Derna Academy Journal for Applied Sciences

E-ISSN: 3006-3159

DAJAS

Maternal Knowledge of Prenatal Screening and Down Syndrome among Pregnant Women in Eastern Libya: A Multicentre Cross-Sectional Study University

Taweda Abdelraouf Akrim [1*]

[1] Faculty of Pharmacy, University of Tobruk, Tobruk, Libya

*Corresponding author email: taweda_akrim @tu.edu.ly

Volume : 7 **Issue: 1** **Page Number: 1 - 15**

Keywords:
Prenatal Screening; Down syndrome; Maternal knowledge; Pregnant women; Libya.

Received: 06\06\2026
Accepted: 13\07\2026
Published: 14\07\2026

https://doi.org/10.71147/0rjbjq66

ABSTRACT

Prenatal screening for Down syndrome is an essential component of antenatal care because it supports informed decision-making and early identification of fetal chromosomal abnormalities. However, evidence regarding pregnant women's knowledge of prenatal screening remains limited in Libya. This study assessed maternal knowledge of prenatal screening and Down syndrome and examined the demographic and obstetric factors associated with maternal knowledge among pregnant women attending antenatal care services in eastern Libya. A quantitative multicenter cross-sectional study was conducted among 2,000 pregnant women recruited from antenatal clinics in Benghazi, Derna, Al-Marj and Al-Bayda using purposive sampling. Data were collected using a structured self-administered electronic questionnaire assessing socio-demographic characteristics, obstetric history, and knowledge of prenatal screening and Down syndrome. Data were analyzed using IBM SPSS Statistics version 28. Descriptive statistics, reliability and validity assessment, normality testing, Pearson's correlation, simple linear regression, and multiple linear regression analyses were performed. Most participants were aged 25–29 years (35.5%), had university education (41.5%), were multiparous (58.5%), and had previously received counselling regarding prenatal screening (61.5%). The overall knowledge score indicated a moderate level of knowledge (mean = 3.56 ± 0.59). The highest knowledge scores related to the importance of counselling before screening (4.26 ± 0.68) and healthcare professionals explaining screening results (4.18 ± 0.71), whereas knowledge of non-invasive prenatal testing and the distinction between screening and diagnostic testing was comparatively lower. Maternal educational level ($r = 0.48$, $\beta = 0.44$), maternal age ($r = 0.31$, $\beta = 0.28$), gestational age ($r = 0.22$, $\beta = 0.20$), and previous obstetric experience ($r = 0.36$, $\beta = 0.33$) were all significant positive predictors of maternal knowledge (all $p < 0.001$). The adjusted regression model explained 38.7% of the variance in maternal knowledge. These findings highlight the need to strengthen antenatal education and structured counselling to improve informed decision-making regarding prenatal screening in Libya.

1. INTRODUCTION

Down syndrome (DS) is the most common chromosomal disorder associated with intellectual disability and remains an important public health concern because it affects survival, health outcomes and quality of life across the lifespan. Despite substantial advances in prenatal diagnosis and healthcare, marked inequalities continue to exist between high-income countries and low- and middle-income countries, where access to prenatal screening, specialist services and family support remains limited (de Graaf et al., 2017; de Graaf et al., 2021; Fortea et al., 2024). Prenatal screening has become an integral component of modern antenatal care because it enables the early identification of fetal chromosomal abnormalities, including Down syndrome, allowing pregnant women and healthcare professionals to make informed clinical decisions and plan appropriate pregnancy management. Down syndrome is caused primarily by trisomy 21 and is associated with intellectual disability and lifelong healthcare needs affecting individuals and families worldwide (de Graaf et al., 2017; de Graaf et al., 2021). Screening methods have evolved considerably during the past three decades, progressing from maternal age-based assessment to biochemical screening, ultrasound markers and, more recently, non-invasive prenatal testing with improved diagnostic performance (Smith et al., 2018; Zhao et al., 2023). Although these developments have improved prenatal care internationally, equitable access and adequate maternal understanding remain uneven across many developing countries. Knowledge of prenatal screening represents a fundamental requirement for informed decision-making because women must understand the purpose, benefits, limitations and possible outcomes of screening before providing informed consent. Prenatal screening estimates the probability that a fetus has a chromosomal abnormality, whereas diagnostic procedures are used to confirm whether the abnormality is present. Women should therefore understand the distinction between screening and diagnosis, possible false-positive and false-negative findings, and the need for confirmatory invasive testing following a high-risk result (Pruksanusak et al., 2009; Rabiee et al., 2019). However, evidence from developed and developing countries indicates that many pregnant women possess insufficient knowledge of Down syndrome, prenatal screening tests and available diagnostic procedures, even where organised screening programmes are available (Pruksanusak et al., 2009; Rabiee et al., 2019; Zhao et al., 2023; Arab & Halawani, 2024). Women may express favourable attitudes towards screening without fully understanding test accuracy, interpretation or subsequent clinical management. Adequate information is therefore necessary to ensure that participation reflects informed choice rather than routine acceptance. Research has demonstrated that maternal knowledge is influenced by demographic, educational, reproductive and healthcare-related characteristics. Higher educational attainment consistently predicts greater understanding of prenatal screening, while maternal age, gestational age, household income, previous pregnancy experience and information from healthcare professionals have also been associated with knowledge levels (Pruksanusak et al., 2009; Rabiee et al., 2019; Zhao et al., 2023). Similarly, structured counselling and low-literacy decision aids have substantially improved women's conceptual and numerical understanding of prenatal screening, including non-invasive prenatal testing (Smith et al., 2018). Screening utilisation has also been associated with education, income and the location of antenatal care, suggesting that access to suitable information and services may shape both knowledge and subsequent participation (Farshbaf Khalili et al., 2012). Nevertheless, willingness to undergo screening may exceed actual understanding, and the availability of testing alone may not ensure informed participation. Maternal knowledge should therefore be assessed separately from willingness or screening uptake. Available evidence from Africa remains considerably more limited than that from Europe, North America and Asia. Most African research concerning Down syndrome has focused on childhood comorbidities, congenital heart disease, survival, disability and access to healthcare, while relatively little work has examined maternal awareness, prenatal diagnosis or screening practices (McGlinchey et al., 2025). Epidemiological evidence also remains incomplete because of differences in diagnostic capacity, registration systems, healthcare access and reporting practices across countries (Molteno et al., 1997; Hafez et al., 1984; Adeyokunnu, 1982). Research in Zimbabwe found that most pregnant women recognised the general importance of prenatal ultrasound, but many did not understand its role in detecting congenital abnormalities (Chinene & Mudadi, 2023). Shortages of specialised genetic services, limited antenatal counselling and uneven access to information may further reduce opportunities for informed reproductive decision-making. Multicentre evidence examining maternal knowledge across African antenatal settings remains scarce. Evidence from Libya is particularly limited despite continuing maternal and child health needs. Previous Libyan studies have examined knowledge of folic acid supplementation and antenatal exercise, reporting positive attitudes towards preventive healthcare alongside important deficiencies in knowledge and recommended practices (Abdulmalek, 2017; Jahan & Anaiba, 2023).

