Can We Make Assumptions About the Psychosocial Impact of Living as a Carrier, Based on Studies Assessing the Effects of Carrier Testing?

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Received: 31 March 2010 / Accepted: 1 September 2010 / Published online: 29 September 2010
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Abstract Receiving the results of genetic carrier testing may have an impact on the psychosocial health of the individual. Numerous studies have been conducted to assess the psychosocial effects of carrier status for a range of conditions. To systematically review research focused on the psychological and social impact of carrier testing on individuals in order to identify factors affecting the impact of carrier testing results, and discern areas where further research is needed. Twenty relevant papers meeting criteria for inclusion in this review were found. The main themes identified across these studies included: anxiety, guilt and stigmatization, effect on family relationships, effect on self image, active coping mechanisms and reproductive issues. Variables related to the psychosocial effect of carrier testing included whether the carrier has an affected child, mode of inheritance, genetic counseling, and life stage. A key finding concerns carriers who already have an affected child; they are more likely to experience guilt and self-blame, and change their reproductive plans compared to carriers without affected children. Additionally, some participants reported clinical features of the disorder for which they were being tested. Genetic counselors may erroneously assume that parents with affected children are aware of their own carrier status in the absence of testing, and they may offer inadequate support. Additionally, counselors should attempt to address patient misconceptions related to their health and carrier status.

Keywords Systematic review · Carrier testing · Genetic · Psychosocial · Genetic counseling

Introduction

Variations in genetic material are inherent in all humans. While many of these variations do not change the protein product for which the gene codes, others may have a more deleterious effect (Adkison and Brown 2007). In autosomal or X linked recessive conditions, one normal copy of the gene is usually sufficient to ensure the protein product is not adversely affected; however if individuals are heterozygous, having one normal and one mutated copy of the gene, they are said to be a “carrier” of the condition. The offspring of carriers could be at risk of inheriting the disease. A woman carrying an X linked recessive condition, such as fragile X or Duchenne muscular dystrophy, could pass the condition to her children (usually her sons) but in the case of autosomal recessive conditions, such as cystic fibrosis or thalassaemia, both parents need to be carriers of the same disease for their children to be at risk. Fragile X does differ from most other X linked conditions because premutation carriers [individuals with 55 to 200 CGG repeats (Kronquist et al. 2008)] can be mildly affected by the condition, can present with late-onset
fragile X-associated tremor/ataxia syndrome (FXTAS) (Reis et al. 2008), and have an increased risk of premature ovarian failure (Hunter et al. 2008).

The term “carrier” is also used to describe individuals who have a balanced chromosome translocation. The translocation does not affect their own health, but their children could inherit an unbalanced form of the translocation that could have an adverse phenotypic effect (Meza-Espinoza et al. 2008).

Because of the potential reproductive implications of carrier status, individuals who are aware they could be carriers may wish to be certain of their own status. Carrier testing for a range of genetic diseases has been offered to individuals with a family history of the condition, or through community based screening programs in particular ethnic groups, for example community based screening for Tay Sachs disease in the Ashkenazi Jewish population conducted since the 1970’s (Kaback et al. 1993). Population carrier testing has also been offered either regionally or nationally, for conditions including cystic fibrosis, thalassaemia and fragile X (Hartley et al. 1997; Kaufman et al. 2008; Metcalfe et al. 2008; Sangkitporn et al. 2004; Zlotogora et al. 2009).

