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Awareness of down syndrome screening among educated Muslim women is associated with a favorable attitude toward testing

Kholoud Arab^{1,2*}  and Lujain Halawani^{1,2}

Abstract

Objective There is a general assumption that Muslim women refuse Down syndrome screening, and therefore, many health practitioners do not offer it or briefly discuss it with their participants. This study aims to objectively assess women's awareness, knowledge, and attitudes toward Down Syndrome screening (D.S.S) in a Muslim-majority population.

Methods We conducted a cross-sectional study among attendees of antenatal clinics at a major university hospital in Saudi Arabia, aiming for a sample size of at least 385 Muslim women. A semi-structured questionnaire assessed awareness of different D.S.S. options and the source of that information (2 items), specific knowledge of D.S.S. (14 items), and attitudes (4 items). The knowledge and attitudes scores were calculated using a five-level agreement Likert-type scale.

Results Among 434 participants, with an even distribution among all age groups and a majority of a college degree holder or higher (71%), 178 (41.0%) reported awareness of D.S.S. Factors associated with increased awareness were maternal age above 40 or those under 30, nulliparity, and extended family history of fetal congenital anomalies (P-value = 0.03, 0.015, and 0.017, respectively). Recognized tests were ultrasound measurement of nuchal translucency (71.9%) and first-trimester serum screening (58.4%). The sources of knowledge were obstetricians (53.9%), followed by family and friends (27.0%). The overall mean \pm SD knowledge score was 53.9 ± 8.7 out of 70, and the mean attitude score was 17.4 ± 2.9 out of 20. Having 1 or 2 children is associated with a higher knowledge score, and most participants who reported awareness of D.S.S. (51.7%) had a favorable attitude toward screening.

Conclusion Awareness of D.S.S. among Muslim women is associated with favorable attitudes towards testing, contradicting the general assumption and highlighting the need for systematic education to increase awareness and subsequent testing uptake.

Keywords Down syndrome, Attitude, Knowledge, Screening, Saudi Arabia, Health disparity, Muslim women

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Introduction

Down syndrome (D.S.) is one of the most common chromosomal abnormalities, affecting approximately 1.5 per 1,000 live births [1–3], and is characterized by the presence of either a partial or complete third copy of chromosome 21 [3–6]. D.S. is associated with intellectual disabilities and congenital malformations, leading to significant medical and social implications [6, 7].

Advances in technology, genetic analysis, and biochemistry allowed for the development of prenatal screening of D.S. and measurement of the occurrence risk, with several prenatal screening tests, each with variable sensitivity and specificity. Examples of these tests include the triple or quadruple screen, the integrated first-trimester screen, and cell-free D.N.A.

To improve the efficacy of screening programs, the target populations, specifically pregnant women and women of childbearing age, should have adequate awareness and understanding of the utility and tools of prenatal screening and the screened anomaly. Inadequate knowledge and misconceptions may lead to nonadherence and failure of the screening strategy at the public health level [8].

In a review of D.S.S. practice in multiple developed countries, screening was reported to be integrated into routine obstetrical care, where accessibility and genetic counseling programs for pregnant women were offered to ensure awareness and accurate information about screening facts and options as well as the implications of positive results. Such practice enabled couples to decide whether to accept or deny testing [9–11].

Historically, D.S.S. has been linked to the termination of pregnancy [12]. This association introduced several ethical dilemmas regarding prenatal screening, notably in conservative societies where termination of pregnancy is commonly declined [13, 14]. For example, in Saudi Arabia, it is generally perceived that many pregnant women have a negative attitude toward prenatal screening, associated with several misconceptions about the test's utilities and goals [15–17]. Therefore, prenatal screening for Down Syndrome is not routinely offered in obstetrical care. Instead, it is often discussed at the physician's discretion and based on participants' risk factors. As a result, the perceived community knowledge of D.S.S. and the available prenatal screening options remains low.

This study aims to objectively assess awareness and knowledge of prenatal screening for D.S. and the available screening options among pregnant women attending antenatal clinics at one of the leading university hospitals in Saudi Arabia. It further explored women's attitudes toward the utility of the screening test and their favorability to take the test.

