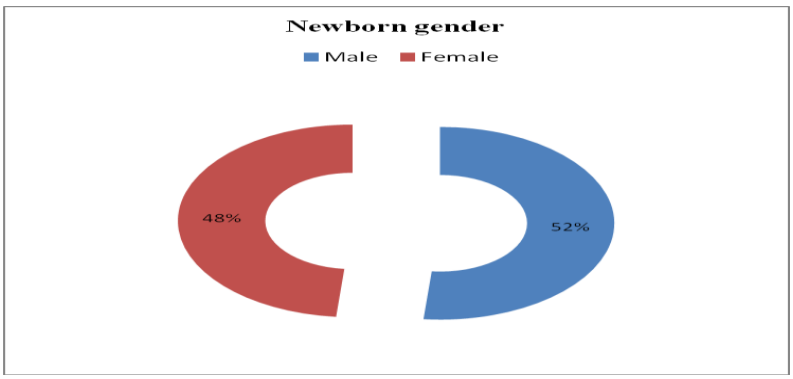

Figure 1: Gender (n=794)
Males constituted 51.5% (409) of the sample, while females accounted for 48.5% (385), as illustrated in Figure 1.

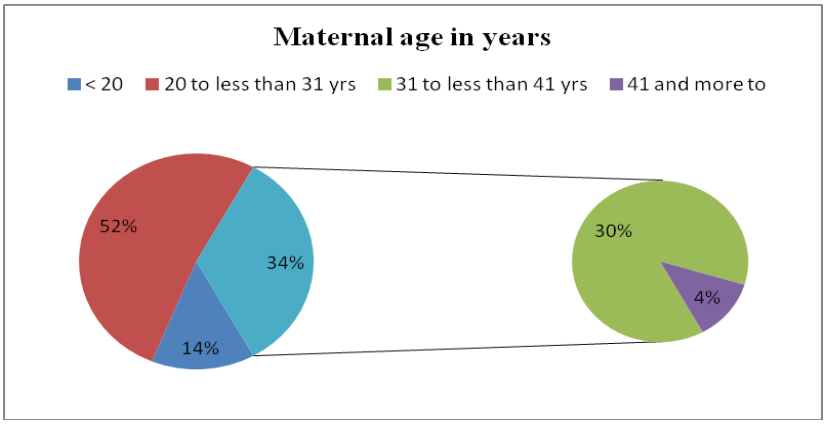

Figure 2: Maternal ages (n=794)
Figure 2: Age (n=794)
The maternal age group with the highest frequency, as shown in Figure 2, was between 20 and under 31 years, accounting for 52%.

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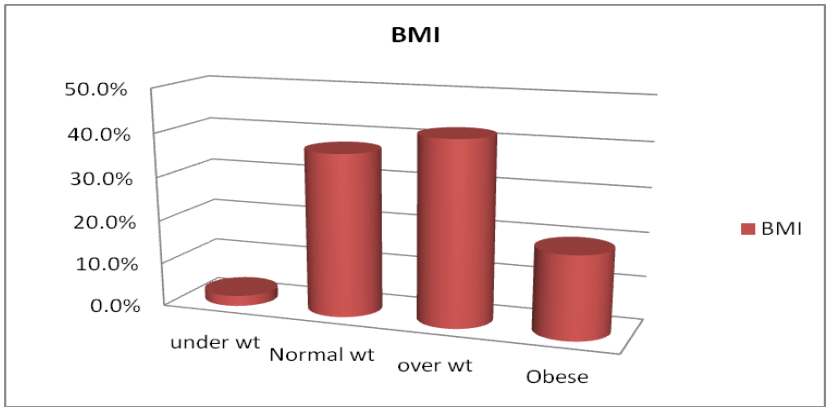

Figure 3: Maternal BMI (n=794)

The most common BMI category among the sample was overweight, comprising 41.7%, while obese mothers accounted for 18.9%. On the other hand, 37% had a normal BMI, as depicted in Figure 3.

Head circumference showed a significant statistical association with maternal BMI (P-value = 0.017) as presented in Table 1.