Numerous studies have assessed the psychosocial impact of carrier testing and living as a carrier (Anido et al. 2005; Childs et al. 1976; Kenen and Schmidt 1978; McConkie-Rosell et al. 2001). As early as 1976, Childs et al. highlighted a number of emotional issues experienced by carriers including anxiety, self-stigmatization, and concern for offspring. Since then, other studies have assessed the impact of carrier testing in relation to a number of variables such as the particular condition (Anido et al. 2005), the mode of inheritance (James et al. 2006), the population being screened (Axworthy et al. 1996) and the impact of gender (Marteau et al. 1997). We conducted a systematic review to synthesize this body of knowledge. Carriers of fragile X were included in the review because a body of knowledge exists relating to the psychosocial effect of carrier testing on this group (Anido et al. 2007; Anido et al. 2005; McConkie-Rosell et al. 2000; McConkie-Rosell et al. 2001). Because female fragile X carriers can sometimes be affected by the condition, although in general more mildly, fragile X does differ from autosomal recessive and some other X linked conditions. However, because we were trying to ascertain similarities and differences across a range of different conditions, we felt it was relevant to include this group in the systematic review.

Specifically, the aim of this systematic review was to answer the following questions: (1) What are the factors affecting the impact of carrier testing results on individuals? (2) What is the methodological quality of the body of literature examining the psychosocial effects of carrier testing? (3) Can we make any assumptions about the psychosocial impact of living as a carrier, based on studies assessing the impact of carrier testing?

Methods

In conducting this systematic review the methods described by Pope et al. (2007) which involve using specific search parameters, defining inclusion and exclusion criteria, and undertaking quality appraisal of the studies that are included, were used as a guide. Due to the wide range of methods, conditions and samples in the studies reviewed, we did not conduct a meta-analysis of the data.

Search Methods

The following databases were searched: CINAHL, Embase, Ovid, Medline, PsychINFO, Pubmed and Web of Science, using the following search terms:
carrier testing or carrier test* or carrier screening or genetic screening or population screening or cascade testing or heterozygote testing AND genetic or DNA or chromosome or autosomal recessive or recessive or X-linked AND depression or emotion or guilt or anxiety or worry or stress or blame or psychological or psychosocial or social or effect or impact or psychological impact or social impact or personal or carrier status or distress or relief or burden or coping or coping strategy or communication or coping behavior* or emotion* or stigma or self concept or attitude* or psychology or social adaptation or reproductive uncertainty or risk perception or genetic counselling or genetic counseling or carrier couples or family planning or prospective risk AND NOT children NOT cancer NOT prenatal NOT predictive.

Limits were set on publication dates (January 1990 to May 2010), language (English), and population (Human; Age: Adult.).

An author search and an ancestral search (reference search) were also carried out after relevant studies were identified. Keywords from relevant studies found this way were fed back into the search terms to ensure the search was thorough.
Inclusion and exclusion factors

Studies were included if they were:

- systematic reviews, literature reviews randomized controlled trials, quasi-experiments, observational studies, surveys or qualitative studies
- published between January 1990 to May 2010. We included studies published from 1990 onwards as around this time DNA carrier testing became feasible clinically for patients with a family history of recessive and X-linked conditions (Broide et al. 1993; Kerem et al. 1989). At the same time, studies that assessed the impact of the test on the patient began to appear in the literature
- focused on the psychological and social impact of the test result on the patient
- focused on either autosomal recessive and X linked conditions, or carriers of chromosomal changes such as translocations.

Studies were excluded if they were:

- about cancer, adult onset conditions or other dominantly inherited conditions, because the nature of the information derived from these tests will be different from receiving carrier information for recessive, X-linked or chromosomal conditions
- ones in which there was potential for participants to find out that they were homozygotes for a particular gene mutation where the age of onset of the disease was in adulthood (e.g., hemochromatosis)
- focused on pregnant women because their feelings may be influenced by worry for their offspring, and also because their decision to seek testing would be influenced by the immediate needs of a current pregnancy (Cheuvront et al. 1998)
- ones that included children or adolescents because it is likely that they will have very different psychosocial reactions and information needs than adults
- focused only on recall of information about risk
- focused only on motivation for taking/not taking the test.