Materials and methods

We conducted an observational cross-sectional study from 1 January 2021 to 28 February 2021. It involved pregnant women attending the antenatal clinics at King Abdulaziz University Hospital (K.A.U.H), Jeddah, Saudi Arabia. Inclusion criteria included all pregnant women coming for antenatal visits who identified as Muslim. The sample size was calculated as 385 participants based on a 95% confidence interval with a 5% margin of error and 50% population proportion. High-risk pregnant women with current pregnancies suspected or diagnosed with D.S. or another congenital anomaly were excluded.

The study protocol was reviewed and ethically approved by the Research Ethics Committee of King Abdulaziz University Hospital (Reference No: 710–20). Verbal and written consent were obtained during data collection. Subjects agreed to participate and publish the results. The investigators approached all eligible participants visiting the clinic during the study period and explained the study's objectives. Written consent was obtained from agreeable participants, and data was collected using a semi-structured questionnaire. The questionnaire was created online via Google form in Arabic and English and administered face-to-face interviews of the participants by trained investigators in a digital format (on iPad). (See supplementary material for a detailed questionnaire). The questionnaire was divided into four parts. Part one comprises sociodemographic data, including age, number of children, educational level, residency location, previous child with D.S. in offspring or other relatives' children, and history of congenital anomalies in offspring. Part two explored awareness of prenatal screening for D.S. of the different tests offered, including nuchal translucency, first and second-trimester serum screening, and cell-free D.N.A. Participants who reported being aware of testing options were questioned on sources of knowledge, including obstetricians, family physicians, media, relatives, and friends. Part three consisted of a scale to measure knowledge about D.S. (four items) and D.S.S. (ten items); each item was a five-level agreement Likert-type scale enabling the calculation of a knowledge score for the two subscales. Finally, part four explored attitudes towards prenatal screening using a four-item scale, each item consisting of a five-level agreement Likert-type scale enabling the calculation of an attitudes score. Parts three and four were only administered to participants who declared being aware of D.S.S. After conducting a literature review; the authors developed the questionnaire to reflect on the most up-to-date D.S.S. information. Similar studies conducted in different countries were cited to help create a comprehensive questionnaire [18–22]. The two authors evaluated the applicability and content validity in the index population. It was then assessed by a third clinical provider not involved in this

Table 1 Participants' characteristics (N=434)

Parameter	Category	N=434	%
Age (years)	20–30	149	34.3
	31–40	158	36.4
	>40	127	29.3
Number of children	0	99	22.8
	1–2	125	28.8
	>2	210	48.4
Level of education	Up to Secondary	85	19.6
	Diploma	40	9.2
	University	265	61.1
	Higher education	44	10.1
Residency location	City	390	89.9
	Rural area	44	10.1
Previous children with D.S.	No	423	97.5
	Yes	11	2.5
Another baby with congenital anomalies	No	413	95.2
	Yes	21	4.8
Family history of congenital anomalies other than offspring	No	399	91.9
	Yes	35	8.1

research, a maternal-fetal medicine specialist. Cronbach's alpha calculated the internal consistency of the knowledge and attitude scales (in social studies, values of 0.7 are significant) [23]. Before conducting the study, the questionnaire was tested with ten pregnant women who were not included to assess the clarity of wording and ease of understanding. Appropriate changes were performed to correct any ambiguous wording or difficult-to-understand sentences.

Outcome definition

Three primary outcomes were reported. (1) Awareness about D.S.S. and factors associated were analyzed as a dichotomous variable; (2) the knowledge and attitude levels about D.S. and D.S.S. were analyzed as a numerical variable consisting of the knowledge and attitude scores; and (3) attitudes towards prenatal screening were further analyzed as a binomial variable including favorable and unfavorable attitude. A favorable attitude was defined as a positive response (agree or strongly agree) to all four attitude questions.