Table 1: Maternal BMI and baby anthropometric measurements

Maternal BMI	weight		length		Head circumference		Chest circumference		Total
	normal	abnormal	normal	abnormal	normal	abnormal	normal	abnormal	
Under weight	19	0	16	3	19	0	13	6	19
Normal weight	284	11	225	70	270	25	230	65	295
Over weight	319	16	281	54	304	31	264	71	335
Obese	139	6	120	25	132	13	125	20	145
Total	761	33	642	152	725	69	632	162	794
p-value	**0.087**		**0.055**		**0.017**		**0.129**		

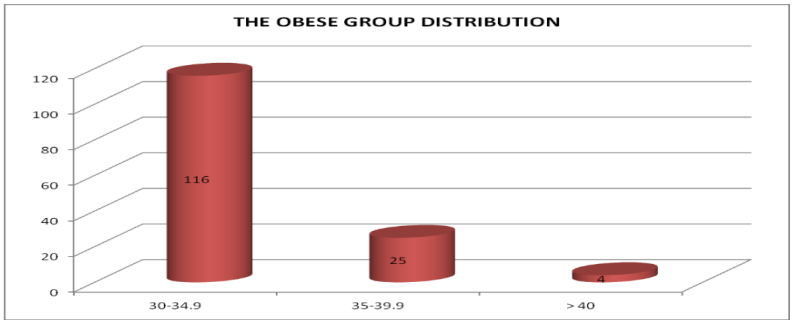

Figure 4: Distribution of obese mothers (n=145)

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A total of 145 mothers (18.9%) were categorized as obese; among them, 116 fell under Class 1 obesity, while 4 were classified as Class 3 with severe obesity, as illustrated in Figure 4.

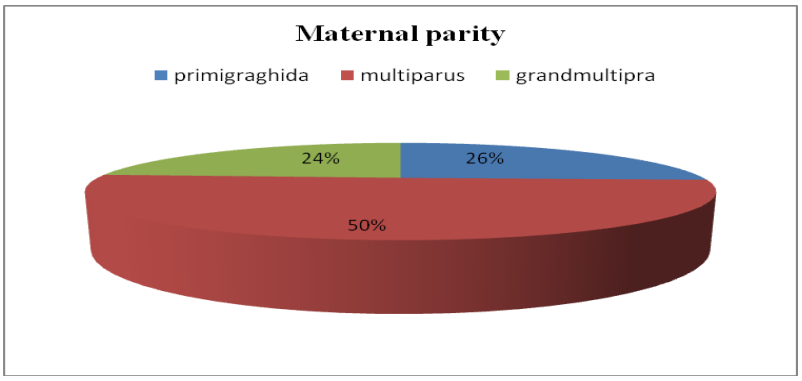

Figure 5: Maternal parity (n=794)
Figure 5 showed that 50% (400) were multiparious and 26% (240) were primigravida, and 24% (190) were grandmultipra.

Maternal parity demonstrated a statistically significant association with newborn weight (P-value = 0.006) and head circumference (P-value = 0.008), as in Table 2.

Table 2. Maternal parity and baby anthropometric measurements (n=794)

Maternal parity	Weight		Length		Head circumference		Total
	Normal	abnormal	Normal	abnormal	Normal	abnormal	
Primigravida	94.6%	5.4%	79.4%	20.6%	90.7%	9.3%	100% (240)
Multiparous	98%	2%	81.5%	18.5%	94%	6%	100% (400)
Grandmultipra	92.6%	7.4%	81.1%	18.9%	86.3%	13.7%	100% (190)
Total	95.8%	4.2%	80.9%	19.1%	91.3%	8.7%	100% (794)
p-value	**0.006**		**0.824**		**0.008**		

*Normal=measurements lie between 2nd and 98th centiles for weight, length and head circumference. In chest circumference above 30 cm. Abnormal any measurements lie below 2nd and above 98th centiles. Fore chest circumference below 30 cm.