Search Outcome

The literature search generated 1694 articles for consideration. Following exclusion based on title and abstract, the full text of 41 articles was retrieved. An ancestral and an author search identified 10 further studies. After reading the papers in full, 31 studies were excluded because they did not meet the inclusion criteria, leaving 20 relevant studies to be included in the systematic review. There were substantial differences in construct, design, measures, population and outcomes across the studies. In this section we cite one example of each particular design, measure or outcome studied. Table 1 contains a more detailed report of the characteristics of each study. Thirteen studies were quantitative, three were qualitative and four were mixed methods. Study designs comprised longitudinal studies (Bekker et al. 1994), randomised controlled trials (Callanan et al. 1999), and cross sectional studies (Dunn et al. 2008). Samples from different populations including the general population (Henneman et al. 2002), high risk groups (McConkie-Rosell et al. 2001) of Jewish decent (Marteau et al. 1992) and women only (Anido et al. 2005) were included. Sample size varied from eight participants (Anido et al. 2007) to 2220 participants (Honnor et al. 2000). Data collection methods varied from questionnaires (Bekker et al. 1994), to focus groups (Anido et al. 2005) and in-depth interviews (Williams and Schutte 1997). Various measures were used, including the Spielberger State-Trait Anxiety Inventory (STAI) (Spielberger et al. 1970), the Health Orientation Scale (HOS) (Wooldridge and Murray 1988) and the Tennessee Self Concept Scale (TSCS) (Fitts and Warren 1996). In two cases the same cohort of participants was involved in two studies, however because different findings were presented in the different papers, both studies were included in the review (Cheuvront et al. 1998; Newman et al. 2002).

Quality Appraisal

Each study was assessed using a quality appraisal tool developed by Kmet et al. (2004). The Kmet scale enables assessment of both qualitative and quantitative studies. This tool has proven internal validity and provides a systematic, reproducible and quantitative means of simultaneously assessing the quality of research encompassing a broad range of study designs. Using this tool, the first author scored each paper based on quality criteria including the description of the research question, appropriateness of design, justification of sampling strategy, appropriate data collection and analysis and estimates of variance (for quantitative studies) to produce a score phrased as a percentage. Five papers across the range of scores were selected and a blind appraisal was made by the second author to verify the results. The papers were ranked in the same order by both appraisers.