Statistical methods

Data was downloaded as an Excel sheet, coded and edited, and transferred to Statistical Package for Social Sciences version 21.0 for Windows (S.P.S.S. Inc., Chicago, IL, U.S.A.) for statistical analysis. Categorical variables are presented as percentage and frequency, while continuous variables are presented as mean±standard deviation (SD). Factors associated with the awareness about D.S. prenatal screening were analyzed using the chi-square test or Fisher's exact test, as appropriate. Factors associated with knowledge about D.S. and prenatal

Table 2 Awareness of Down syndrome prenatal screening

Item	Answered Yes N=178	%
What screening tests have you heard of for D.S.?		
<i>Ultrasound from 11–13 weeks to measure nuchal translucency</i>	128	71.9
<i>First-trimester maternal serum screening</i>	104	58.4
<i>Second-trimester maternal serum screening</i>	82	46.1
<i>Noninvasive Prenatal Testing</i>	88	49.4
Sources of knowledge		
<i>Obstetrician</i>	96	53.9
<i>Relatives or friends</i>	48	27.0
<i>Family physician</i>	5	2.8
<i>Media</i>	0	0.0
<i>Others</i>	6	3.4

screening were analyzed by comparing the mean scores between the different categories of factors using an independent t-test or One-Way ANOVA, as appropriate. In addition, factors associated with favorable attitudes were analyzed using the proper chi-square or Fisher's exact test. A p -value of <0.05 was used to reject the null hypothesis, which rejects the association between participants' knowledge of Down syndrome screening and their attitude toward testing.

Results

A total of 520 responses were received; of these, 86 were identified to be duplicated. Thus, 434 participants were included, with fair distribution across the three age categories: 20–30 (34.3%), 31–40 (36.4%), and >40 (29.3%). Approximately half were mothers of 3 children or more. The educational levels were remarkably high, with 71.2% having a university degree or higher. History of D.S. in the offspring and other relatives' children was 2.5% and 8.1%, respectively (Table 1).

Only 41.0% of the participants (178/434) declared being aware of prenatal screening of D.S., and the ultrasound measurement of nuchal translucency from 11 to 13 weeks was the most frequently identified test (71.9%), followed by first-trimester maternal serum screening (58.4%). Sources of knowledge were most frequently obstetricians (53.9%), followed by relatives or friends (27.0%), while only 2.8% declared having received information about D.S.S. from their family physicians (Table 2).

Awareness of D.S.S. was higher among women below 30 (48.3%) and above 40 (41.7%) compared to those between 31 and 40 years (33.5%) ($p=0.031$). Nulliparous women were more aware of D.S. prenatal screening (52.5%) than their counterparts ($p=0.015$). History of D.S. among relatives' children was associated with higher awareness of prenatal screening (60.0% versus 39.3%) compared with the absence of such history, and the result was statistically significant ($p=0.017$) (Table 3).

Table 3 Factors associated with awareness of Down syndrome prenatal screening

Parameter	Category	Awareness of Down Syndrome screening		
		N=434	%	p-value
Age (years)	20–30	72	48.3	0.031*
	31–40	53	33.5	
	>40	53	41.7	
Number of children	0	52	52.5	0.015*
	1–2	52	41.6	
	>2	74	35.2	
Level of education	General education	33	38.8	0.299
	Diploma	13	32.5	
	University	109	41.1	
	Post-Graduate	23	52.3	
Residency location	City	158	40.5	0.528
	Rural area	20	45.5	
Previous children with D.S.	No	174	41.1	1.000 ^F
	Yes	4	36.4	
Another baby with congenital anomalies	No	169	40.9	0.860
	Yes	9	42.9	
Family history of congenital anomalies other than offspring	No	157	39.3	0.017*
	Yes	21	60.0	

*; Statistically significant result ($p < 0.05$), F: Fisher's exact test.

Table 4 Knowledge and attitudes of Down syndrome and prenatal screening ($N = 178$)

Subscale	No. items	Cronbach's alpha	Mean \pm S.D.	Range
Overall knowledge	14	0.814	53.9 \pm 8.7	14–70
Knowledge about D.S.	4	0.601	15.7 \pm 3.2	4–20
Knowledge about prenatal screening	10	0.818	38.2 \pm 6.9	10–50
Attitudes about D.S. prenatal screening	4	0.707	17.4 \pm 2.9	4–20