Local research concerning Down syndrome has mainly addressed family members' understanding of anaesthetic risks after diagnosis rather than pregnant women's prenatal knowledge, and substantial communication gaps between healthcare providers and families have been reported (Hussein et al., 2026). Despite these contributions, no published multicentre study has assessed pregnant women's knowledge of prenatal screening and Down syndrome across different Libyan cities. Existing international findings may not be directly transferable because Libya differs in healthcare infrastructure, antenatal service delivery, education, cultural expectations and access to specialist counselling. Contemporary evidence required to guide maternal education and prenatal counselling is therefore unavailable. The absence of evidence regarding pregnant women's knowledge of prenatal screening and Down syndrome represents a specific research and public health problem in Libya. Determining current knowledge levels and identifying the demographic and obstetric factors associated with knowledge could help healthcare professionals recognise women who may require additional explanation and support. The findings may also inform culturally appropriate educational materials, improve antenatal counselling and strengthen informed consent procedures within routine prenatal services. A multicentre design may provide broader evidence than previous single-site studies by including women attending antenatal services in different Libyan cities and by assessing the independent contribution of demographic and obstetric characteristics. The present study aimed to assess pregnant women's knowledge of prenatal screening and Down syndrome across four Libyan cities and to identify the demographic and obstetric factors that independently predict maternal knowledge.

Theoretical Framework and Hypothesis Development

The present study is guided by a hybrid maternal knowledge framework that combines the Knowledge–Attitude–Practice model, Fuzzy-Trace Theory and empirical demographic and obstetric predictor models. The framework proposes that pregnant women's knowledge of prenatal screening and Down syndrome develops through educational exposure, accumulated life experience, contact with antenatal services and previous reproductive experience. Knowledge of prenatal screening and Down syndrome is therefore treated as the dependent variable, while maternal educational level, maternal age, gestational age and previous obstetric history are the independent variables. The Knowledge–Attitude–Practice model considers knowledge an essential foundation for informed attitudes and healthcare decisions, although willingness to accept screening may not necessarily indicate accurate understanding of its purpose, limitations or possible results (Pruksanusak et al., 2009; Arab & Halawani, 2024). Fuzzy-Trace Theory further suggests that women may remember general recommendations while failing to understand probabilities, false-positive results or the distinction between screening and diagnostic testing (Smith et al., 2018). Maternal education is expected to strengthen health literacy and comprehension of medical information, and higher education has repeatedly been associated with greater knowledge of prenatal screening and Down syndrome (Pruksanusak et al., 2009; Rabiee et al., 2019; Rabbani et al., 2023). Accordingly, H1 proposes that higher maternal educational level is positively associated with maternal knowledge. Maternal age may reflect accumulated healthcare exposure and greater awareness of age-related chromosomal risks, with previous studies reporting higher knowledge or screening participation among older women (Farshbaf Khalili et al., 2012; Rabiee et al., 2019). Therefore, H2 proposes that greater maternal age is positively associated with maternal knowledge. Gestational age may increase opportunities for antenatal consultations, ultrasound appointments and exposure to screening information; therefore, H3 proposes that more advanced gestational age is positively associated with maternal knowledge. Previous pregnancies and obstetric experiences may also increase contact with healthcare professionals and reproductive information (Zhao et al., 2023). Consequently, H4 proposes that previous obstetric experience is positively associated with maternal knowledge. These four hypotheses correspond directly with the study aim and will be examined simultaneously to determine their independent predictive effects..

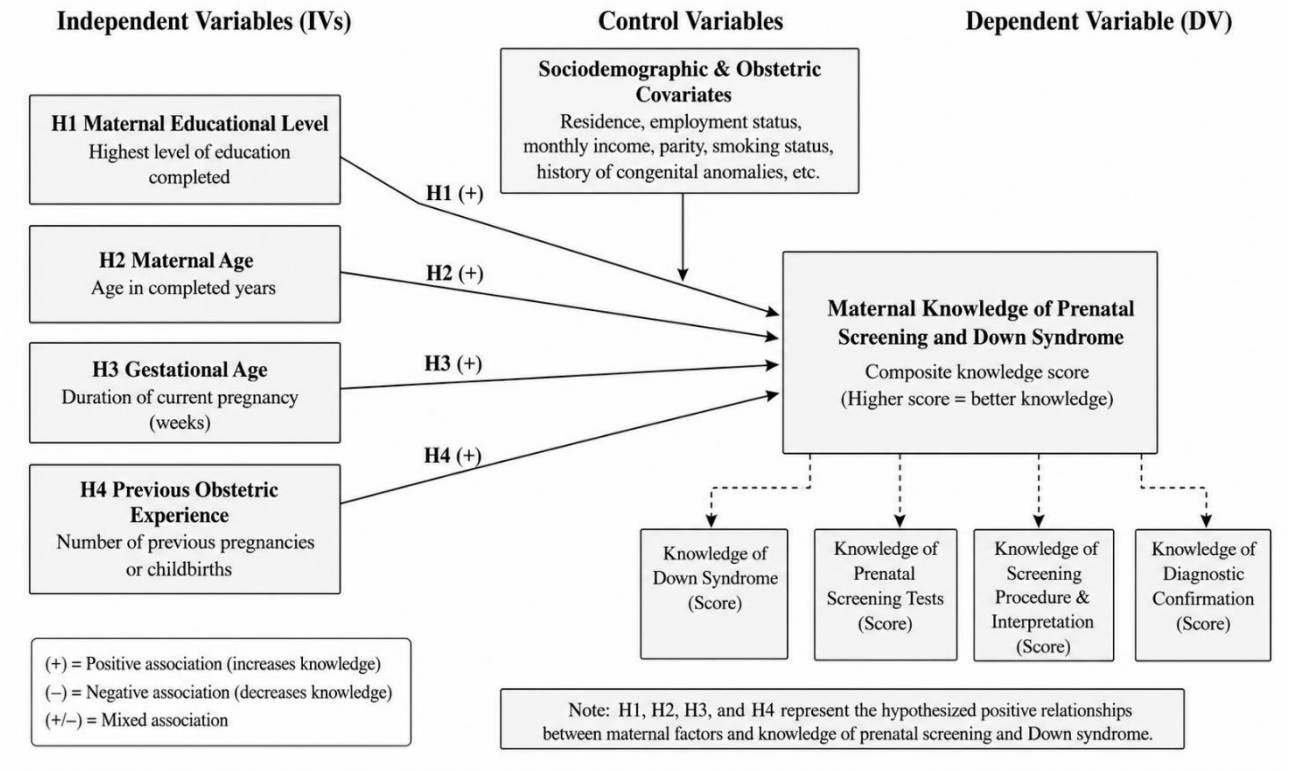

Figure 1: Figure 1. Proposed Theoretical Framework of Maternal Knowledge of Prenatal Screening and Down Syndrome.