All 20 papers scored greater than 60% on the Kmet scale (range between 63% to 95%; median 81%) and therefore none were excluded on the basis of quality (Kmet et al. do not provide a 'cut-scale' at which studies
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<td>Avdo et al. 2007</td>
<td>To explore the attitudes towards FX mutation testing among women identified from the general population.</td>
<td>Qualitative, in-depth interviews. Eight women from the general population of reproducive ages, who had been identified as FX carriers. Aged 20-44.</td>
<td>Semi-structured qualitative in-depth interviews were conducted in person, one by phone. Topic guides consisted of twenty-eight questions covering topics including testing experience, premature ovarian failure, affect of information on relationships and family planning.</td>
<td>Interpretive phenomenological analysis. Tapes transcribed. Researching primary patients in data noted. After independent analysis, team members compared their assessment to discuss clarification of themes.</td>
<td>Women were strongly unprepared for positive carrier results. For many carriers the information was not received at this stage of their lives in terms of family planning and personal relationships. Many expressed the information could be delivered in the future. For majority, providing information to family was not problematic. Providing information to a partner depended on understandings of relationships. Based on information came in a sequence but for most women was not quickly out of mind.</td>
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<td>Avdo et al. 2005</td>
<td>To identify issues related to carrier testing and population screening for preconception carrier women.</td>
<td>Qualitative, Focus groups. General population and women from families with FX from Atlanta, aged 25-90. Forty focus group participants. Ten women per focus group.</td>
<td>Focus groups were audio and video recorded. Questions included: How would you describe your first reaction to getting results? Did your test result cause you to take any action or make decisions about your life plans? Did you react the way you expected? Findings compared. Themes then compared to existing literature to determine novel findings.</td>
<td>Thematic analysis. Tapes transcribed. Primary patterns noted and classified into themes. Data analyzed independently then findings compared. Themes then compared to existing literature to determine novel findings.</td>
<td>Nearly all carriers from FX families reported some sort of guilt experience. Reactions of guilt expressed equally strongly—relief for carriers in terms of finding diagnosis, and relief for non-carriers. Anxiety dissipated either immediately or over a few months. Carrier status led to reconsideration of life plans. Adolescents exposed to experiences of guilt experienced by several carriers. Timing of carrier testing with respect to a woman's life stage and views on abortion differentiate whether the information on carrier status will be seen as beneficial or detrimental.</td>
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<td>Bredler et al. 1992</td>
<td>To evaluate the short term effects of information received on psychological adjustment to carrier status.</td>
<td>Longitudinal, study. Self-completed postal questionnaire completed at three time points.</td>
<td>Adults between 18-45 years, from a general population in London, England, were randomized to either a treatment or a control group. Thirty-five participants were approached (100% retention). Full data received from 427 women and 14 men.</td>
<td>Questionnaires at three time points: before testing, upon receiving results, three months later. SF-36 used to assess anxiety. Six interviews with carriers six months after receiving test results.</td>
<td>MANOVA Univariate analysis. No information on how interview data were analyzed. Results of study had no effect on perceived impact of carrier status. Those who received a positive result were more anxious over a period of time. Anxiety as a result of carrier status may be more than simply a reflection of the information itself.</td>
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<td>Collman et al. 1999</td>
<td>To identify risk perceptions, psychological status and reproductive plans of carrier by non-carrier couples.</td>
<td>Randomized controlled trial comparing conventional education and testing with clinic education and testing.</td>
<td>CF carrier testing offered to 100 partners of previously identified carriers of CF. Fifty-seven participants were tested. Participants: 16 years, not pregnant, living in the study clinic area in North Carolina. Participants randomly assigned to either clinic or home screening.</td>
<td>Survey during interval between partners' testing and receiving results six months later. SF-36 used to measure anxiety and personality trait. Positive and negative effects measured using PANSAS.</td>
<td>Paired comparison t-test. Descriptive statistics used to summarize data. Results showed no significant differences between the two groups. Both groups showed a decrease in anxiety score six months after completion of testing. Anxiety score in non-carriers increased over time, while no significant change was observed in carrier groups.</td>
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<td>Chestnut et al. 1998</td>
<td>To assess psychological and knowledge outcomes of targeted educational intervention to CF gene-positive education and carrier testing.</td>
<td>Randomized controlled trial comparing: (1) education and testing with clinic education and testing. (2) education and testing with home screening.</td>
<td>Two hundred and ninety-nine accept offer of free education and testing, aged 18-45 years (majority between 25-45 years). Participants were relatives of people with CF living in North Carolina. Participants randomly assigned into two groups before being contacted: those assigned to the clinic (93) and those assigned to education and testing at home (296).</td>
<td>Participants completed a baseline telephone interview and completed a questionnaire at two time points: while waiting for their test results and immediately after learning their test results. SF-36 used to measure anxiety.</td>
<td>Data analyzed using SUDAAN software for clustered samples. Using chi2 (p&lt;0.05) was considered significant. No significant differences in terms of positive or negative affect on anxiety while waiting for results or after results were known as a result of where person had been educated and tested. Nonstatistically significant differences on any of the outcome measures based on carrier status (anxiety, positive and negative affect, satisfaction with education and testing arrangements).</td>
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Dom et al. 2008

A descriptive study which aims to report adult carriers' and their husbands' perspectives of carrier diagnosis for haemophilia A and B

Carriers registered on the Katherine Dom study Haemophilia Centre database at the Royal Free, London. Two hundred and ninety-five carriers identified aged 18-65 and were interviewed face to face. Sixty-six carriers responded. Mean age 42; 76% were in a relationship and 78% of their husbands/partners completed the questionnaire.

Questionnaires influenced by Systematic Theory. Included yes/no, multiple choice, control scenarios, ranking and open ended questions.

Most of the data analysis was descriptive, where appropriate a Student's t-test or a Mann-Whitney non-parametric test was used and a value of p < 0.05 was considered statistically significant.