The knowledge scale was evaluated using a five-level agreement Likert-type scale for the 14 items included. With an expected score of 1–5 per item and 14–70 for the total knowledge score. Analysis of the internal consistency of the overall knowledge scale of the 14 items showed Cronbach's $\alpha = 0.814$, and calculation of the knowledge score showed mean \pm SD = 53.9 \pm 8.7 out of 70 (Table 4). The attitude scale was evaluated similarly for the included four items, with an expected score of 1–5 per item and 4–20 for the total attitude score. Analysis of the internal consistency of the attitude scale showed Cronbach's $\alpha = 0.707$, and the mean \pm SD attitude score was 17.4 \pm 2.9 (range = 4–20) (Table 4). Bivariate correlations between the attitude and overall knowledge score showed Pearson's correlation coefficient $r = 0.524$ (p -value < 0.001). Knowledge score was higher among women who had one or two children (mean \pm SD = 56.4 \pm 8.1) compared to those who had no children (53.9 \pm 9.5) or those who had three or more (52.1 \pm 8.2), and the difference was statistically significant

($p = 0.022$). No other statistically significant association of knowledge about D.S. and D.S.S. was observed (Table 5).

Of the 178 participants aware of D.S.S. (178/434), 74.7% (132/178) had a favorable attitude; of those, 51.7% (92/178) were optimally, and 23.0% (40/178) were sub-optimally favorable, and the remainder were uncertain or had an unfavorable attitude. However, not statistically significant, maternal age of more than 40 and modest education levels were associated with favorable attitudes towards testing. For instance, 64.2% of women above 40 favored D.S.S. compared to less than 50% of women 40 years old and younger. Similarly, 66.7% of women with a general education level favor D.S.S. compared to those with a university degree or higher, where less than 50% favor D.S.S. No other notable association was observed (Table 6).

Discussion

Summary of findings

The present study showed that almost 60.0% of pregnant women attending antenatal clinics at K.A.U.H in Saudi Arabia have never heard of D.S.S, despite the sample's high educational level, comprising 71.2% of participants with a university education or higher. Furthermore, awareness was significantly lower among women between 30 and 40 years old and those with children. Of those who reported knowledge of D.S.S., the vast majority had a favorable attitude toward screening, with over two-thirds being optimally favorable to undertaking the screening.

Table 5 Factors associated with knowledge about D.S. and prenatal screening (N= 178)

Parameter	Category	Knowledge of D.S. and D.S. prenatal screening (score)		
		Mean	SD	p-value
Age (years)	20–30	54.8	9.2	0.174
	31–40	52.0	8.7	
	> 40	54.5	7.7	
Number of children	0	53.9	9.5	0.022*
	1–2	56.4	8.1	
	> 2	52.1	8.2	
Level of education	Up to Secondary	53.8	5.9	0.797
	Diploma	52.2	10.1	
	University	53.8	8.9	
	Higher education	55.2	10.6	
Residency location	City	53.6	8.7	0.237
	Rural area	56.1	8.4	
Previous children with D.S.	No	53.8	8.7	0.337
	Yes	58.0	8.9	
Another baby with congenital anomalies	No	54.0	8.8	0.436
	Yes	51.7	7.0	
Family history of congenital anomalies other than offspring	No	53.6	8.6	0.177
	Yes	56.3	9.4	
Knowledge source: obstetrician	No	52.8	9.2	0.125
	Yes	54.8	8.2	
Knowledge source: family physician	No	53.8	8.8	0.388
	Yes	57.2	5.8	
Knowledge source: relatives, friends	No	54.5	8.7	0.107
	Yes	52.1	8.5	
Knowledge source: internet	No	54.1	9.2	0.671
	Yes	53.5	7.8	

*, Statistically significant result ($p < 0.05$)

Awareness of prenatal screening

In our study, only 41% of the participants were aware of D.S.S., consistent with several international reports raising concerns about insufficient awareness, knowledge, and understanding of prenatal screening for D.S. in developing countries, resulting in a lower screening uptake than in developed countries. Lack of knowledge and awareness is partly responsible for the discrepancy in testing uptake between developing and developed countries rather than participants' demographics or belief differences.

In a study from other developing countries with similar sociodemographic makeup to Saudi Arabia, like Morocco, the vast majority of surveyed women did not know about D.S.S. and never heard of it. More than 85% voiced interest in pursuing screening when counseled about testing and its implications [24].

Knowledge of prenatal testing

In addition, we have shown in this study that even in conservative societies, parents' ability to accept testing is influenced by their knowledge level of the subject at hand, which is associated with a positive attitude toward

testing [20]. Factors that influenced the level of knowledge were maternal age and having children. There is higher awareness in women under 30, likely related to the generational effect, as younger people are more aware of medical advances due to unlimited access to online educational resources rather than relying on medical information from a healthcare professional.

