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Decision to abort after a prenatal diagnosis of sex chromosome abnormality: a systematic review of the literature

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We performed a systematic review of factors affecting parental decisions to continue or terminate a pregnancy after prenatal diagnosis of a sex chromosome abnormality, as reported in published studies from 1987 to May 2011. Based on the Matrix Method for systematic reviews, 19 studies were found in five electronic databases, meeting specific inclusion/exclusion criteria. Abstracted data were organized in a matrix. Alongside the search for factors influencing parental decisions, each study was judged on its methodological quality and assigned a methodological quality score. Decisions either to terminate or to continue a sex chromosome abnormality-affected pregnancy shared five similar factors: specific type of sex chromosome abnormality, gestational week at diagnosis, parents' age, providers' genetic expertise, and number of children/desire for (more) children. Factors unique to termination decisions included parents' fear/anxiety and directive counseling. Factors uniquely associated with continuation decisions were parents' socioeconomic status and ethnicity. The studies' average methodological quality score was 10.6 (SD = 1.67; range, 8–14). Findings from this review can be useful in adapting and modifying guidelines for genetic counseling after prenatal diagnosis of a sex chromosome abnormality. Moreover, improving the quality of future studies on this topic may allow clearer understanding of the most influential factors affecting parental decisions.

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Key Words: parental decisions; pregnancy outcome; prenatal diagnosis; sex chromosome abnormality; systematic review

INTRODUCTION

Sex chromosome abnormalities (SCAs), with an incidence of approximately 1 in 400 men and 1 in 650 women, represent one of the most common types of chromosome abnormalities observed in human fetuses.[1] SCAs refer to the presence of a superfluous or deficient X or Y chromosome and include 45,X (Turner syndrome), 47,XXY (Klinefelter syndrome), 47,XXX (Triple X syndrome), and 47,XYY karyotypes.[2]

Compared with other genetic disorders that result in a shortened lifespan and severe degeneration, the most common symptoms associated with SCAs are neither life-threatening nor severe. Symptoms among the less severe SCAs (Triple X syndrome and 47,XYY karyotypes) include learning difficulties, particularly verbal skills or language problems,[3] borderline low-to-normal intelligence quotient (IQ), and slightly shorter or taller stature.[4] Symptoms among the more severe SCAs (Turner and Klinefelter syndromes) include infertility, cardiac and kidney malformation (in Turner syndrome) and infertility, small testes, and problems with psychological development, lower IQ, and delayed speech development (in Klinefelter syndrome).[5]

Similar to many genetic disorders, SCAs can be detected through various prenatal tests, such as amniocentesis and chorionic villus sampling. Such ability to test prenatally comes with the need for parents to decide whether to continue or terminate the affected pregnancy.[6]

Relative to other autosomal abnormalities, SCAs have been associated with high abortion rates, despite their nonlife-threatening impact. In studies conducted by Christian et al.,[7] Hamamy et al.,[8] and Shaffer et al.,[9] findings pointed to abortion rates between 68 and 81% after a SCA diagnosis. Thus, it is important to understand the underlying factors which affect parents' decisions to continue or terminate a SCA-affected pregnancy.

To date, only a few studies have examined potential factors associated with parental decisions regarding a SCA-affected pregnancy. Factors identified thus far include the type of SCA, maternal age, religion, culture, socioeconomic status (SES), and the attitudes of the attending healthcare professionals.[10–12] Additionally, the scientific and clinical literatures exhibit a conspicuous absence of systematic reviews synthesizing relevant studies and assessing their methodological quality.[13,14] To improve evidence-based clinical practice to facilitate better prenatal care and genetic services, it is important to assess the literature regarding this topic.[15]

To the best of our knowledge, this report represents one of the first efforts to fill this review gap. The purpose of this study, therefore, is to answer the following questions through a systematic review of the extant literature: (1) What are the factors associated with a parental decision to terminate a pregnancy after detection of a SCA? (2) What are the factors associated with a parental decision to continue a pregnancy? (3) What

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is the methodological quality of the current body of literature examining SCA decision making by parents? A long-term goal of this review is to assist physicians, geneticists, genetic counselors, and other health professionals in educating and counseling parents about pregnancies affected by SCAs.

MATERIALS AND METHODS

Following Garrard's Matrix Method,[16] which provides guidelines for comprehensive searches and synthesis of findings in systematic literature reviews, we first identified peer-reviewed journal articles within five electronic databases (Medline, ERIC, PsycINFO, Annual Reviews, and CINAHL), using variations and combinations of MeSH terms with Boolean operators. These search terms included "sex chromosome abnormality," "prenatal diagnosis," "parental decisions," "pregnancy outcome," "pregnancy termination," "attitudes," "parents' attitude(s)," "decision-making," and "genetic counseling." An initial search retrieved 150 English-language articles from the databases' inception, till May 2011.

After screening these articles, we retained only those which met our inclusion/exclusion criteria. For inclusion, studies needed to (1) be published in a peer-reviewed journal; (2) be written in English; (3) have empirically examined either a specific type or all types of SCAs; and (4) have presented factors affecting parental decisions to abort or continue an affected pregnancy. Studies were excluded if they (1) published abstracts only, (2) did not examine either a specific type or all types of SCAs, or (3) did not describe factors affecting parental decision making regarding SCA. Finally, 19 publications met these inclusion/exclusion criteria and became this review's final sample.

After searching, we used a review matrix to organize the information abstracted from each article. The review matrix included information on study design, methods, study origin, the timing of data collection, types of SCAs, sample characteristics, data collection methods, measurement instruments, reporting of the data's validity and reliability, types of statistical analyses, rates of terminated pregnancies, factors associated with decisions to either continue or terminate a pregnancy, and the methodological quality score (MQS) assigned to each study (see **Table 1** for an abridged form of the review matrix).

When studies used more than one statistical technique to test for associations between specific factors and actual decisions, we reported the factors resulting from the more rigorous statistical tests. For instance, if a study used two analyses such as χ^2 and multiple regression, we reported the factors resulting from the multiple regression analysis. When extracting study findings for statistical significance, we used a critical level of probability of 0.05, even though some studies used a higher critical level, such as 0.10. In addition, when studies identified termination or continuation factors through both noninferential and inferential analyses, we report the factors assessed through both types of analyses.