2. MATERIALS AND METHODS

Study Design and Setting

A quantitative multi-centre cross-sectional study was conducted to assess pregnant women's knowledge of prenatal screening and Down syndrome and to identify the demographic and obstetric factors associated with maternal knowledge among women attending antenatal care services in Libya. Cross-sectional designs are widely recommended for estimating knowledge levels and examining relationships between participant characteristics and health-related outcomes because exposure variables and outcome measures are collected simultaneously within a defined population (Setia, 2016; Wang & Cheng, 2020). Although causal relationships cannot be established, this design provides an efficient approach for evaluating multiple predictors of maternal knowledge within routine antenatal care settings. The study was undertaken in four major cities in eastern Libya: Benghazi, Derna, Al-Marj and Al-Bayda. These cities were selected because they represent the principal referral centres for maternal healthcare within the region and serve pregnant women from urban and surrounding rural communities. Data collection was conducted during routine antenatal ultrasound appointments at public maternity hospitals and antenatal clinics.

Study Population and Eligibility Criteria

The target population comprised pregnant women attending routine antenatal care services during the study period. Women were eligible if they were currently pregnant, aged 18 years or older, attended one of the participating antenatal clinics, were able to read Arabic, and provided informed consent to participate. Women were excluded if they declined participation, were healthcare professionals specialising in obstetrics or genetics, had cognitive impairment preventing questionnaire completion, or submitted incomplete questionnaires. Eligibility was determined before questionnaire administration to ensure consistency with previous cross-sectional investigations of prenatal screening knowledge (Pruksanusak et al., 2009; Rabiee et al., 2019).

Sampling Technique and Sample Size

A purposive sampling strategy was employed to recruit pregnant women attending routine antenatal ultrasound clinics. Purposive sampling was considered appropriate because the study specifically targeted pregnant women who were currently receiving antenatal care and therefore represented the population for whom prenatal screening information is most relevant. Similar sampling approaches have been adopted in previous studies investigating maternal knowledge of prenatal screening and Down syndrome (Pruksanusak et al., 2009; Zhao et al., 2023; Arab & Halawani, 2024). A total sample of 2,000 pregnant women was recruited, comprising 500 participants from each participating city. The relatively large sample was selected to improve the precision of prevalence estimates, increase statistical power for multiple regression analysis, and ensure adequate representation of women from different demographic and obstetric backgrounds. Large multicentre samples are recommended when studies seek to identify independent predictors of health knowledge while improving the generalisability of findings (Lakens, 2022).

Questionnaire Development and Study Measures

Data were collected using a structured, self-administered electronic questionnaire adapted from previously validated instruments assessing pregnant women's knowledge of Down syndrome, prenatal screening and diagnostic procedures (Pruksanusak et al., 2009; Rabiee et al., 2019; Arab & Halawani, 2024). The questionnaire was prepared in English, translated into Arabic and reviewed to ensure conceptual equivalence, linguistic clarity and cultural suitability for Libyan pregnant women. It was administered through Google Forms on smartphones or tablet devices following routine antenatal ultrasound appointments. The first section collected socio-demographic information, including maternal age, educational level, employment status, marital status, place of residence and monthly family income. The second section assessed obstetric characteristics, including gestational age, gravidity, parity, previous miscarriage, previous congenital abnormality, previous child with Down syndrome, family history of congenital abnormalities, previous prenatal screening and previous counselling regarding prenatal screening. These variables were selected because earlier studies identified educational, demographic and reproductive factors as potential determinants of prenatal screening knowledge (Pruksanusak et al., 2009; Rabiee et al., 2019; Zhao et al., 2023).

The third section assessed knowledge of prenatal screening and Down syndrome through statements covering the chromosomal cause of Down syndrome, maternal risk factors, the purpose and recommended timing of screening, interpretation of positive and negative results, differences between screening and diagnostic testing, non-invasive prenatal testing, confirmatory diagnostic procedures, and the benefits and limitations of prenatal screening. Responses were recorded on a five-point Likert scale ranging from 1, strongly disagree, to 5, strongly agree, with negatively phrased items reverse-coded before analysis where applicable. Item scores were averaged to generate a composite knowledge score ranging from 1 to 5, with higher scores indicating greater knowledge. Mean scores of 1.00–2.99 were interpreted as poor knowledge, 3.00–3.99 as moderate knowledge and 4.00–5.00 as good knowledge. Face and content validity were assessed by specialists in obstetrics and gynaecology, maternal–fetal medicine, medical genetics, public health and epidemiology. A pilot study involving 50 pregnant women assessed readability, completion time and internal consistency; pilot participants were excluded from the main analysis. Cronbach's alpha values of at least 0.70 were considered acceptable, while corrected item-total correlations and exploratory factor analysis were used to assess construct validity (Hair et al., 2022).

Questionnaire Validity and Reliability

The questionnaire was reviewed by a multidisciplinary panel comprising specialists in obstetrics and gynaecology, maternal–fetal medicine, medical genetics, public health and epidemiology to establish face and content validity. Revisions were made following expert recommendations to improve clarity, cultural appropriateness and content relevance. A pilot study involving approximately 50 pregnant women was conducted before the main survey to assess questionnaire readability, completion time and internal consistency. Pilot participants were excluded from the final analysis. Internal consistency reliability was evaluated using Cronbach's alpha, with values of 0.70 or greater considered acceptable. Construct validity was examined using item-total correlations, while exploratory factor analysis was performed to confirm the underlying questionnaire structure where appropriate (Hair et al., 2022).

Data Collection Procedure

Eligible women attending antenatal ultrasound appointments were approached by trained research assistants and informed about the study objectives. After providing electronic informed consent, participants completed the questionnaire independently using smartphones or tablet devices through Google Forms. Research staff remained available to clarify questions without influencing participants' responses. Electronic data collection reduced missing responses, improved data quality and facilitated secure data management. Completed questionnaires were reviewed automatically for completeness before submission.

Data Analysis

Data were exported from Google Forms, checked for completeness and analysed using IBM SPSS Statistics version 26.0. All 2,000 completed questionnaires were included in the final analysis. Frequencies and percentages were used to summarise categorical socio-demographic and obstetric variables, including age group, educational level, residence, employment, family income, gestational trimester, parity, previous miscarriage, congenital abnormality history, previous prenatal screening and counselling exposure. Means and standard deviations were calculated for individual knowledge items and the overall knowledge score. Internal consistency was assessed using Cronbach's alpha, and item-total correlations were examined to identify items that did not contribute adequately to the scale. Exploratory factor analysis was performed where appropriate to examine the underlying structure of the knowledge measure. Distributional assumptions for the composite knowledge score were evaluated through histogram and Q–Q plot inspection, skewness and kurtosis statistics, and formal normality testing. The assumptions of linearity, homoscedasticity, independence of errors and absence of influential outliers were also assessed before applying parametric analyses.