We found that having children is associated with lower knowledge levels in the study population, contrary to reports from other developing countries where women with children were more likely to have higher knowledge [11]. This discrepancy is likely related to the implementation of national screening programs in these countries, highlighting the need for this kind of systematic education in Saudi Arabia.

While educational content needs to be tailored to accommodate cultural differences, it should enable informed decision-making, provide relevant information, and avoid excessive and complex details that may be discussed in individual cases. In addition, it must address positive result significance and options [20, 25]. The persisting probability of false positive results may add to the psychological distress and uncertainty of the concerned

Table 6 Factors associated with favorable attitude towards prenatal screening (N= 178)

Parameter	Category	Favorable attitude (optimal)		p-value
		N	%	
Age (years)	20–30	34	47.2	0.093
	31–40	24	45.3	
	> 40	34	64.2	
Number of children	0	27	51.9	0.913
	1–2	28	53.8	
	> 2	37	50.0	
Level of education	General education	22	66.7	0.200
	Diploma	7	53.8	
	University	54	49.5	
	Higher education	9	39.1	
Residency location	City	81	51.3	0.753
	Rural area	11	55.0	
Previous children with D.S.	No	89	51.1	0.622 ^F
	Yes	3	75.0	
Another baby with congenital anomalies	No	88	52.1	0.741 ^F
	Yes	4	44.4	
Family history of congenital anomalies other than offspring	No	82	52.2	0.691
	Yes	10	47.6	
Knowledge source: obstetrician	No	42	51.2	0.908
	Yes	50	52.1	
Knowledge source: family physician	No	90	52.0	0.674 ^F
	Yes	2	40.0	
Knowledge source: relatives, friends	No	68	52.3	0.785
	Yes	24	50.0	
Knowledge source: internet	No	58	49.6	0.435
	Yes	34	55.7	

F: Fisher's exact test.

parents, which may constitute another barrier to undertaking the test. This urges healthcare professionals to be more aware of the levels of accuracy and limitations of the available tests [11, 26].

Attitudes toward prenatal screening

In the present study, among the 178 aware women, attitudes were classified as being optimally favorable to prenatal screening if participants agreed with all four following statements (prenatal screening reduces the mother's anxiety, it provides helpful information to parents, it is valuable and recommendable, and they showed preparedness to uptake the screening in a future pregnancy.). They would be classified as suboptimally favorable if they agreed to three out of the four statements. Due to the positive correlation between knowledge and attitude, we conclude that participants with unfavorable attitudes might have a different position after further education and counseling. However, this needs to be examined in another study examining participants' attitudes before and after counseling.

To understand the general negative attitudes towards prenatal screening, it is essential to acknowledge the popular and religious beliefs regarding having a D.S.

child and the related ethical questions in religious communities. In Islamic societies, having a child with a congenital anomaly is considered God's will (Allah's will), which imposes acceptance and excludes the possibility of abortion. Consequently, some parents may be unfavorable to prenatal testing to avoid challenging their faith by anticipating Allah's decision [27, 28]. Philosophically, it is judicious to confront the advent of noninvasive prenatal screening tests for congenital anomalies with the dilemma of abortion practice and its social acceptance [29].

Limitations

The study is limited by the self-declared knowledge and the digital administration of the questionnaire on an electronic device, which may produce a selection bias, such as over-representing highly educated individuals.

Conclusion

Assessing awareness, exploring knowledge gaps, and understanding the attitudes among the population about D.S.S. is vital to promoting the early detection and management of D.S. There are low levels of awareness and knowledge among Muslim women about D.S.S. (41.0%)

of the sampled population having heard about it. Interestingly, those who reported awareness and knowledge have a generally positive attitude toward screening. Despite the participants' generally higher level of education (71.0%), the level of academic education did not appear to influence their awareness and knowledge of D.S.S., highlighting the need for systematic education programs involving all women and their partners about D.S.S. counseling and education. The content of the education programs should be appropriately designed to enable informed decision-making while addressing the common misconceptions and ethical questions concerning participants' faith, preference, and psychological sensitivity to prevent a reverse effect on their attitudes. Of note is that this integrative approach to parents' education should consider enhancing the counseling skills of physicians and healthcare providers.