We also assessed the quality and characteristics of every study's methodology and assigned to each a MQS. The criteria for the MQS were based on previous systematic literature reviews[30,31] and were developed by the research team to include the most appropriate criteria for this review. Specifically, we examined each study's design, methods, the sample's size, age and ethnicity, the use of measurement instruments, the reporting of data validity and reliability, the complexity (or robustness) of the statistical techniques, and whether factors were tested for statistical significance. The highest possible MQS was 20 points. A higher value for the MQS represents better methodological quality. The MQS criteria and the frequency distribution scoring for each component of the 19 reviewed studies are listed in **Table 2**.

RESULTS

Studies' characteristics

Nineteen studies met our inclusion/exclusion criteria. Seventeen studies used quantitative methods, and two used mixed methods. Studies were carried out world-wide: in the United States (n = 5), Turkey (n = 2), Canada (n = 1), Israel (n = 1), South Korea (n = 1), Taiwan (n = 1), Uruguay (n = 1), the United Kingdom (n = 1), France (n = 1), Switzerland (n = 1), Germany (n = 1), Hungary (n = 1), Italy (n = 1), and one publication from the European Union (the United Kingdom, France, Switzerland, Netherlands, and Germany). More than half of the reviewed studies (n = 14) were published between 2001 and 2010; five studies were published between 1987 and 2000. Seven of the 19 studies (37%) were published in the journal *Prenatal Diagnosis*, four were published in the *American Journal of Medical Genetics*, four reports were found in the *European Journal of Obstetrics & Gynecology, Reproductive Biology*, *Obstetrics & Gynecology*, and in the *Australian and New Zealand Journal of Obstetrics and Gynaecology*; two were published in *Genetic Counseling* and in the *Journal of Genetic Counseling*, one study was published in the *Southern Medical Journal,* and one in the *Journal of Korean Medical Science*.

Studies' findings

Several studies identified similar factors associated with both types of decisions: to terminate or to continue a SCA-affected pregnancy. The factors that were identical for both types of decisions were the type of SCA, parents' age, gestational week at diagnosis, number of children/desire for (more) children, and providers' genetic expertise. Factors such as parents' fear/anxiety and directive counseling received related only to decisions to abort an SCA-affected pregnancy. Also, finally, parents' SES and ethnicity were factors associated exclusively with decisions to continue an affected pregnancy, in the reviewed studies.

Because 47% of reviewed studies reported only descriptive data (frequencies or percentages) and more than half of studies (53%) reported both descriptive and statistical (inferential) data, we present both types of data as findings (identified as such in the text). Moreover, we present the factors according to their frequency of occurrence (most common factors, first). In the text, we do not discuss factors identified in only one study, but we do present them in the matrix (**Table 1**).

Factors associated with termination and continuation decisions

Type of SCA as a termination factor

Descriptive data: Type of SCA represented the most frequent factor associated with terminating a pregnancy, identified in more than half of the reviewed studies (57.9%).[3,8–10,18,20,22,23,27–29] Two specific types of SCAs, 45,X (Turner syndrome) and 47,XXY (Klinefelter syndrome), in particular, were associated with termination. Nine studies (47.4%)[8–10,18,20,23,27–29] indicated that parents with a Turner syndrome-affected fetus would be more likely to terminate the pregnancy, with an average termination rate of 76% (range: 33–100%). Seven studies (36.8%)[3,8–10,18,20,22] reported a diagnosis of Klinefelter syndrome led parents to decide to terminate the pregnancy, yielding an average termination rate of 61% (range: 44–85%). As an example, a study conducted by Sagi et al.[20] examined 60 cases from patient records in the 10 years between 1989 and 1998 and identified that all five pregnancies (100%) exhibiting 45,X (Turner syndrome) and 85% ($n = 7$) with 47,XXY (Klinefelter syndrome) were terminated. Moreover, Hamamy et al.[8] assessed 61 records of SCAs at the University Hospital of Geneva and found that, among SCAs, Turner syndrome led to the highest rate of pregnancy termination (100%) and Klinefelter syndrome, to the second highest rate of termination (73.9%).

Specifically, three reviewed studies (15.8%) reported that prognoses of infertility, cardiac and kidney malformations, psychological problems, and unexpected anomalies/severity led to pregnancy termination (manifestations associated with Turner and Klinefelter syndromes). In one of these studies, Mezei et al.[25] surveyed 20 women whose fetuses were diagnosed with SCA and reported that seven women claimed these prognoses as the main reason for termination. In a second study, Sagi et al.[20] interviewed parents using a semistructured questionnaire and found that parents were more likely to abort the SCA-affected pregnancies with similar prognoses. The third study by Meschede et al.[19] found pregnancy termination for Klinefelter syndrome was correlated with prognosis of an unexpected anomaly (commonly associated with this karyotype).

Inferential data: Among the reviewed studies that included inferential statistical analyses, four (21.1%)[7,24,25,27] also indicated Turner syndrome, Klinefelter syndrome, and 45,X mosaicism (a variation of Turner syndrome) were main factors associated with parental decisions to terminate an affected pregnancy. For example, Christian et al.[7] examined 169 retrospective patient medical records of SCA diagnosis and found that Turner and Klinefelter syndromes exhibited a statistically significant association with pregnancy termination ($P < 0.001$). Additionally, after reviewing 89 retrospective patient records in Hungary, Mezei et al.[25] concluded that "pregnancies with a diagnosis of the more severe 45,X and 47,XXY karyotypes were terminated more often than pregnancies with a diagnosis of the less severe 47,XYY and 47,XXX karyotypes ($P < 0.05$)." A study by Shaw et al.[27] reported that 45,X mosaicism was more strongly associated with termination of pregnancies than other types of SCA mosaicisms ($P < 0.004$).

Type of SCA as a continuation factor

Descriptive data: Thirteen reviewed studies (68.4%)[3,8–10,14,17–19,21,23,26–28] reported descriptive data identifying two specific types of SCAs (47,XXX (Triple X syndrome) and/or 47,XYY) as most frequently associated with decisions to continue a pregnancy after a SCA diagnosis. Among the 13 studies, 11[3,10,14,17–19,21,23,26–28] reported that 47,XXX (Triple X syndrome) was most likely to lead to an elective continuation of the pregnancy, with an average continuation rate of 68% (range: 50–100%). Eleven studies[8–10,14,17,19,21,23,26–28] indicated that 47,XYY was also associated with a high likelihood for continuation of an affected pregnancy (with an average continuation rate of 68%: range, 50–100%).