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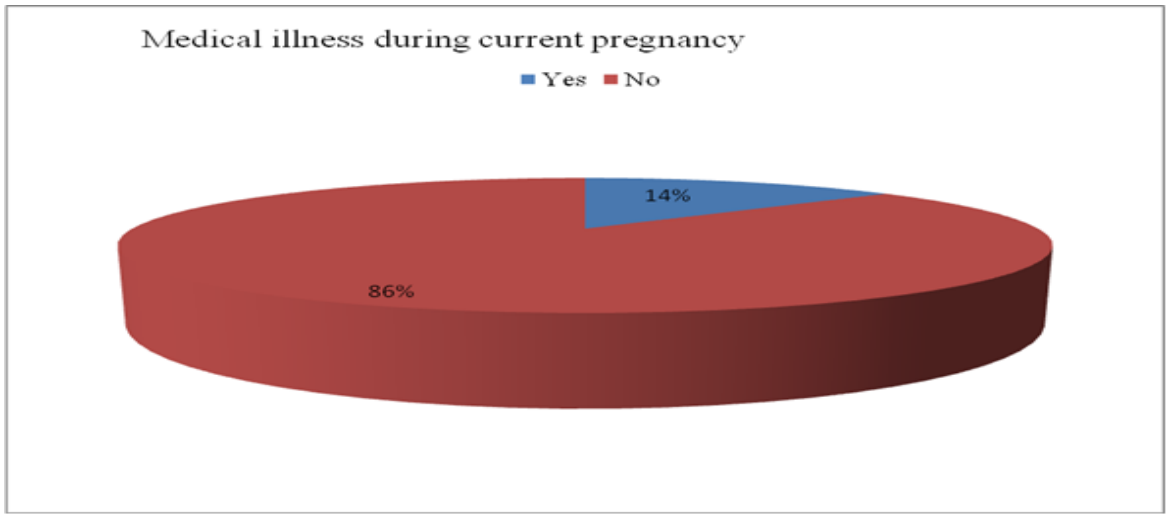

Figure 6. Medical illness during current pregnancy (n=794)
As illustrated in Figure 6, 86% (683) of mothers did not experience any medical illness during pregnancy, while 14% (111) experienced medical conditions during this period.

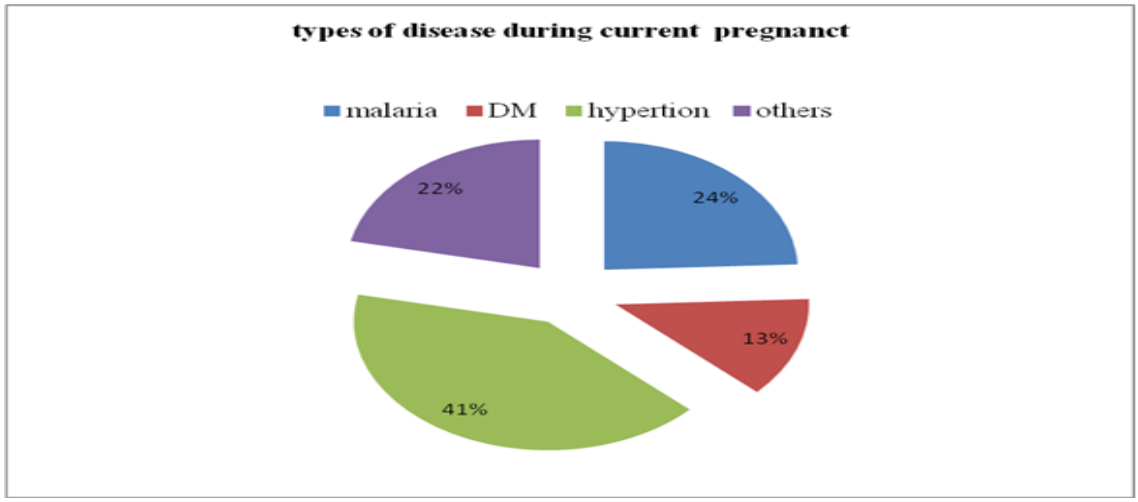

Figure 7. Types of disease during current pregnancy (n=111)
The most common health issue during pregnancy was hypertension (41%), followed by malaria (22%) and diabetes (13%) as in Figure 7.

The prevalence of morbidities during pregnancy had statistically significant association with weight, length, head circumference, and chest circumference (all P-values < 0.05), as detailed in Table 3.