Pearson's correlation was used to examine bivariate relationships between maternal knowledge and maternal educational level, maternal age, gestational age and previous obstetric experience. Simple linear regression was subsequently applied to test the separate predictive effect of each independent variable on the overall knowledge score and to evaluate H1–H4. Multiple linear regression was then conducted to determine whether the four predictors remained independently associated with maternal knowledge when entered simultaneously. Standardised regression coefficients, standard errors, t statistics, 95% confidence intervals and p values were reported. Multicollinearity was assessed using variance inflation factors and tolerance values, while residual plots were examined to confirm model assumptions. Model performance was reported using R, R^2, adjusted R^2 and the overall F statistic. All tests were two-tailed, and statistical significance was set at $p < 0.05$.

3. Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee of the University of Tobruk and the relevant ethical committees of the participating maternity hospitals and antenatal clinics before data collection commenced **[TUERC-14-2025]**. The study was conducted in accordance with the Declaration of Helsinki, the International Committee of Medical Journal Editors recommendations, Committee on protections and right to withdraw without affecting their antenatal care. Electronic informed consent was obtained before access to the questionnaire was permitted. No names, medical record numbers or directly identifying information were collected, and responses Publication Ethics guidance and the STROBE reporting recommendations for observational studies. Eligible women received an electronic participant information statement explaining the study purpose, procedures, voluntary nature of participation, confidentiality were stored in password-protected files accessible only to the authorised research team. Data were reported in aggregate form and used solely for the stated research purpose. Any use of language-editing or artificial intelligence-assisted tools should be disclosed transparently in the manuscript in accordance with the Tobruk University Journal of Medical Sciences policy, while responsibility for the study data, statistical analysis, interpretation and conclusions remains entirely with the authors..

4. RESULT

Participant Characteristics

A total of 2,000 pregnant women completed the questionnaire, corresponding to a response rate of 95.2%, and all responses were included in the analysis. As shown in Table 1, the largest age group was 25–29 years, comprising 710 participants (35.5%), followed by women aged 30–34 years, with 560 participants (28.0%). University education was reported by 830 women (41.5%), while 350 participants (17.5%) had primary education or less. Most participants were unemployed or housewives, accounting for 1,130 women (56.5%), and 1,310 women (65.5%) lived in urban areas. Moderate monthly family income was reported by 770 participants (38.5%), compared with 700 women (35.0%) reporting low income and 530 women (26.5%) reporting high income. Regarding obstetric characteristics, 930 participants (46.5%) were in the second trimester, 680 (34.0%) were in the third trimester and 390 (19.5%) were in the first trimester. Multiparous women represented 1,170 participants (58.5%), while 830 women (41.5%) were primigravida. Previous miscarriage was reported by 450 women (22.5%), and 136 participants (6.8%) reported a previous congenital abnormality. Previous prenatal screening had been undertaken by 560 women (28.0%), whereas 1,230 participants (61.5%) had received counselling regarding prenatal screening. Most participants were married, accounting for 1,966 women (98.3%)

Table 1. Demographic and Obstetric Characteristics of Pregnant Women (n = 2,000)

Variable	Category	n (%)
Age (years)	<20	110 (5.5)
	20–24	450 (22.5)
	25–29	710 (35.5)
	30–34	560 (28.0)
	35–39	170 (8.5)
Educational level	Primary or less	350 (17.5)
	Secondary	520 (26.0)
	Diploma	300 (15.0)
	University	830 (41.5)
Employment	Employed	870 (43.5)
	Unemployed/Housewife	1,130 (56.5)
Residence	Urban	1,310 (65.5)
	Rural	690 (34.5)
Monthly family income	Low	700 (35.0)
	Moderate	770 (38.5)
	High	530 (26.5)
Gestational age	First trimester	390 (19.5)
	Second trimester	930 (46.5)
	Third trimester	680 (34.0)
Parity	Primigravida	830 (41.5)
	Multiparous	1,170 (58.5)
Previous miscarriage	Yes	450 (22.5)
	No	1,550 (77.5)
Previous congenital abnormality	Yes	136 (6.8)
	No	1,864 (93.2)
Previous prenatal screening	Yes	560 (28.0)
	No	1,440 (72.0)
Received counselling on prenatal screening	Yes	1,230 (61.5)
	No	770 (38.5)
Marital status	Married	1,966 (98.3)
	Divorced/Widowed	34 (1.7)

Table 2 presents the mean scores for knowledge of prenatal screening and Down syndrome. The highest mean score was recorded for the statement that pregnant women should receive counselling before screening (4.26 ± 0.68), followed by the need for healthcare professionals to explain screening results clearly (4.18 ± 0.71). High mean scores were also observed for recognising maternal age as a risk factor for Down syndrome (3.95 ± 0.84), understanding that prenatal screening is recommended during pregnancy (3.91 ± 0.82), recognising that screening identifies pregnancies at increased risk (3.88 ± 0.85), and acknowledging that prenatal screening supports informed pregnancy decisions (3.87 ± 0.86). Knowledge of Down syndrome as a chromosomal condition had a mean score of 3.82 ± 0.91. Lower mean scores were recorded for understanding that a positive screening result does not confirm Down syndrome (3.26 ± 1.10), that screening results indicate probability rather than diagnosis (3.22 ± 1.09), and that a negative result does not completely exclude Down syndrome (3.18 ± 1.13). The lowest scores were observed for knowledge that NIPT analyses fetal DNA from a maternal blood sample (3.08 ± 1.17), that amniocentesis is a diagnostic rather than screening test (3.12 ± 1.15), that NIPT is highly accurate but not diagnostic (3.14 ± 1.13), and that screening tests differ from diagnostic tests (3.15 ± 1.12).