Inferential data: Three reviewed studies (15.8%)[7,24,25] running statistical tests also identified 47,XXX (Triple X syndrome) and 47,XYY as the main factors for continuing pregnancies. For example, a study carried out by Christian et al.[7] reviewed records between 1971 and 1997 and found that 47,XXX (Triple X syndrome) and 47,XYY had statistically higher rates of pregnancy continuation than Turner or Klinefelter syndrome ($P < 0.001$). Moreover, these authors reported mosaic karyotypes as associated with pregnancy continuation—"18 of 36 (50%) pregnancies with mosaic SCA were continued compared with 25 of 72 (35%) pregnancies with nonmosaic SCA ($P < 0.20$)."

Parents' age as a termination factor

Descriptive data: Five reviewed studies (26.3%)[8,24,26,28,29] pointed to maternal age as a factor associated with the decision to terminate an SCA-affected pregnancy. Among these studies, four identified younger women (≤36 years) as more likely to terminate their pregnancies. Research by Quadrelli et al.,[26] for instance, examined 52 SCA diagnoses in the genetic unit of the Hospital Italiano in Uruguay and reported that women of young maternal age (mean = 32.6 ± 5.2 years) were more likely to terminate their pregnancy compared with those who were older (mean = 36.4 ± 4.4 years). The study conducted by Balkan et al.[29] also revealed that women who were of younger maternal age (mean = 32.6 ± 6.7 years) elected to terminate their pregnancies at higher rates than older women (mean = 35.4 ± 5.3 years). Hamamy et al.,[8] however, reported in their study that women would be more likely to terminate the pregnancy if their age was 36.8 years (older maternal age).

Inferential data: Two reviewed studies (10.5%) also indicated that young maternal age (≤36 years) was a factor for terminating pregnancy and assessed this through statistical significance testing. The study by Shaffer et al.[9] evaluated 147 cases of SCA retrospectively in the United States and found that women younger than 35 years were more likely to end their affected pregnancies, when compared with women older than 35 years. Moreover, Holmes-Siedle et al.[10] reported that not only younger mothers were more likely to terminate a pregnancy (36 vs. 39 years) but also fathers who were of a young age (35–36 years) were more likely to decide in favor of termination, when compared with fathers aged 40–41 years ($P < 0.05$).

Table 1 Matrix of reviewed studies (by publication date)

Authors	Study design/ sample/data	Types of sex chromosome abnormality	Data analysis	Rate of pregnancy termination (%)	Continuation factors for the pregnancy: uncontrolled analysis[a]	Continuation factors for the pregnancy: controlled analysis[b]	Termination factors for the pregnancy: uncontrolled analysis[a]	Termination factors for the pregnancy: controlled analysis[b]
Holmes-Siedle et al.[10]	The United Kingdom 1979–1984 Retrospective Quantitative *n* = 40 Patient records	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), 47,XYY, and 45,X mosaicism	Bivariate	62.5%	Specific types of SCA	Maternal age Number of children Providers and availability of genetic counseling	Specific types of SCA	Maternal age Number of children Providers and availability of genetic counseling
Verp et al.[3]	The United States January 1977–June 1986 Retrospective Quantitative *n* = 17 Patient records	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), 47,XYY, and 46,XX Autosomal abnormalities: trisomy 21, 18, 13 Supernumerary markers (11q), (G), Inv (13), reciprocal translocation (balanced) (5;11), and deletion 14p	Bivariate	41.2%	Specific types of SCA		Specific types of SCA	
Robinson et al.[17]	The United States 1989 Cross-sectional Quantitative *n* = 327 Data from author responded to each by counseling either parents or referring professionals (physician and genetic counselor)	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), 47,XYY, and mosaicism	Bivariate	33.6%	Specific types of SCA	Providers and availability of genetic counseling		Providers and availability of genetic counseling
Vincent et al.[18]	The United States 1986 Retrospective Quantitative *n* = 26,950 Patient records	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), 47,XYY, and mosaicism Autosomal abnormalities: trisomy 21, 18, 13, and mosaicism 47,+mar and de novo	Bivariate	31.8%	Specific types of SCA		Specific types of SCA	
Meschede et al.[19]	Germany 1989–1997 Cross-sectional Quantitative *n* = 55 Patient records	Klinefelter (47,XXY), Triple X syndrome (47,XXX), 47,XYY, and mosaicism (47,XXY/46,XY, 47, XYY/46,XY,47,XXX/46,XX)	Descriptive	12.7%	Specific types of SCA Providers and availability of genetic counseling		Severe symptoms Gestational week	

[a]Factors were not tested for statistical significance. [b]Factors were tested for statistical significance.

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Table 1 Continued

Authors	Study design/ sample/data	Types of sex chromosome abnormality	Data analysis	Rate of pregnancy termination (%)	Continuation factors for the pregnancy: uncontrolled analysis[a]	Continuation factors for the pregnancy: controlled analysis[b]	Termination factors for the pregnancy: uncontrolled analysis[a]	Termination factors for the pregnancy: controlled analysis[b]
Christian et al.[7]	Canada 1971–1997 Retrospective Quantitative *n* = 169 Patient records	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), 47,XYY, and mosaicism	Bivariate	68.4%		Specific types of SCA		Specific types of SCA
Sagi et al.[20]	Israel 1989–1998 Cross-sectional Mixed *n* = 60 Patient records	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), 47,XYY, and mosaicism	Bivariate	80%			Specific types of SCA Severe symptoms Parent's fear/ anxiety Providers and availability of genetic counseling	
Kim et al.[21]	South Korea 1992–2001 Retrospective Quantitative *n* = 25 Patient records	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), 47,XYY, and mosaicism	Bivariate	40%	Specific types of SCA Gestational week	Providers and availability of genetic counseling	Gestational week	Providers and availability of genetic counseling
Marteau et al.[22] (DADA study group)	The United Kingdom, Germany, Netherland, France, Switzerland 1986–1997 Retrospective Quantitative *n* = 111 Patient records	Klinefelter (47,XXY)	Univariate/ multivariate logistic regression	44%	Specific types of SCA Maternal age Socioeconomic Number of children	Providers and availability of genetic counseling Gestational week	Specific types of SCA Number of children	Providers and availability of genetic counseling Gestational week
Forrester et al.[23]	The United States 1986–1999 Retrospective Quantitative *n* = 205 Patient records	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), 47,XYY, and mosaicism	Bivariate	28%	Specific types of SCA		Specific types of SCA	

[a]Factors were not tested for statistical significance. [b]Factors were tested for statistical significance.