Carriership was considered an issue by both groups at two key points: 34% once their relationship had become serious and 28% once they had been diagnosed with haemophilia. Thirty-eight percent of carriers said the timing of the test had a negative effect on them. Reasons cited were fear of losing their partner, personal identity, feelings of being blamed by their partner and a prolonged sense of guilt. Where timing was seen as positive (22%) it was because of feeling completely accepted by their husband/partner despite the diagnosis. Forty percent reported a negative effect on the husband/partner, 15% reported a positive effect. Carriers' perception of the effect on their husband ranged from loss of support to anxiety and anger. Self-assessments of both carriers and husbands/partner showed the effects had mostly been negative (22%).

Fennos and Ionesson 1995b

To explore levels of understanding and feelings about carrier status and genetics of CF in affected families.

Mixed method study. Qualitative interviews and questionnaire to measure anxiety and depression, and knowledge of CF.

Eighty-four individuals interviewed including 54 adult CF siblings and 30 spouses. Of the 54 interviewed siblings, 45 had been tested and nine had not at the time of the interview. Participants ranged in age from 3-55 years. Twenty-six were male siblings and 28 female siblings. They were recruited through the Genetics Department at Children's Hospital, Oakland, CA.

Semi-structured face to face interviews including: What was your reaction to the results? Were they what you had expected at different stages? Scales were developed for various categories capturing important aspects of family functioning and psychosocial adjustment. Questionnaires included anxiety and depression scales from Hopkins checklist.

Inter-rater reliabilities obtained for interview codes. Hypotheses analyised using t-test. Results showed no relationship between guilt and family functioning explored through a Pearson's correlation.

Fifty-three percent (53%) of CF siblings assessed were carriers before testing and were neither upset nor surprised by positive results. Those with a negative result were relieved. For those that did not assume they were carriers, a positive result did not come as a shock as they knew there was a strong possibility they were identified carriers and non-carriers were equally likely to have moderate to severe anxiety around their child's health.

Carriers felt more afraid, worse, sicker, less relaxed, less happy, more worried and cuddly than test-negative individuals. However there was no difference on the guilt, reduced ability to function and health scale. No difference was found between carriers and non-carriers relating to feeling guilty, reduced ability to function and health scale. Carriers did not have a poorer perception of their current health than non-carriers. Carriers described more positive feelings about themselves when they considered their own result compared to feelings they attributed to most carriers'.

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Giardini et al. 2002

To explore levels of understanding and feelings about carrier status and genetics of CF in affected families.

An assessment of CF knowledge and emotional consequences of CF in a population testing 18 months after screening.

Cross-sectional study. Self-completed postal questionnaire survey.

English speaking individuals aged 18-50 years who presented for testing were invited to complete a questionnaire. Participants ranged in age from 18 to 55 years. Twenty-six were male siblings and 28 female siblings. They were recruited through the Genetics Department at Children's Hospital, Oakland, CA.

All individuals who had been tested were sent a consecutive sample. Questionnaire contained the EOC.

Eighteen months after testing follow-up questionnaires were sent to a consecutive sample. Questionnaire contained the EOC.

Significance level for test set at 0.001

Recruitment of individuals aged 18-50 years, through GP or Municipal Health Service between 1994-2000. Five hundred and fifty-five couples gave written consent to CF testing after education. Testing was voluntary. Eighteen carriers identified, Partners tested negative. Response rate for completion of all three questionnaires was 17 carriers, 15 partners with negative test results and 964 other participants.

Three self-administered questionnaires at three time points, Time One = before genetic education and counselling, Time Two = before receiving test results, Time Three = six months after receiving test results.

t-test or Fisher exact test, P values of p < 0.05 considered significant. Multiple logistic regression.