Abbreviations

D.S.	Down Syndrome
D.S.S.	Down Syndrome Screening
K.A.U.H	King Abdulaziz University Hospital

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12905-024-03346-y>.

Supplementary Material 1

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Author contributions

Kholoud Arab (K.A.) and Lujain Halawani (L.H.) conceived and designed the study. L.H. collected data, and team members mentioned in the acknowledgment section. L.H. conducted the statistical analysis, and K.A. further validated and interpreted the results. K.A. and L.H. completed the first draft and then edited the draft for intellectual content. Finally, both K.A. and L.H. reviewed and approved the final version.

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Data availability

Research Data is available for reviewers upon request. Data is available by contacting the corresponding author, Dr. Kholoud Arab on kholoudarab@gmail.com.

Declarations

Ethics approval and consent to participate

The study protocol was reviewed and ethically approved by the Research Ethics Committee of King Abdulaziz University Hospital in accordance with the Declaration of Helsinki (Reference No: 710–20). Verbal and written consent were obtained during data collection. Subjects agreed to participate and publish the results. Informed consent to participate in the study was obtained from all participants for all forms of personally identifiable data, including biomedical, clinical, and biometric data.

Consent to publish

Not Applicable.

Competing interests

The authors declare no competing interests.

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References

- Enea-Drapeau C, Carlier M, Huguet P. Tracking subtle stereotypes of children with trisomy 21: from facial-feature-based to implicit stereotyping. *PLoS ONE*. 2012;7(4):e34369. <https://doi.org/10.1371/journal.pone.0034369>.
- Thompson JA. Disentangling the roles of maternal and paternal age on birth prevalence of down syndrome and other chromosomal disorders using a bayesian modeling approach. *BMC Med Res Methodol*. 2019;19(1):82. <https://doi.org/10.1186/s12874-019-0720-1>.
- Kazemi M, Salehi M, Kheirollahi M. Down Syndrome: current status, challenges and Future perspectives. *Int J Mol Cell Med*. 2016;5(3):125–33.
- Arumugam A, Raja K, Venugopalan M et al. Down syndrome—A narrative review with a focus on anatomical features. *Clin Anat*. 2016; 29.
- Diamandopoulos K, Green J. Down syndrome: an integrative review. *J Neonatal Nurs*. 2018.
- Bull MJ. Down Syndrome. *N Engl J Med*. 2020;382(24):2344–52. <https://doi.org/10.1056/NEJMra1706537>.
- Day SM, Strauss DJ, Shavelle RM, et al. Mortality and causes of death in persons with Down syndrome in California. *Dev Med Child Neurol*. 2005;47(3):171–6. <https://doi.org/10.1017/s0012162205000319>.
- Reid B, Sinclair M, Barr O, et al. A meta-synthesis of pregnant women's decision-making processes with regard to antenatal screening for Down syndrome. *Soc Sci Med*. 2009;69(11):1561–73. <https://doi.org/10.1016/j.socscimed.2009.09.006>.
- Dahl K, Hvidman L, Jørgensen FS, et al. Knowledge of prenatal screening and psychological management of test decisions. *Ultrasound Obstet Gynecol*. 2011;38(2):152–7. <https://doi.org/10.1002/uog.8856>.
- Wilmot HC, de Graaf G, van Casteren P, et al. Down syndrome screening and diagnosis practices in Europe, United States, Australia, and New Zealand from 1990–2021. *Eur J Hum Genet*. 2023;31(5):497–503. <https://doi.org/10.1038/s41431-023-01330-y>.
- Hill M, Johnson J-A, Langlois S, et al. Preferences for prenatal tests for Down syndrome: an international comparison of the views of pregnant women and health professionals. *Eur J Hum Genet*. 2016;24(7):968–75. <https://doi.org/10.1038/ejhg.2015.249>.
- Natoli JL, Ackerman DL, McDermott S, et al. Prenatal diagnosis of Down syndrome: a systematic review of termination rates (1995–2011). *Prenat Diagn*. 2012;32(2):142–53. <https://doi.org/10.1002/pd.2910>.
- AbdulAzeez S, Al Qahtani NH, Almandil NB, et al. Genetic disorder prenatal diagnosis and pregnancy termination practices among high consanguinity population, Saudi Arabia. *Sci Rep*. 2019;9(1):17248. <https://doi.org/10.1038/s41598-019-53655-8>.
- de Jong A, Dondorp WJ, de Die-Smulders CE, et al. Non-invasive prenatal testing: ethical issues explored. *Eur J Hum Genet*. 2010;18(3):272–7. <https://doi.org/10.1038/ejhg.2009.203>.
- Babay ZA. Attitudes of a high-risk group of pregnant Saudi Arabian women to prenatal screening for chromosomal anomalies. *East Mediterr Health J*. 2004;10(4–5):522–7.
- Youssef RENE, Elweshahi HMT, Ashry MH. Knowledge, attitudes and beliefs of women in the reproductive age towards prenatal screening for congenital malformations, Alexandria-Egypt. *Int J Reprod Contracept Obstet Gynecol*. 2017;6:1707–12.
- Seven M, Akyüz A, Eroğlu K, et al. Women's knowledge and use of prenatal screening tests. *J Clin Nurs*. 2017;26:1869–77.
- Brajenović-Milić B, Dorčić TM. Men's knowledge about maternal serum screening for Down Syndrome and their attitude towards Amniocentesis. *J Genet Couns*. 2017;26(1):141–9. <https://doi.org/10.1007/s10897-016-9989-y>.
- Pop-Tudose ME, Popescu-Spineni D, Armean P et al. Attitude, knowledge and informed choice towards prenatal screening for Down Syndrome: a cross-sectional study. *BMC Pregnancy Childbirth*. 2018; 18.
- Skirton H, Barr O. Antenatal screening and informed choice: a cross-sectional survey of parents and professionals. *Midwifery*. 2010;26(6):596–602. <https://doi.org/10.1016/j.midw.2009.01.002>.
- Wehbe K, Brun P, Gornet M, et al. DEPIST 21: information and knowledge of pregnant women about screening strategies including non-invasive