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Table 1 Continued

Authors	Study design/ sample/data	Types of sex chromosome abnormality	Data analysis	Rate of pregnancy termination (%)	Continuation factors for the pregnancy: uncontrolled analysis[a]	Continuation factors for the pregnancy: controlled analysis[b]	Termination factors for the pregnancy: uncontrolled analysis[a]	Termination factors for the pregnancy: controlled analysis[b]
Brun et al.[24]	France 1991–2001 Retrospective Quantitative *n* = 98 Patient records	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), and 47,XYY	Bivariate	55%	Maternal age Gestational week Socioeconomic Ethnicity Number of children	Specific types of SCA	Maternal age Gestational week	Specific types of SCA
Hamamy et al.[8]	Switzerland 1980–2001 Retrospective Quantitative *n* = 61 Patient records	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), 47,XYY, and mosaicism	Bivariate	72.1%	Specific types of SCA	Number of children	Specific types of SCA Maternal age Parent's fear/ anxiety	Number of children
Mezei et al.[25]	Hungary 1990–2001 Retrospective Quantitative *n* = 89 Patient records	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), 47,XYY, and mosaicism	Bivariate	55%		Specific types of SCA	Severe symptoms Providers and availability of genetic counseling	Specific types of SCA
Shaffer et al.[9]	The United States 1983–2003 Retrospective Quantitative *n* = 833 Patient records	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), 47,XYY, and autosomal abnormalities: trisomy 21, 18, 30	Bivariate/ multivariate logistic regression	81%	Specific types of SCA Ethnicity	Maternal age	Specific types of SCA	Maternal age
Clementi et al.[14]	Italy 1997–2000 Retrospective Quantitative *n* = 52 Patient records	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), 47,XYY, and mosaicism	Bivariate	13.5%	Specific types of SCA Providers and availability of genetic counseling		Parent's fear/ anxiety	
Quadrelli et al.[26]	Uruguay 1982–2003 Cross-sectional Quantitative *n* = 52 Patient records	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), and 47,XYY	Bivariate	21%	Specific types of SCA Maternal age Gestational week		Maternal age Gestational week	

[a]Factors were not tested for statistical significance. [b]Factors were tested for statistical significance.

Table 1 Continued on next page

Table 1 Continued

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Shaw et al.[27]	Taiwan 1991–2005 Retrospective Quantitative *n* = 57 Patient records	Turner (45,X), Klinefelter (47,XXY), Triple X syndrome (47,XXX), 47,XYY, and mosaicism	Bivariate	47.4%	Specific types of SCA	Specific types of SCA Providers and availability of genetic counseling	Specific types of SCA Providers and availability of genetic counseling	Specific types of SCA
Yilmaz et al.[28]	Turkey 2002–2007 Retrospective Quantitative *n* = 9 Patient records	Turner (45,X), Klinefelter (47,XXY) Triple X syndrome (47,XXX), and 47,XYY	Descriptive	44.4%	Specific types of SCA Maternal age Gestational week Providers and availability of genetic counseling Number of children		Specific types of SCA Maternal age Gestational week Providers and availability of genetic counseling Number of children	
Balkan et al.[29]	Turkey 2004–2007 Retrospective Mixed *n* = 10 Patient records	Turner (45,X), Klinefelter (47,XXY), and Triple X syndrome (47,XXX)	Descriptive Qualitative analysis	60%	Specific types of SCA Maternal age Gestational week Number of children		Specific types of SCA Maternal age Number of children Qualitative If mother's health is at risk or if the baby is deformed The severity of abnormality and religiosity	

[a]Factors were not tested for statistical significance. [b]Factors were tested for statistical significance.

Table 2 Methodological characteristics and frequency distribution of each criterion among 19 reviewed studies

Methodological characteristics	Scoring options (maximum total score = 20 points)	Distribution of characteristics among 19 reviewed studies[a] Frequency (*n*)	Percentage
Study design	Cross-sectional design = 1 point	4	21.1
	Retrospective design = 2 points	15	78.9
	Prospective design = 3 points	0	0
Study methods	Quantitative methods or qualitative methods = 1 point	17	89.5
	Mixed methods = 2 points	2	10.5
Sample size	Small sample (<50) = 1 point	5	26.3
	Medium sample (>50 and <100) = 2 points	9	47.4
	Large sample (>100) = 3 points	5	26.3
Age	Not reported = 0 point	6	31.6
	Reported = 1 point	13	68.4
Ethnicity	Not reported = 0 point	13	68.4
	Reported = 1 point	6	31.6
Theoretical framework	Not reported = 0 point	19	100
	Reported = 1 point	0	0
Data validity testing	Not reported = 0 point	19	100
	Reported = 1 point	0	0
Data reliability testing	Not reported = 0 point	19	100
	Reported = 1 point	0	0
Data analysis	Qualitative analyses (content analysis and thematic analysis) = 1 point	0	0
	Univariate statistics/ descriptive = 1 point	3	15.8
	Bivariate statistics/ ANOVA = 2 points	14	73.7
	Multiple/logistic regression/ ANCOVA = 3 points	2	10.5
	Multivariate statistics (structural equation modeling) = 4 points	0	0
Factors affecting parental decision	Factors were identified, but not tested for statistical significance = 1 point	9	47.4
	Factors were identified and tested for statistical significance = 2 points	10	52.6

ANCOVA, analysis of covariance; ANOVA, analysis of variance.
[a]The frequency and percentages were calculated based on 19 reviewed studies.

Parents' age as a continuation factor

Descriptive data: If younger mothers are more likely to abort a SCA-affected pregnancy, older mothers are more likely to continue the pregnancy, according to five (26.3%)[22,24,26,28,29] of the reviewed studies. Brun et al.,[24] for instance, retrospectively analyzed 98 SCA cases and found that older women (≥37 years) were more likely to choose to continue the pregnancy. In addition, Yilmaz et al.,[28] after reviewing nine SCA patient records in Turkey, reported that women of older maternal age (≥34 years) were more likely to continue their affected pregnancies.