Carriers felt more afraid, worse, sicker, less relaxed, less happy, more worried and cuddly than test-negative individuals. However there was no difference on the guilt, reduced ability to function and health scale. No difference was found between carriers and non-carriers relating to feeling guilty, reduced ability to function and health scale. Carriers did not have a poorer perception of their current health than non-carriers. Carriers described more positive feelings about themselves when they considered their own result compared to feelings they attributed to most carriers'.
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<td>Horner et al., 2000</td>
<td>Acceptance of carrier testing for CF in the community when offered in a primary care setting.</td>
<td>Longitudinal, self-completed postal questionnaire survey at two time points (pre and post-test).</td>
<td>Five thousand one hundred and two individuals aged 35-69 years, recruited through 26 general practices and a family planning clinic in Western Australia, completed questionnaires at Time One. Two thousand, two hundred and twenty (43.5%) took tests. 69 carriers identified. Response rate at three to six months follow up was 58.4%</td>
<td>Two questionnaires administered at two time points. Time One — before testing and both before and after receiving information about CF. Time Two three to six months after receiving test results. STAI was used to measure anxiety at both time points.</td>
<td>X2 test used to compare proportions and odds ratios (OR) and 95% confidence intervals (CI) were calculated using SPSS.</td>
<td>There were no significant differences between number of carriers and non-carriers: patients and test-negative individuals or test-negative and asymptomatic individuals for State Anxiety Inventory scores.</td>
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<td>James et al., 2006</td>
<td>A survey of family members with chronic granulomatous disease and Duchenne Becker muscular dystrophy and spinal muscular atrophy types II/III.</td>
<td>Cross-sectional study. Self-completed postal questionnaire survey.</td>
<td>Recruitment of adults aged 18 years or older was through US registries, participants in other studies and patient organizations. Consisted of 112 members of 51 families (69% response) with granulomatous disease and 56 members of 35 families with Duchenne Becker muscular dystrophy and spinal muscular atrophy types II/III.</td>
<td>Cross-sectional mail survey of adults with conditions mentioned. Included Multiscale Depression Inventory and the HPS.</td>
<td>X2 tests Two-tailed tests Mann-Whitney U-statistic and linear regressions.</td>
<td>Mothers carrying X-linked conditions were more worried about risks to future generations than mothers carrying recessive conditions. X-linked mothers were more likely to feel guilty (both currently and in the past) and blame themselves. X-linked fathers blamed their child's mother and X-linked mothers felt more blamed by fathers. There were no differences in level of guilt or self-blame between autosomal recessive mothers and fathers. X-linked family members were more likely to consider being a carrier stigmatizing. Participants reported less levels of guilt during the study. Carriers felt anxious one week after receiving test results. Only one newly diagnosed at the three months follow-up. Seven out of ten carriers felt relieved one week after receiving test results. None of the participants, including carriers, preserved themselves as being less healthy after receiving the test results. Sixty-eight percent felt relieved at Time Three, and 62% at Time Four. Four participants, including two carriers, were disappointed once a week after receiving test results at Time Three, but none were disappointed at Time Four three months follow-up. Four other respondents reported feelings of disappointment at Time Four, including two non-carrier patients of CF carriers. Twenty-seven percent of participants stated they would have considered not having more children if found to be in a carrier couple, although majority reported...</td>
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A study to determine how carriers of a recessive gene for Tay-Sachs perceived their health related to non-carriers.

Cross sectional study. Self-completed postal questionnaire survey.

Three groups screened for Tay-Sachs. One group recruited from cultural exhibitions for Jewish community, another through the mail synagoge, the third group included relatives (down and non-Jewish) of previously affected children and previously identified carriers as well as persons identified by routine screening. Twenty-seven carriers and 55 non-carriers responded to the questionnaire. Mean age: 29 years minus carriers and 37.5 years (carriers).

Questionnaire including three questions from SF-36 Health Status Questionnaire and two questions developed for the study. Multiple choice questions.

F test for statistical comparison of proportions.

A study of women at risk to inherit the FX mutation.

Mixed methods, longitudinal study at two time points. Interview included open and closed questions.