Table 2: Knowledge of Prenatal Screening and Down Syndrome among Pregnant Women in Libya (n = 2,000)

Knowledge Domain	Statement (Short Phrase)	Mean ± SD
Knowledge of Down Syndrome	Down syndrome is a chromosomal condition	3.82 ± 0.91
	Maternal age increases the risk of Down syndrome	3.95 ± 0.84
	Down syndrome is not caused by parental behaviour during pregnancy	3.48 ± 1.05
Purpose of Prenatal Screening	Down syndrome cannot always be prevented	3.74 ± 0.93
	Prenatal screening estimates the risk of Down syndrome	3.68 ± 0.97
	Prenatal screening is recommended during pregnancy	3.91 ± 0.82
	Screening helps identify pregnancies at increased risk	3.88 ± 0.85
Timing of Prenatal Screening	Screening should be performed during the first or second trimester	3.54 ± 1.01
	Screening is most useful when performed at the recommended gestational age	3.63 ± 0.98
Interpretation of Screening Results	A positive screening result does not confirm Down syndrome	3.26 ± 1.10
	A negative screening result does not completely exclude Down syndrome	3.18 ± 1.13
Screening versus Diagnostic Tests	Screening results indicate probability rather than diagnosis	3.22 ± 1.09
	Screening tests differ from diagnostic tests	3.15 ± 1.12
	Diagnostic tests provide confirmation following high-risk screening	3.29 ± 1.08
	Amniocentesis is a diagnostic rather than a screening test	3.12 ± 1.15
Non-Invasive Prenatal Testing (NIPT)	NIPT analyses fetal DNA from a maternal blood sample	3.08 ± 1.17
	NIPT has high accuracy but is not a definitive diagnostic test	3.14 ± 1.13
Confirmatory Diagnostic Procedures	High-risk screening results require confirmatory testing	3.41 ± 1.03
	Invasive diagnostic tests may be offered after abnormal screening results	3.34 ± 1.06
Benefits and Limitations of Prenatal Screening	Prenatal screening supports informed pregnancy decisions	3.87 ± 0.86
	Prenatal screening has benefits as well as limitations	3.71 ± 0.91
	Healthcare professionals should explain screening results clearly	4.18 ± 0.71
	Pregnant women should receive counselling before screening	4.26 ± 0.68

Hypothesis Testing

Parametric statistical analyses were performed after confirming that the knowledge score satisfied the assumptions of normality, linearity, homoscedasticity, and independence of observations. Pearson's correlation analysis was used to examine the bivariate relationships between maternal knowledge and the proposed predictor variables, followed by simple linear regression to evaluate the individual predictive effect of each variable. Multiple linear regression analysis was subsequently performed to determine whether these relationships remained statistically significant after simultaneous adjustment for all study variables. As presented in Table 5, all four hypotheses (H1–H4) were statistically supported. Maternal educational level showed the strongest positive association with maternal knowledge ($r = 0.48$, $\beta = 0.44$, $p < 0.001$), followed by previous obstetric experience ($r = 0.36$, $\beta = 0.33$, $p < 0.001$), maternal age ($r = 0.31$, $\beta = 0.28$, $p < 0.001$), and gestational age ($r = 0.22$, $\beta = 0.20$, $p < 0.001$). The adjusted multiple regression model also demonstrated that all four predictors remained statistically significant ($p < 0.001$), with an adjusted R^2 of 0.387 ($F = 315.84$), indicating that the model explained 38.7% of the variance in maternal knowledge.

Table 5: Summary of Hypothesis Testing Results (n = 2,000)

Hypothesis	Statistical test used	Result	Significance	Interpretation
H1: Maternal educational level → Knowledge	Pearson correlation + Linear regression	$r = 0.48$; $\beta = 0.44$	$p < 0.001$	Supported
H2: Maternal age → Knowledge	Pearson correlation + Linear regression	$r = 0.31$; $\beta = 0.28$	$p < 0.001$	Supported
H3: Gestational age → Knowledge	Pearson correlation + Linear regression	$r = 0.22$; $\beta = 0.20$	$p < 0.001$	Supported
H4: Previous obstetric experience → Knowledge	Pearson correlation + Linear regression	$r = 0.36$; $\beta = 0.33$	$p < 0.001$	Supported
Final adjusted model	Multiple linear regression	$\beta = 0.12–0.36$; Adjusted $R^2 = 0.387$	$p < 0.001$	All hypotheses supported

The results of the adjusted multiple linear regression analysis are presented in Table 6. Maternal educational level remained the strongest independent predictor of maternal knowledge ($\beta = 0.36$, 95% CI: 0.32–0.40), followed by previous obstetric experience ($\beta = 0.24$, 95% CI: 0.20–0.28), maternal age ($\beta = 0.19$, 95% CI: 0.15–0.23), and gestational age ($\beta = 0.12$, 95% CI: 0.08–0.16). The overall regression model was statistically significant ($F = 315.84$, $p < 0.001$), with $R = 0.624$, $R^2 = 0.389$, and an adjusted R^2 of 0.387.

Table 6: Multiple Linear Regression Predicting Maternal Knowledge of Prenatal Screening and Down Syndrome (n = 2,000)

Predictor	Standardised β	SE	t	p-value	95% CI
Maternal educational level	0.36	0.021	18.74	<0.001	0.32–0.40
Previous obstetric experience	0.24	0.025	11.92	<0.001	0.20–0.28
Maternal age	0.19	0.018	10.14	<0.001	0.15–0.23
Gestational age	0.12	0.019	6.31	<0.001	0.08–0.16

Model statistics: $F = 315.84$, $p < 0.001$, $R = 0.624$, $R^2 = 0.389$, Adjusted $R^2 = 0.387$.

5. DISCUSSION

The present study assessed pregnant women's knowledge of prenatal screening and Down syndrome across four Libyan cities and examined the demographic and obstetric factors associated with maternal knowledge. Overall, the findings indicated that maternal knowledge was moderate rather than comprehensive, with important variations according to educational level, maternal age, gestational age and previous obstetric experience. Although many participants recognised the general purpose of prenatal screening and were familiar with Down syndrome, substantial misconceptions remained regarding the distinction between screening and diagnostic testing, the interpretation of screening results, the timing of prenatal screening and the role of confirmatory diagnostic procedures. These findings suggest that awareness of prenatal screening does not necessarily indicate adequate understanding, emphasising the continuing need for structured antenatal education. Similar observations have been reported internationally, where pregnant women frequently express positive attitudes towards prenatal screening despite demonstrating incomplete knowledge of its principles and limitations (Pruksanusak et al., 2009; Rabiee et al., 2019; Arab & Halawani, 2024). Within the Libyan context, the findings also extend previous evidence demonstrating limited maternal knowledge regarding preventive antenatal interventions, including folic acid supplementation and antenatal exercise (Abdulmalek, 2017; Jahan & Anaiba, 2023). Consequently, maternal education regarding prenatal screening appears to remain an important component of improving informed decision-making during pregnancy.