Inferential data: Two reviewed studies (10.5%)[9,10] tested the association between parents' age and pregnancy continuation, finding that women who were older (≥36 years) were more likely to continue the pregnancy. For instance, Holmes-Siedle et al.[10] found that older mothers (age: 39 years) and fathers (age: 40–41 years) were significantly more likely to continue an affected pregnancy, when compared with 36-year-old mothers and 35–36-year-old fathers (at a probability level of ≤0.001).

Gestational week at diagnosis as a termination factor

Descriptive data: Six of the 19 reviewed studies (31.6%)[19,21,24,26,28,29] indicated that gestational week at SCA diagnosis was associated with the termination of the pregnancy, but findings were inconsistent. Among these six studies, four[24,26,28,29] documented that a shorter gestational period was associated with a decision to terminate the pregnancy. The study conducted by Balkan et al.,[29] for instance, analyzed 10 patient records and identified that women with shorter gestational periods (mean = 17.8 ± 3.4 weeks) were more likely to electively choose termination than those with longer gestational periods (mean = 19.1 ± 3.8 weeks). Yilmaz et al.[28] also reported similar findings. However, two studies[19,21] documented higher likelihood of termination associated with longer gestational periods. For example, Kim et al.[21] retrospectively analyzed 25 patient records in the 10 years between 1992 and 2001 and found that women with longer gestational periods (mean = 19.4 ± 3.6 weeks) decided to terminate their SCA-affected pregnancies, when compared with those with shorter gestational periods (mean = 17.5 ± 2.6 weeks).

Inferential data: One reviewed study also found that gestational week at SCA diagnosis was a factor for terminating a pregnancy and assessed this through statistical significance testing. Marteau et al.[22] found that women with a shorter gestational period (<20 weeks) were most likely to decide to terminate, when compared with gestational periods of 20–24 weeks ($P < 0.05$).

Gestational week at diagnosis as a continuation factor

Descriptive data: There was no clear pattern of association between gestational week at diagnosis and decision to continue a pregnancy. Five reviewed studies (26.3%)[21,24,26,28,29] reported that women who were further along in their pregnancies (>17 weeks) were more likely to continue the pregnancy. Brun et al.,[24] for example, assessed patient records in the 11 years between 1991 and 2001 and found that women at or above 17 weeks of gestation at diagnosis tended to continue the pregnancy more often than women at or below 16 weeks. However, Kim et al.[21] (between 1992 and 2001) identified that women with shorter gestational periods (≤18 weeks) were more likely to continue their pregnancies.

Inferential data: Similar to the descriptive data obtained by Kim et al.,[21] Marteau et al.[22] identified a short gestational period (<20 weeks) as positively associated with decisions to continue a SCA-affected pregnancy. Marteau et al.[22] also identified women with shorter gestational periods (<20 weeks) as being more likely to continue an affected pregnancy, when compared with those who were farther along (between 20 and 24 weeks) ($P < 0.05$).

Number of children or desire for (more) children as a termination factor

Descriptive data: Whether parents already had children was one of the factors influencing their decision to terminate a pregnancy after diagnosis (documented in three reviewed studies; 15.8%).[22,28,29] Among these studies, two (9.5%) indicated that parents who had one child or more tended to terminate their currently affected pregnancies. The study by Yilmaz et al.,[28] for instance, analyzed retrospective data for 6 years (2002–2007) and found that couples who already had a child would be more likely to terminate their pregnancies. Additionally, Balkan et al.[29] examined retrospective data in Turkey and found that women who had five children were more likely to end the pregnancy, when compared with women who had four children. Conversely, a retrospective and multinational study conducted by Marteau et al.[22] claimed that parents who decided to terminate their pregnancy had no children, whereas parents who had one or more children opted for continuation.

Inferential data: Two reviewed studies (10.5%) statistically tested whether number of live children was associated with decisions to terminate a SCA-affected pregnancy. Holmes-Siedle et al.[10] reported that couples with few previous children (mean = 0.8) were more likely to terminate their pregnancies than couples with more children (mean = 1.53); ($P < 0.05$). However, Hamamy et al.[8] found that couples who had a mean number of previous children of 1.3 (either with prior or current partners) were significantly more likely to terminate the pregnancy ($P < 0.05$).

Number of children or desire for (more) children as a continuation factor

Descriptive data: Desire to have children affected parental decisions to continue a SCA-affected pregnancy in four reviewed studies (21.1%).[22,24,28,29] These four studies indicated that parents' desire for children was positively associated with their decision to continue the pregnancy. For example, Balkan et al.[29] assessed retrospective data between 2004 and 2007 and reported that parents who wanted more children were more likely to continue their pregnancies. In addition, Marteau et al.[22] identified that parents who had more than one child were more likely to continue the SCA-affected pregnancy.

Inferential data: Two reviewed studies (10.5%)[8,10] also indicated—through inferential statistical analyses—that parents' desire for children was a factor for pregnancy continuation. After reviewing 61 patient records between 1980 and 2001, Hamamy et al.[8] found that parents' desire to have more children was more likely to lead to a continuation of the pregnancy than parents' desire to have fewer children ($P < 0.05$).

Providers' genetic expertise as a termination factor

Descriptive data: None of the reviewed studies provided descriptive data regarding providers' genetic expertise and its influence on parents' decision making.

Inferential data: Four reviewed studies (21.1%)[10,17,21,22] pointed to genetic counseling provided by nongeneticists as associated with a likelihood of terminating an affected pregnancy. In one of these studies, Marteau et al.[22] examined 111 cases of Klinefelter syndrome in five countries (the United Kingdom, France, Switzerland, the Netherlands, and Germany) and found that women who were counseled by nongeneticist health professionals, such as obstetricians or pediatricians, were significantly more likely to terminate an affected pregnancy than those counseled by a geneticist ($P < 0.01$).

Providers' genetic expertise as a continuation factor

Descriptive data: Three studies (15.8%)[14,19,28] identified genetic counseling sessions involving a genetic specialist as a factor affecting parents' decisions to continue a SCA-affected pregnancy. For instance, Meschede et al.[19] examined 55 patient records between 1989 and 1997 and found that genetic counseling by a geneticist led to a continuation of the pregnancy.

Inferential data: Five reviewed studies (26.3%)[10,17,21,22,27] identified that genetic counseling provided by genetic specialists was associated with a likelihood of continuing an affected pregnancy. For example, a study carried out by Kim et al.[21] found that if genetic counseling was provided by an MD geneticist, parents would be more likely to continue their pregnancies than if counseling was offered by an obstetrician ($P < 0.001$). Similarly, Shaw et al.[27] assessed 57 retrospective patient records between 1991 and 2005 and found that genetic counseling by perinatologists was significantly more likely to lead to the continuation of the pregnancy ($P < 0.048$).