Women all had 50% of being a carrier. Study sample: 42 Caucasian women 26 carriers and 16 non-carriers from 17 families. Women aged 18-21 years, mean age 20.9 years, 80% married and 71% had at least one child. All women had a family member diagnosed with the condition.

Questionnaire including Fragile X VAS developed by principle investigator and test colleagues, and structured interview with open and closed ended questions including: How do you feel about your carrier status?" 


A study to explore self-concept of women at risk for inheriting the FX mutation.

Mixed methods, longitudinal study at two time points (before testing and six months after). Interview included open and closed questions.

Women all had 50% of being a carrier. Study sample: 42 Caucasian women 26 carriers and 16 non-carriers from 17 families. Women aged 18-21 years, mean age 20.9 years, 80% married and 71% had at least one child. All women had a family member diagnosed with the condition.

Questionnaire including Tennessee Self-Concept Scale Fragile X VAS. Structured interview consisting of 50 questions including: Has finding out your carrier status changed the way you view yourself?


No differences between the three groups in how they perceived their current health. Concerning current health with health status two years previously showed no differences between the groups. Groups differed in their expectations about future health. Carriers of Tay-Sachs held the least optimistic view of their future health compared to the other two groups. Carriers were less optimistic about their risk of developing something wrong in the future.

Being at risk was upsetting, frightening and scary. At Time Two non-carriers reported feeling happy, relieved, grateful. Relief related to no longer having to worry about their children or grandchildren’s risk. Carriers said they were upset and concerned, mainly for their children, grandchildren or own reproduction. Fifty-five percent used active coping statements as discussing feelings about being a carrier. Possible “survivor guilt” reported by one non-carrier. Significant difference between carrier and non-carrier at Time Two was result after combined perceptions of the non-carrier women. Women who were carriers were equally as upset learning their risk status as knowing that they were in fact carriers. Carriers said initially learning carrier status was upsetting. Carriers reported an improvement in level of upset at Time Two. At Time Two non-carriers viewed condition as more serious than at Time One.