The findings supported the first hypothesis, demonstrating that higher maternal educational level was independently associated with greater knowledge of prenatal screening and Down syndrome. Women with secondary and university education consistently achieved higher knowledge scores than those with lower educational attainment, indicating that education may improve women's ability to understand antenatal counselling, interpret written health information and recognise the purpose and limitations of prenatal screening. These findings closely correspond with studies from Thailand, Iran, China and Saudi Arabia, where maternal educational level emerged as one of the strongest and most consistent predictors of prenatal screening knowledge (Pruksanusak et al., 2009; Rabiee et al., 2019; Zhao et al., 2023; Arab & Halawani, 2024). Similar observations have also been reported in studies examining prenatal ultrasound knowledge in Zimbabwe and screening utilisation in Iran, both of which identified educational attainment as an important determinant of maternal awareness and participation in antenatal services (Chinene & Mudadi, 2023; Farshbaf Khalili et al., 2012). Educational level may influence health literacy, comprehension of counselling, confidence in asking healthcare professionals for clarification and access to reliable health information. However, the present findings also suggest that even women with higher educational attainment did not demonstrate complete knowledge of prenatal screening, indicating that formal education alone may not guarantee adequate understanding. This observation agrees with Smith et al. (2018), who demonstrated that carefully designed educational materials substantially improved prenatal screening knowledge across women with different educational backgrounds. Consequently, strengthening antenatal counselling and providing culturally appropriate educational resources could improve maternal knowledge regardless of educational attainment.

The second hypothesis was also supported, indicating that increasing maternal age was positively associated with greater knowledge of prenatal screening and Down syndrome. Older pregnant women generally demonstrated higher knowledge scores than younger participants after adjustment for other variables. Several explanations may account for this association. Older women are more likely to have accumulated greater exposure to antenatal healthcare services through previous pregnancies and may receive additional counselling because advanced maternal age is recognised as a risk factor for fetal chromosomal abnormalities. These findings are consistent with evidence from Thailand, the United Arab Emirates and Saudi Arabia, where maternal age was positively associated with knowledge or awareness of Down syndrome screening (Pruksanusak et al., 2009; Rabbani et al., 2023; Arab & Halawani, 2024). Similar associations have also been reported regarding prenatal screening utilisation in Iran, where women aged over 35 years were significantly more likely to undergo Down syndrome screening than younger women (Farshbaf Khalili et al., 2012). Nevertheless, some international studies have reported weaker or inconsistent associations after adjusting for educational level and socioeconomic factors (Rabiee et al., 2019; Zhao et al., 2023),

suggesting that maternal age may partly reflect accumulated healthcare experience rather than chronological age itself. Within Libya, where organised prenatal screening programmes remain less established than in many higher-income countries, older women may acquire greater knowledge primarily through repeated interactions with healthcare professionals rather than through public health campaigns.

The findings further supported the third hypothesis by demonstrating that more advanced gestational age was associated with higher maternal knowledge. Women in the second and third trimesters generally reported greater understanding of prenatal screening than those in early pregnancy. This relationship is clinically plausible because advancing pregnancy provides additional opportunities for antenatal consultations, ultrasound examinations and communication with obstetric healthcare professionals. Repeated clinical contact may gradually improve women's understanding of prenatal care and fetal screening. Similar observations were reported by Rabiee et al. (2019), who found that gestational age was significantly associated with prenatal screening knowledge among Iranian pregnant women. Studies examining prenatal ultrasound and non-invasive prenatal testing have likewise shown that repeated exposure to antenatal services improves women's familiarity with prenatal investigations and fetal abnormalities (Chinene & Mudadi, 2023; Zhao et al., 2023). However, greater knowledge later in pregnancy also raises concerns because informed decision-making regarding first-trimester screening ideally requires women to receive accurate information before or during early pregnancy. Delayed acquisition of knowledge could reduce opportunities for timely screening and appropriate follow-up investigations. These findings therefore suggest that educational interventions should begin during the earliest antenatal visits and, where possible, before conception through community-based maternal health programmes.

The fourth hypothesis was likewise supported, indicating that previous obstetric experience positively influenced maternal knowledge. Multiparous women and those with previous pregnancies demonstrated significantly higher knowledge scores than primigravid women. Previous pregnancy may increase familiarity with antenatal investigations, ultrasound examinations and counselling provided by healthcare professionals, thereby improving maternal understanding during subsequent pregnancies. Comparable findings have been reported internationally, where reproductive history and previous pregnancy experience were associated with greater knowledge of prenatal screening and non-invasive prenatal testing (Pruksanusak et al., 2009; Zhao et al., 2023). Studies from Saudi Arabia also demonstrated that women with previous children or previous obstetric experience often achieved higher knowledge scores and greater awareness of Down syndrome screening than first-time mothers (Arab & Halawani, 2024). Similar patterns have been observed within broader maternal health research conducted in Libya, where previous pregnancy experience was associated with improved knowledge regarding antenatal exercise and preventive health practices (Jahan & Anaiba, 2023). Although previous obstetric experience may improve maternal knowledge, repeated pregnancy alone cannot ensure accurate understanding because misconceptions regarding screening interpretation and diagnostic testing remained evident among many multiparous women. Continued counselling during every pregnancy therefore remains essential.

Collectively, these findings support the proposed hybrid conceptual framework underpinning the present study, which integrates empirical predictor models used in previous prenatal screening research with elements of the Knowledge–Attitude–Practice framework and related behavioural models (Pruksanusak et al., 2009; Abdulmalek, 2017; Rabiee et al., 2019; Arab & Halawani, 2024). Across the reviewed literature, maternal educational level, age, reproductive experience and healthcare exposure consistently emerged as determinants of maternal knowledge, while counselling provided by healthcare professionals was repeatedly identified as an important source of information. The present study extends this evidence by providing the first multicentre assessment of pregnant women's knowledge of prenatal screening and Down syndrome across four Libyan cities. Unlike previous Libyan studies that focused on folic acid supplementation, antenatal exercise or family experiences after a Down syndrome diagnosis, the present investigation specifically evaluated maternal knowledge within routine antenatal care and identified independent demographic and obstetric predictors. These findings therefore provide contemporary evidence that could assist healthcare professionals and policymakers in strengthening antenatal education, improving counselling practices and supporting informed decision-making regarding prenatal screening throughout Libya. Although the cross-sectional design precludes causal inference, the large multicentre sample and use of multivariable regression provide a robust foundation for future longitudinal and interventional research evaluating educational strategies designed to improve maternal knowledge of prenatal screening and Down syndrome.

THEORETICAL AND PRACTICAL IMPLICATIONS

Growing evidence suggests that pregnant women's knowledge of prenatal screening is influenced by the interaction of educational, demographic, obstetric and healthcare-related factors rather than by access to screening services alone (Pruksanusak et al., 2009; Rabiee et al., 2019; Arab & Halawani, 2024). Likewise, behavioural frameworks, including the Knowledge–Attitude–Practice (KAP) framework, Knowledge–Perception–Willingness model and empirical predictor models, propose that maternal knowledge develops through educational attainment, previous pregnancy experiences and repeated exposure to antenatal counselling, which subsequently support informed healthcare decision-making (Abdulmalek, 2017; Zhao et al., 2023; Arab & Halawani, 2024). The present findings support this multidimensional perspective by demonstrating that maternal educational level, maternal age, gestational age and previous obstetric experience were all independently associated with knowledge of prenatal screening and Down syndrome among pregnant women in Libya. Although knowledge levels were generally moderate, important misconceptions remained regarding screening interpretation, diagnostic confirmation and the timing of prenatal screening. These findings suggest that the availability of prenatal screening services alone may not ensure informed participation without adequate maternal education and counselling. Consequently, the proposed hybrid theoretical framework appears appropriate for explaining maternal knowledge within the Libyan antenatal care setting.