Factors associated exclusively with termination decisions

Parents' fear/anxiety

Descriptive data: Three reviewed studies (15.8%)[8,14,20] reported parents' fear as a factor associated with the termination of a SCA-affected pregnancy. For example, after reviewing 60 cases from patient records in Israel, Sagi et al.[20] identified that the fear of abnormal development among children would more likely lead parents to elect pregnancy termination. Moreover, Clementi et al.,[14] who analyzed 52 cases, ascertained that fear of unexpected anomalies caused parents to terminate the pregnancy.

Inferential data: None of the reviewed studies statistically tested whether parents' fear/anxiety was significantly associated with decisions to terminate SCA-affected pregnancies.

Directive counseling

Descriptive data: Four reviewed studies (21.1%)[20,25,27,28] revealed that counseling directiveness was a factor influencing parental decisions to terminate pregnancy. In one of these studies,

Sagi et al.[20] showed that if genetic counseling was geared toward providing information about terminating the pregnancy, women were more likely to do so. Additionally, Mezei et al.[25] identified 12 women who reported that counseling affected their decision to terminate the pregnancy due to the type of information provided.

Inferential data: None of the reviewed studies statistically tested whether directive counseling was significantly associated with decisions to terminate SCA-affected pregnancies.

Factors associated exclusively with continuation decisions

Parents' SES

Descriptive data: SES was related to the continuation of pregnancy in two reviewed studies (10.5%),[22,24] but findings were inconsistent. The study conducted by Marteau et al.[22] reported that middle-class parents decided in favor of continuing the pregnancy, when compared with working-class parents. However, in the research by Brun et al.,[24] parents with low SES were likely to electively continue the pregnancy more often than those with middle and high SES.

Inferential data: None of the reviewed studies statistically tested whether SES was significantly associated with decisions to continue SCA-affected pregnancies.

Ethnicity

Descriptive data: In two studies (10.5%), ethnicity was a factor associated with the continuation of the pregnancy; however, the findings, once again, were inconsistent. For example, Shaffer et al.[9] retrospectively analyzed 147 patient records in the 21 years between 1983 and 2003 and found that Hispanic parents were more likely to continue their SCA-affected pregnancies than parents from other ethnic backgrounds, such as whites, African Americans, or Asians. However, the study conducted by Brun et al.[24] found that white parents were the ones more likely to continue their pregnancies.

Inferential data: None of the reviewed studies statistically tested whether ethnicity was associated with decisions to continue SCA-affected pregnancies.

Methodological quality of the reviewed studies (MQS)

According to the criteria we used to assess the methodological quality of each reviewed study (**Table 2**), the average MQS was 10.6 (SD = 1.67), within a theoretical range of 4–20 points (actual MQS range, 8–14 points). Most reviewed studies used quantitative data analyses (89.5%) with a retrospective design (78.9%). Two studies (10.5%) used a mixed-methods design (quantitative and qualitative). Regarding sample size, almost half of the studies (47.4%) had medium-sized samples ($50 < n < 100$). Regarding age and ethnicity, 13 studies (68.4%) described participants' age, but ethnicity was not present in 68.4% of the reports. None of the studies were based on a theoretical framework (100%). All researchers (100%) used their own instrument to measure potential factors affecting parental decision making. Zero studies reported validity and reliability of their own data. Fourteen reports (73.7%) used bivariate statistics/analysis of variance. Although more than half of reviewed studies (52.6%) also tested the association between factors and decisions to terminate or continue a SCA-affected pregnancy using statistical tests, only two (10.5%)[9,22] reported use of multiple/logistic regression to assess findings related to decision making. The majority of studies used and reported uncontrolled (less robust) statistical analyses.

DISCUSSION

Based on the findings from the 19 studies we reviewed, this systematic review identified nine factors associated with terminating or continuing a SCA-affected pregnancy. Among the nine factors, five are common to both termination and continuation decisions, including specific type of SCA, parents' age, gestational week at diagnosis, providers' genetic expertise, and number of children/desire for (more) children. The factors uniquely associated with decisions to abort were parents' fear/ anxiety and directive counseling. Conversely, the factors uniquely associated with decisions to continue a pregnancy were parents' SES and ethnicity.

Among all identified factors, the specific type of SCA was the most frequently reported variable influencing both pregnancy termination and continuation. Specifically, if parents learned their fetuses had Turner or Klinefelter syndrome, they would be more likely to terminate the pregnancy. Such decision is, most likely, influenced by parents' concerns about the specific symptoms associated with these two types of SCA and their fear/anxiety about these symptoms. The potential for infertility, cardiac and kidney malformations, sexual underdevelopment, cognitive or learning difficulties, and reduced IQ generate concerns about the children's future. Conversely, because the other types of SCAs—Triple X syndrome and 47,XYY—only cause mild-to-moderate medical conditions, including speech or language problems and borderline low-to-normal IQ, parents might be less likely to terminate pregnancies carrying these "milder" types of SCAs.

Most of the factors the reviewed studies identified cannot be changed through educational or counseling efforts; however, the information provided by healthcare providers and genetic counselors can be improved. In the reviewed studies, if pregnant women received genetic counseling from genetics specialists, they were more likely to continue their SCA-affected pregnancies, compared with women receiving counseling from nonspecialists. This may be the case because, potentially, parents will trust experts on the topic more often than they will trust nonexperts.[32] Given that providers with genetics knowledge are better informed about the details of each syndrome and tend to espouse more positive attitudes toward SCAs, parents may feel more comfortable dealing with a SCA-affected pregnancy if they are being supported by expert knowledge. In other words, nongeneticist healthcare professionals may lack the appropriate genomic education training and have outdated knowledge about SCAs; it is conceivable they might be prone to delivering more negative information to parents.[33] To provide parents better quality genetic counseling services, healthcare

professionals who do not have specialized genetics knowledge need to be updated and exposed to appropriate information regarding SCAs.[33,34]

Additionally, from the reviewed studies, we learn that if parents receive directive counseling recommending termination, they are more likely to abort their SCA-affected pregnancies. It is worth noticing that although nondirective counseling is hard to practice, healthcare providers should attempt not to bring their own judgments and values into the genetic counseling sessions. Nondirective counseling leads to better-informed decision making and should be emphasized in the training for those providing genetic counseling and education.[35]