Table 3. Maternal diseases during current pregnancy and baby anthropometric measurements (n=111)

Maternal diseases during current pregnancy	weight		length		Head circumference		Chest circumference	
	mean	SD	mean	SD	mean	SD	mean	SD

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Malaria	2.93	0.41	46.16	2.46	34.39	1.25	31.39	1.82
DM	3.47	0.40	47.82	1.95	35.32	1.07	33.43	1.87
Hypertension	2.82	0.58	46.22	2.79	33.91	1.76	30.48	2.85
Others	3.05	0.38	47.45	1.87	31.70	1.37	31.40	1.53
p-value	**0.000**		**0.045**		**0.013**		**0.001**	

*Normal=measurements lie between 2nd and 98th centiles for weight, length and head circumference. In chest circumference above 30 cm. Abnormal any measurements lie below 2nd and above 98th centiles. Fore chest circumference below 30 cm.

Discussion:-

There are a significant gender differences exist in the prevalence and incidence of conditions affecting newborns. Male infants are more prone to preterm birth, higher mortality rates, infections, sepsis, and congenital abnormalities (Gebremeskel et al, 2022). This study revealed no significant differences concerning the gender of the newborns.In this study, the most common maternal age falls within 20 to 31 years old. This age is aligned to the common maternal age worldwide and in the USA (Brown et al, 2025).The most mothers BMI category in this study was overweight. Mothers who are overweight or obese are more likely to give birth to infants with higher birth weights, which are also associated with newborn measurements such as head circumference which clearly identified in this study. The prevalence of overweight and obesity among pregnant women in Khartoum State, Sudan is rising at a concerning pace, especially in urban regions, posing a notable public health challenge (Eltayeb & Khalifa, 2021). Research reveals a strikingly high occurrence, with one study reporting that over 35% of pregnant women are overweight and almost 20% are obese (Eltayeb & Khalifa, 2021).

In additional, this study showed correlation between pregnancy complications and newborn measures regarding weight, length, head circumference, and chest circumference. Pregnancy complications like diabetes and hypertension considerably heighten the likelihood of unfavorable outcomes for newborns, including issues with birth weight. Such complications frequently result in respiratory difficulties and developmental challenges (Sokou et al, 2025). On the same issue, the most frequent health issue encountered during pregnancy in this study was hypertension, malaria, and diabetes. In Sudan, Hypertension during pregnancy is a significant contributor to maternal morbidity and mortality in Sudan, responsible for around 16.1% of maternal fatalities (Elhassan et al, 2025). Regarding malaria, Prevalence rates are significant, with studies reporting pregnant women infection rates up to 38.5% in some areas (Suliman et al, 2021). Furthermore, the prevalence of diabetes is notably high among the Sudanese population (Abdelnour et al, 2025). Some studies attribute this to the fact that sugar is one of Sudan's primary products (Abdelnour et al, 2023). Therefore, Effective management of malaria, diabetes, and hypertension among pregnant women in Sudan necessitates a comprehensive approach to antenatal care (Adam et al, 2011). This involves promoting the use of insecticide treated nets, ensuring timely malaria treatment with Artemisinin Based Combination Therapies, and closely monitoring and controlling blood pressure and blood sugar levels (Ali et al, 2011).

The occurrence of morbidities during pregnancy in this study showed significant relationship with weight, length, head circumference, and chest circumference. It is well documented in the literature that Maternal health issues, such as obesity and diabetes, have a direct impact on neonatal outcomes specifically towards weights, head circumferences, and chest circumferences (Shoji et al, 2022).Finally, enhancing maternal and neonatal health in Sudan demands immediate, multi-dimensional efforts aimed at rebuilding health systems affected by conflict (Elhassan et al, 2025: Olaleye et al, 2023). This involves establishing well equipped neonatal intensive care units and reinforcing primary healthcare services (Elhassan et al, 2025). Priority actions include providing midwives with emergency care training, expanding antenatal care coverage, ensuring access to critical medical supplies, and raising community awareness about safe childbirth practices (Olaleye et al, 2023).

Conclusion:-

The study emphasized that maternal health issues in Khartoum State, Sudan such as overweight, hypertension, malaria, and diabetes significantly affect neonatal measurements, including height, weight, head circumference, and chest circumference. This underscores the pressing need for nationwide interventions aimed at enhancing primary healthcare services to improve the health of both mothers and newborns.

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