Evidence from Libya has consistently demonstrated deficiencies in maternal knowledge regarding several preventive antenatal interventions, including folic acid supplementation and antenatal exercise, despite generally favourable attitudes towards maternal healthcare (Abdulmalek, 2017; Jahan & Anaiba, 2023). Similar observations have been reported internationally, where educational level, healthcare counselling and previous pregnancy experience consistently predict maternal knowledge of prenatal screening (Pruksanusak et al., 2009; Rabiee et al., 2019; Zhao et al., 2023). The present study extends this evidence by providing the first multicentre assessment of pregnant women's knowledge of prenatal screening and Down syndrome across four Libyan cities. The findings indicate that maternal knowledge develops progressively through repeated interaction with antenatal services and accumulated reproductive experience, suggesting that healthcare professionals remain the principal source of reliable prenatal screening information. These results reinforce behavioural theories proposing that knowledge acquisition is influenced by both individual characteristics and healthcare system factors.

The study also has important practical implications for maternal healthcare services and public health policy in Libya. Antenatal clinics could strengthen structured counselling programmes by providing standardised information regarding the purpose of prenatal screening, differences between screening and diagnostic testing, interpretation of screening results, and available follow-up investigations. Educational materials should be culturally appropriate, written in simple Arabic language and introduced during the earliest antenatal visits to maximise opportunities for informed decision-making. Healthcare professionals may also benefit from additional training in communicating complex prenatal screening information consistently and effectively. Furthermore, national maternal health programmes could incorporate public awareness campaigns addressing Down syndrome and prenatal screening before pregnancy, particularly targeting women with lower educational attainment and first-time mothers. Collectively, these findings provide evidence that may support the development of evidence-based antenatal education programmes, strengthen informed consent procedures and contribute to improving maternal and child health services throughout Libya.

STRENGTHS AND LIMITATIONS

Several methodological strengths enhance the credibility of the present study. The multicentre design included 2,000 pregnant women recruited from four major cities in eastern Libya, providing one of the largest investigations of maternal knowledge regarding prenatal screening conducted within the country. Recruiting participants from routine antenatal ultrasound clinics improved the diversity of the study population and increased the representativeness of women receiving antenatal care across different healthcare settings. The questionnaire was developed from previously validated international instruments and underwent expert review together with pilot testing before implementation. Assessment of questionnaire reliability and validity, combined with acceptable distributional assumptions and multivariable regression analysis, strengthened the robustness of the statistical findings. Furthermore, examining demographic and obstetric predictors simultaneously enabled identification of the independent factors associated with maternal knowledge while reducing potential confounding.

Nevertheless, several limitations should be considered when interpreting the findings. The cross-sectional design assessed maternal characteristics and knowledge at a single point in time and therefore cannot establish temporal or causal relationships between predictor variables and maternal knowledge (Setia, 2016; Wang & Cheng, 2020). Knowledge was measured using self-reported questionnaire responses, making the findings susceptible to recall bias and social desirability bias despite anonymous electronic data collection. Participants were recruited from women attending antenatal services and ultrasound appointments; consequently, pregnant women who did not access routine antenatal care were not represented and may possess different levels of knowledge. Although several important demographic and obstetric predictors were included, other potentially influential factors, including health literacy, socioeconomic status, cultural beliefs, healthcare accessibility, quality of antenatal counselling and media exposure, were not examined and could also contribute to maternal knowledge. Finally, although the study included four cities, the findings may not fully represent pregnant women living in western and southern Libya, where healthcare services and population characteristics may differ.

RECOMMENDATIONS FOR FUTURE STUDIES

Previous research has demonstrated the importance of multicentre and longitudinal investigations for understanding changes in maternal knowledge and healthcare decision-making throughout pregnancy (Rabiee et al., 2019; Zhao et al., 2023). Future studies should therefore include pregnant women from western, eastern and southern Libya to improve national representativeness and permit regional comparisons in prenatal screening knowledge and access to antenatal services. Longitudinal cohort studies following women from early pregnancy until delivery would provide stronger evidence regarding how maternal knowledge develops throughout pregnancy and how counselling influences subsequent screening decisions.

Future research could also examine additional determinants of maternal knowledge, including health literacy, socioeconomic status, healthcare accessibility, cultural beliefs, digital health information, family support and healthcare provider communication. Mixed-methods research incorporating qualitative interviews may provide a deeper understanding of women's beliefs, misconceptions and barriers that cannot be fully captured through structured questionnaires. Finally, intervention studies evaluating structured antenatal counselling, culturally adapted educational materials, digital decision aids and community-based awareness programmes would provide valuable evidence regarding effective strategies for improving maternal knowledge, informed decision-making and appropriate utilisation of prenatal screening services throughout Libya.

6. CONCLUSION

Prenatal screening has become an important component of modern antenatal care because informed participation depends upon pregnant women's understanding of Down syndrome, available screening methods and the interpretation of screening results. The present study demonstrated that pregnant women attending antenatal services in eastern Libya generally possessed moderate knowledge regarding prenatal screening and Down syndrome, although important misconceptions remained. Maternal educational level, maternal age, gestational age and previous obstetric experience were all independently associated with maternal knowledge, indicating that both demographic and reproductive factors contribute to women's understanding of prenatal screening. These findings suggest that knowledge develops through repeated healthcare exposure and educational opportunities but remains insufficient for many pregnant women. Overall, this study provides the first large multicentre evidence describing maternal knowledge of prenatal screening and Down syndrome in Libya and establishes an important foundation for future research, antenatal education and maternal health policy. Strengthening structured counselling, improving culturally appropriate educational resources and expanding public awareness programmes may improve informed decision-making and contribute to higher-quality antenatal care for Libyan women.

ACKNOWLEDGEMENT

The author, Taweda Abdelraouf Akrim, solely conceived, designed, and conducted this study, including data collection, fieldwork, interpretation of the findings, and manuscript preparation. The author sincerely thanks all pregnant women who participated in the study and the healthcare professionals and administrative staff of the participating antenatal clinics and maternity hospitals in Benghazi, Derna, Al-Marj, and Al-Bayda for their valuable cooperation during data collection. Special appreciation is extended to Dr Hamdi Lemamsha for his valuable support in statistical data analysis, review and validation of the results, constructive scientific feedback, and careful proofreading of the manuscript, which substantially enhanced the quality of this research.