Another identified factor amenable to change is parents' fear/anxiety. Parents' fear/anxiety can be managed through genetic counseling and pregenetic counseling health education. Genetic counseling can provide parents correct information regarding SCAs and dispel misconceptions; this may lead to subsequent reduction of many of their fears and anxieties.[14,35,36] Topics to be included in the counseling process that may help alleviate parents' fear/anxiety include a discussion of potential abnormalities and possible treatment options for SCAs. Information and connection to support systems, such as health centers in local areas and support groups of families with children affected by the same or similar chromosomal abnormalities, might prove useful resources for coping with fear and anxiety.[2] Moreover, given that SCAs represent complex genetic disorders, pregenetic counseling health education can increase parents' baseline knowledge of genetics, so they can better understand genetic jargon and terminology, when going through brief genetic counseling sessions.[37]

It is worth noting that although gestational week at diagnosis, parents' age, number of children/desire for (more) children, parents' fear/anxiety, SES, and ethnicity are important factors influencing termination and/or continuation of SCA-affected pregnancies, findings from our reviewed studies do not show consistent patterns of associations. Such inconsistency could be the result of noncontrolled statistical analyses and/or poorly designed studies. To better understand the mechanisms linking specific factors and parental decisions whether to terminate or continue the pregnancy, researchers need to be more wary of noncontrolled statistical analyses and conduct more inferential analyses. Thus, further studies are needed, using more sophisticated designs and analytical techniques.

The absence of robust study designs and statistical analyses highlights the overall quality of this body of research. The mean MQS of 10.6 indicates a below-average quality relative to our criteria (a theoretical average of 12 and a theoretical range of 4–20 points). It is also worthy of notice that none of the reviewed studies scored 20 points, and the highest MQS score observed was 14.

Also regarding methodological quality, reviewed studies share important common weaknesses. A salient weakness is the absence of qualitative studies examining parents' experiences with decision making when confronted with a prenatal diagnosis of SCA. Qualitative studies, with in-depth, rich, or "thick data" focusing on the tensions, the uncertainties, and the interplay among the complex factors that affect decision making are curiously absent from this literature. Another methodological weakness is the consistent use of a retrospective design. Because parental decisions regarding a SCA-affected pregnancy involve complex psychological and emotional responses, using a retrospective design may entail important recall biases. Longitudinal designs would allow for better interpretation and richer data.

Also a weakness is the lack of reporting on ethnicity in the reviewed studies (68.4%). Ethnicity can influence the decision regarding a SCA-affected pregnancy because of the different cultural values espoused by certain ethnic or cultural groups. Granted, assessing ethnicity does not reveal the complex influences of cultural values, but it serves as a proxy measure most researchers can easily use.

A further weakness is the absence of reporting on data reliability and validity. Conclusions may have been based on error-laden data;[38] but readers cannot make inferences about the quality of the data, absent the information on their validity/reliability.

Finally, none of the reviewed studies adopted a theoretical framework to design their survey questionnaires. The absence of a theoretical framework in such studies can lead to investigations with misplaced foci: studies that measure trivial factors and ignore salient ones (so defined by theories).[39]

Despite its contribution to the body of knowledge on SCAs and parental decision making regarding affected pregnancies, this review carries two limitations. First, we limited our search to studies published in English, thus we may have omitted important studies published in other languages. Second, to assess the methodological quality of this literature, we adapted the MQS criteria used in previous systematic reviews. Our MQS criteria, therefore, may have biased the review findings in a more rigorous direction. This rigor refers to a preference for quantitative over qualitative studies and a preference for more complex statistical analyses over findings that are merely descriptive.

Concluding, in this systematic literature review, we reported a number of factors associated with parental decisions to terminate or continue a SCA-affected pregnancy. Although most of the identified factors cannot be modified through educational efforts, a few of them are amenable to change. Healthcare providers, for instance, can make a concerted effort to update their knowledge of SCAs. They can also be trained to provide nondirective and culturally sensitive counseling regarding SCAs, specifically. Finally and most importantly, researchers must be alerted to the dire need for additional research on this topic—research of superior theoretical and methodological quality—to equip scientists, clinicians, and public health workers, with a stronger knowledge base from which to build their services.

DISCLOSURE

The authors declare no conflict of interest.

REFERENCES

1. Hassold T, Abruzzo M, Adkins K, et al. Human aneuploidy: incidence, origin, and etiology. *Environ Mol Mutagen* 1996;28:167–175.
2. Linden MG, Bender BG, Robinson A. Genetic counseling for sex chromosome abnormalities. *Am J Med Genet* 2002;110:3–10.