- prenatal testing for Down syndrome. *J Gynecol Obstet Hum Reprod.* 2021;50(7):102001. <https://doi.org/10.1016/j.jogoh.2020.102001>.
22. Yeniceri EN, Kasap B, Akbaba E, et al. Knowledge and attitude changes of pregnant women regarding prenatal screening and diagnostic tests after counselling. *Clin Exp Obstet Gynecol.* 2017;44(1):48–55.
 23. Bland JM, Altman DG. Statistics notes: Cronbach's alpha. *BMJ.* 1997;314(7080):572.
 24. Belahcen A, Taloubi M, Chala S, et al. Mother's awareness and attitudes towards prenatal screening for Down syndrome in Muslim moroccans. *Prenat Diagn.* 2014;34(9):821–30. <https://doi.org/10.1002/pd.4373>.
 25. Schoonen HM, Essink-Bot ML, Van Agt HM, et al. Informed decision-making about the fetal anomaly scan: what knowledge is relevant? *Ultrasound Obstet Gynecol.* 2011;37(6):649–57. <https://doi.org/10.1002/uog.8906>.
 26. van Schendel RV, Kleinveld JH, Dondorp WJ, et al. Attitudes of pregnant women and male partners towards non-invasive prenatal testing and widening the scope of prenatal screening. *Eur J Hum Genet.* 2014;22(12):1345–50. <https://doi.org/10.1038/ejhg.2014.32>.
 27. Bryant LD, Ahmed S, Ahmed M, et al. All is done by Allah'. Understandings of Down syndrome and prenatal testing in Pakistan. *Soc Sci Med.* 2011;72(8):1393–9. <https://doi.org/10.1016/j.socscimed.2011.02.036>.
 28. Choi H, Van Riper M, Thoyre S. Decision making following a prenatal diagnosis of Down syndrome: an integrative review. *J Midwifery Womens Health.* 2012;57(2):156–64. <https://doi.org/10.1111/j.1542-2011.2011.00109.x>.
 29. Kaposy C. A disability critique of the new prenatal test for Down syndrome. *Kennedy Inst Ethics J.* 2013;23(4):299–324. <https://doi.org/10.1353/ken.2013.0017>.

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