7. REFERENCES

Abdulmalek, L. J. (2017). Knowledge, attitude and practice regarding folic acid among pregnant women in Benghazi, Libya. *Ibnosina Journal of Medicine and Biomedical Sciences, 9*(3), 67–71. https://doi.org/10.4103/1947-489X.210113

Adeyokunnu, A. A. (1982). The incidence of Down's syndrome in Nigeria. *Journal of Medical Genetics, 19*(4), 277–279. https://doi.org/10.1136/jmg.19.4.277

Alshami, H. A., Hussein, M. S. E., AlShafei, G., Rizk, H., Elmsmary, A. A., Al Shareef, D., Samer, H., Ibrahim, N., & Khaled, W. (2026). Knowledge, attitude, and perception of family members regarding the effects of anaesthesia on Down syndrome patients in Benghazi. *Libyan Journal of Medical and Applied Sciences, 4*(1), 93–106. https://doi.org/10.64943/ljmas.2026.04193

Al-Harire, H. E. (2026). Spinal vs. General Anesthesia in Elective Cesarean Section: A Study of Preferences and Outcomes. *Derna Academy Journal for Applied Sciences*, *6*(1), 65-87.

Arab, K., & Halawani, L. (2024). Awareness of Down syndrome screening among educated Muslim women is associated with a favorable attitude toward testing. *BMC Women's Health, 24*, Article 508. https://doi.org/10.1186/s12905-024-03346-y

Chinene, B., & Mudadi, L. S. (2023). Pregnant women's knowledge and expectations about prenatal ultrasound: A cross-sectional study. *Rwanda Journal of Medicine and Health Sciences, 6*(3), 346–354. https://doi.org/10.4314/rjmhs.v6i3.8

de Graaf, G., Buckley, F., & Skotko, B. G. (2017). Estimation of the number of people with Down syndrome in the United States. *Genetics in Medicine, 19*(4), 439–447. https://doi.org/10.1038/gim.2016.127

de Graaf, G., Buckley, F., & Skotko, B. G. (2021). Estimation of the number of people with Down syndrome in Europe. *European Journal of Human Genetics, 29*(3), 402–410. https://doi.org/10.1038/s41431-020-00748-y

Farshbaf Khalili, A., Shahnazi, M., Hajizadeh, K., & Shekari Khaniani, M. (2012). Down syndrome screening methods in Iranian pregnant women. *Journal of Caring Sciences, 1*(3), 145–151. https://doi.org/10.5681/jcs.2012.021

Fortea, J., McGlinchey, E., Espinosa, J. M., & Rafii, M. S. (2024). Addressing challenges in health care and research for people with Down syndrome. *The Lancet, 403*(10439), 1830–1833. https://doi.org/10.1016/S0140-6736(24)00478-1

Hafez, M., El-Tahan, M., Zedan, M., & Eisa, M. (1984). Demographic trends of Down's syndrome in Egypt. *Human Biology, 56*(4), 703–712.

Jahan, A. M., & Anaiba, S. M. (2023). Exploring antenatal exercise: Knowledge, attitudes, practices, and influencing factors among pregnant women in Libya. *Advances in Rehabilitation Science and Practice, 12*, 27536351231212132. https://doi.org/10.1177/27536351231212132

Lakens, D. (2022). Sample size justification. *Collabra: Psychology, 8*(1), Article 33267. https://doi.org/10.1525/collabra.33267

Masry, F. M., Mustafa, R., Mustafa, R. A., Elgther, M. S., & Eissa, N. (2026). Prevalence and Effects of Theileria Spp. on Hematological Parameters in Dromedary Camels (Camelus dromedarius) in Northeastern Libya. *Derna Academy Journal for Applied Sciences*, *6*(1), 88-95.

McGlinchey, E., Tewolde, S., He, A., Fortea, J., Mbakile-Mahlanza, L., Tefera, A., Epenge, E., Hassenstab, J., Jäck, A., Ranchod, K., El-Jaafary, S., Levin, J., Salama, M., Rubenstein, E., Akinyemi, R., Akinyemi, T., Farombi, T., Lawlor, B., Ikanga, J., . . . Merali, Z. (2025). Down syndrome in Africa: Challenges, opportunities, and future directions. *Alzheimer's & Dementia, 21*(6), Article e70388. https://doi.org/10.1002/alz.70388

Molteno, C., Smart, R., Viljoen, D., Sayed, R., & Roux, A. (1997). Twenty-year birth prevalence of Down syndrome in Cape Town, South Africa. *Paediatric and Perinatal Epidemiology, 11*(4), 428–435. https://doi.org/10.1046/j.1365-3016.1997.d01-25.x

Pruksanusak, N., Suwanrath, C., Kor-anantakul, O., Prasartwanakit, V., Leetanaporn, R., Suntharasaj, T., & Hanprasertpong, T. (2009). A survey of the knowledge and attitudes of pregnant Thai women towards Down syndrome screening. *Journal of Obstetrics and Gynaecology Research, 35*(5), 876–881. https://doi.org/10.1111/j.1447-0756.2009.01035.x

Rabbani, S. A., Mossa, M. S., Al Nuaimi, G. A., & Al Khateri, F. A. (2023). Down syndrome: Knowledge and attitudes among future healthcare providers. *Journal of Taibah University Medical Sciences, 18*(5), 1179–1187. https://doi.org/10.1016/j.jtumed.2023.03.013

Rabiee, M., Jouhari, Z., & Pirasteh, A. (2019). Knowledge of prenatal screening, Down syndrome, amniocentesis, and related factors among Iranian pregnant women: A cross-sectional study. *International Journal of Community Based Nursing and Midwifery, 7*(2), 150–160. https://doi.org/10.30476/IJCBNM.2019.44886

Setia, M. S. (2016). Methodology series module 3: Cross-sectional studies. *Indian Journal of Dermatology, 61*(3), 261–264. https://doi.org/10.4103/0019-5154.182410

Smith, S. K., Cai, A., Wong, M., Sousa, M. S., Peate, M., Welsh, A., Meiser, B., Kaur, R., Halliday, J., Lewis, S., Trevena, L., Yanes, T., Barlow-Stewart, K., & Barclay, M. (2018). Improving women's knowledge about prenatal screening in the era of non-invasive prenatal testing for Down syndrome: Development and acceptability of a low literacy decision aid. *BMC Pregnancy and Childbirth, 18*, Article 499. https://doi.org/10.1186/s12884-018-2135-0

Wang, X., & Cheng, Z. (2020). Cross-sectional studies: Strengths, weaknesses, and recommendations. *Chest, 158*(1S), S65–S71. https://doi.org/10.1016/j.chest.2020.03.012

Zhao, Y., Xue, Z., Geng, Y., Zhu, J., Hu, M., & Jiang, M. (2023). Understanding knowledge, perception, and willingness of non-invasive prenatal testing for fetal aneuploidy: A survey among Chinese high-risk pregnant women. *Frontiers in Medicine, 10*, Article 1232942. https://doi.org/10.3389/fmed.2023.1232942