3. Verp MS, Bombard AT, Simpson JL, Elias S. Parental decision following prenatal diagnosis of fetal chromosome abnormality. *Am J Med Genet* 1988;29:613–622.
4. Ratcliffe S. Long-term outcome in children of sex chromosome abnormalities. *Arch Dis Child* 1999;80:192–195.
5. Linden MG, Bender BG. Fifty-one prenatally diagnosed children and adolescents with sex chromosome abnormalities. *Am J Med Genet* 2002;110:11–18.
6. Tachdjian G, Frydman N, Morichon-Delvallez N, et al. Reproductive genetic counselling in non-mosaic 47,XXY patients: implications for preimplantation or prenatal diagnosis: Case report and review. *Hum Reprod* 2003;18:271–275.
7. Christian SM, Koehn D, Pillay R, MacDougall A, Wilson RD. Parental decisions following prenatal diagnosis of sex chromosome aneuploidy: a trend over time. *Prenat Diagn* 2000;20:37–40.
8. Hamamy HA, Dahoun S. Parental decisions following the prenatal diagnosis of sex chromosome abnormalities. *Eur J Obstet Gynecol Reprod Biol* 2004;116:58–62.
9. Shaffer BL, Caughey AB, Norton ME. Variation in the decision to terminate pregnancy in the setting of fetal aneuploidy. *Prenat Diagn* 2006;26:667–671.
10. Holmes-Siedle M, Ryynanen M, Lindenbaum RH. Parental decisions regarding termination of pregnancy following prenatal detection of sex chromosome abnormality. *Prenat Diagn* 1987;7:239–244.
11. Schechtman KB, Gray DL, Baty JD, Rothman SM. Decision-making for termination of pregnancies with fetal anomalies: analysis of 53,000 pregnancies. *Obstet Gynecol* 2002;99:216–222.
12. Drake H, Reid M, Marteau T. Attitudes towards termination for fetal abnormality: comparisons in three European countries. *Clin Genet* 1996;49:134–140.
13. Mansfield C, Hopfer S, Marteau TM. Termination rates after prenatal diagnosis of Down syndrome, spina bifida, anencephaly, and Turner and Klinefelter syndromes: a systematic literature review. European Concerted Action: DADA (Decision-making After the Diagnosis of a fetal Abnormality). *Prenat Diagn* 1999;19:808–812.
14. Clementi M, Di Gianantonio E, Ponchia R, Petrella M, Andrisani A, Tenconi R. Pregnancy outcome after genetic counselling for prenatal diagnosis of unexpected chromosomal anomaly. *Eur J Obstet Gynecol Reprod Biol* 2006;128:77–80.
15. Khan K, Kunz R, Kleijnen J. *Systematic Reviews to Support Evidence-Based Medicine: How to Review and Apply Findings of Healthcare Research*. Royal Society of Medicine Press: London, 2003.
16. Garrard J. *Health Sciences Literature Review Made Easy: The Matrix Method*, 2nd edn. Jones and Bartlett Publishers: Sudbury, MA, 2006.
17. Robinson A, Bender BG, Linden MG. Decisions following the intrauterine diagnosis of sex chromosome aneuploidy. *Am J Med Genet* 1989;34:552–554.
18. Vincent VA, Edwards JG, Young SR, Nachtigal M. Pregnancy termination because of chromosomal abnormalities: a study of 26,950 amniocenteses in the southeast. *South Med J* 1991;84:1210–1213.
19. Meschede D, Louwen F, Nippert I, Holzgreve W, Miny P, Horst J. Low rates of pregnancy termination for prenatally diagnosed Klinefelter syndrome and other sex chromosome polysomies. *Am J Med Genet* 1998;80:330–334.
20. Sagi M, Meiner V, Reshef N, Dagan J, Zlotogora J. Prenatal diagnosis of sex chromosome aneuploidy: possible reasons for high rates of pregnancy termination. *Prenat Diagn* 2001;21:461–465.
21. Kim YJ, Park SY, Han JH, et al. Parental decisions of prenatally detected sex chromosome abnormality. *J Korean Med* Sci 2002;17:53–57.
22. Marteau TM, Nippert I, Hall S, et al. Outcomes of pregnancies diagnosed with Klinefelter syndrome: the possible influence of health professionals. *Prenat Diagn* 2002;22:562–566.
23. Forrester MB, Merz RD. Pregnancy outcome and prenatal diagnosis of sex chromosome abnormalities in Hawaii, 1986–1999. *Am J Med Genet* 2003;119A:305–310.
24. Brun JL, Gangbo F, Wen ZQ, et al. Prenatal diagnosis and management of sex chromosome aneuploidy: a report on 98 cases. *Prenat Diagn* 2004;24:213–218.
25. Mezei G, Papp C, Tóth-Pál E, Beke A, Papp Z. Factors influencing parental decision making in prenatal diagnosis of sex chromosome aneuploidy. *Obstet Gynecol* 2004;104:94–101.
26. Quadrelli R, Quadrelli A, Mechoso B, Laufer M, Jaumandreu C, Vaglio A. Parental decisions to abort or continue a pregnancy following prenatal diagnosis of chromosomal abnormalities in a setting where termination of pregnancy is not legally available. *Prenat Diagn* 2007;27:228–232.
27. Shaw SW, Chueh HY, Chang SD, Cheng PJ, Hsieh TT, Soong YK. Parental decisions regarding prenatally detected fetal sex chromosomal abnormality and the impact of genetic counselling: an analysis of 57 cases in Taiwan. *Aust N Z J Obstet Gynaecol* 2008;48:155–159.
28. Yilmaz Z, Sahin FI, Bulakbasi T, Yüregir ÖÖ, Tarim E, Yanik F. Ethical considerations regarding parental decisions for termination following prenatal diagnosis of sex chromosome abnormalities. *Genet Couns* 2008;19:345–352.
29. Balkan M, Kalkanli S, Akbas H, Yalinkaya A, Alp MN, Budak T. Parental decisions regarding a prenatally detected fetal chromosomal abnormality and the impact of genetic counseling: an analysis of 38 cases with aneuploidy in Southeast Turkey. *J Genet Couns* 2010;19:241–246.
30. Goodson P, Buhi ER, Dunsmore SC. Self-esteem and adolescent sexual behaviors, attitudes, and intentions: a systematic review. *J Adolesc Health* 2006;38:310–319.
31. Chen LS, Goodson P. Factors affecting decisions to accept or decline cystic fibrosis carrier testing/screening: a theory-guided systematic review. *Genet Med* 2007;9:442–450.
32. Marteau T, Drake H, Bobrow M. Counselling following diagnosis of a fetal abnormality: the differing approaches of obstetricians, clinical geneticists, and genetic nurses. *J Med Genet* 1994;31:864–867.
33. Hall S, Abramsky L, Marteau TM. Health professionals' reports of information given to parents following the prenatal diagnosis of sex chromosome anomalies and outcomes of pregnancies: a pilot study. *Prenat Diagn* 2003;23:535–538.
34. Suther S, Goodson P. Barriers to the provision of genetic services by primary care physicians: a systematic review of the literature. *Genet Med* 2003;5:70–76.
35. Statham H. Prenatal diagnosis of fetal abnormality: the decision to terminate the pregnancy and the psychological consequences. *Fetal Matern Med Rev* 2002;13:213–247.
36. Schmid M, Drahonsky R, Fast-Hirsch C, Baumühlner K, Husslein P, Blaicher W. Timing of referral for prenatal genetic counselling. *Prenat Diagn* 2009;29:156–159.
37. Kardia SL, Wang C. The role of health education and behavior in public health genetics. *Health Educ Behav* 2005;32:583–588.
38. Patrick DL, Beery WL. Measurement issues: reliability and validity. *Am J Health Promot* 1991;5:305–310.
39. Goodson P. *Theory in Health Promotion Research and Practice: Thinking Outside the Box*, 1st edn. Jones and Bartlett Publishers: Sudbury, MA, 2010.