No evidence of diminished social self-related to non-carriers or to actual carrier status at Time One and Two on Tennessee Self-Concept Scale. Fifty-nine percent of the non-carriers reported feeling better after five months using the Fragile X VAS. An analysis Scale. There was no evidence that being at risk or being a carrier altered perception of health. Some anecdotal evidence to suggest that carriers at Time Two believed they had mild clinical features of FX. Carriers did not report feeling worse about themselves than they had reported at Time One. The difference between carriers and non-carriers at Time Two occurred because non-carriers felt better about themselves and not because the carriers felt worse.
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<td>McCookie-Rossel et al., 1997</td>
<td>A study of carrier women of the FX syndrome to assess their own experiences and attitudes regarding carrier testing.</td>
<td>Mixed methods study using interview and focus group interview.</td>
<td>Twenty-eight female carriers were recruited through the Fragile X Clinic at Duke University Medical Centre. All women had undergone genetic counseling and all knew they were carriers. Twenty-five participated carriers, mean age 41.8 years, mean number of children 2.25, mean number of years since diagnosis 15.9 years.</td>
<td>Structured interview with open and closed ended multiple choice questions at one time point. Questions were asked regarding family history, diagnosis, and medical and family relationships. Also included an 11 item VAS.</td>
<td>Descriptive univariate analysis. Fisher's Exact test in the case of 2x2 frequency tables or Student's t-test for differences between means.</td>
<td>Sixty-seven percent felt knowing about the disease had changed their plans about their family. Eighty-nine percent felt that if they had known earlier they would have either reduced the size of their family or not have had biological children. Eighty-five percent said they would have used prenatal diagnosis. Seventy-six percent said learning they were carriers had changed the way they viewed themselves, 75% in a positive way, 47% in a negative way. Subjects reported that over time there was a decrease in the intensity of the negative feelings associated with first learning carrier status. Eighty-seven percent indicated they did not feel guilty, however, were sometimes angry or depressed and would change their carrier status if they could. Sixty-four percent noted a change in relationships with siblings.</td>
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<td>Newman et al. 2002 (same cohort as Chervenak 1998)</td>
<td>To assess how gender as well as carrier testing arrangements (male and female) affects carrier testing experience.</td>
<td>Randomized controlled trial comparing carrier education and testing.</td>
<td>Two hundred and ninety-nine women were randomized to either education and testing.</td>
<td>Participants completed a baseline telephone interview, and completed a questionnaire at two time points, while waiting for their test results.</td>
<td>All reported regression analysis were conducted using SUDAAN software for clustered samples.</td>
<td>Women reported higher anxiety than men on the STAI administered at baseline but not at follow-up. Men tended to describe themselves with more positive adjectives than women while waiting for test results.</td>
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<td>Parno et al. 2008</td>
<td>A study assessing female FX carrier women.</td>
<td>Longitudinal, self completed postal questionnaire survey at two time points.</td>
<td>Female participants who had been diagnosed with dysmorphic features and had a family history of FX were excluded. Twenty women completed a questionnaire at baseline and 17 were non-carriers and one carrier completed the questionnaire in three months.</td>
<td>Self-administered questionnaires at baseline and three months after learning test results.</td>
<td>Exact Mann-Whitney U. Health Orientation Scale, McNeiner tests.</td>
<td>Perception of the seriousness of FX carrier status increased three months after learning they were not a carrier but did not reach statistical significance. Non-carriers thought they would be more angry and depressed than they felt themselves three months after testing. Self-esteem of non-carriers was essentially unchanged three months after learning they were not carriers.</td>
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| Wixson et al. 1999 | A study assessing the effect of carrier screening for CF carrier status on anxiety levels, attitudes, knowledge and actions of participants. | Longitudinal, self completed postal questionnaire survey at three time points. | Participants were women age 16-44 recruited through primary health care services. Three hundred and twenty-five individuals were screened identifying 106 carriers with known carrier status of CF. Eighty-eight women responded to questionnaire at Time One. Fifty-one women responded at Time Two. Sixty women responded at questionnaire at Time Three. Fifty-one women (50%) were carriers, (85%) were non-carriers at Time Two and Three. | Self-administered questionnaires, STAI used to measure anxiety. Time One = pretest, Time Two = two weeks after results. | Descriptive statistics were calculated. | Eighty-one percent of carriers said they were glad they had been tested. Carriers expressed being surprised (67%) at first, 25% said they were slightly anxious. Provision of written information and genetic counseling helpful (69% and 93%, respectively). Twenty-four percent were worried even after waiting for results of partner. At six months, 50% reported no anxiety or depression. Those not planning further children were either "not worried" or "not interested" about their results. Eighty-nine percent of carriers told result to
CF cystic fibrosis, DMD Duchenne muscular dystrophy, FX fragile X, HhP hemoglobinopathies, TS Tay Sachs, Fragile X VAS Fragile X Visual Analog Scale, HOS Health Orientation Scale, PANAS Positive and Negative Affect Scale, STA Spielberger State-Trait Anxiety Inventory

To enable comparison across the studies, a matrix (Table 1) and Hulm (1994) of studies was drawn up including aspects of each relevant sample and size methods considered to be most important (study design, sample and size methods, quality issues and findings related to the psychosocial impact of the illness). The matrix is summarized in Table 1. To facilitate and compare across data, the approach was based on Grounded Theory (Strauss and Corbin 1998). The results of the analyses related to the psychosocial impact of the illness are listed in Table 1. Due to the range of different qualitative and quantitative approaches used, the meta-analysis was not performed. However, we used an overarching approach to identify themes. The thematic analysis of the data was conducted in a comprehensive manner. The themes were identified by the researchers and compared across the studies. In addition, authors of many studies did not justify their sample size (e.g., Pastore et al. 2001). The number of study limitations that should be considered when interpreting the findings from these research studies should be considered (e.g., Pastore et al. 2001). The use of longitudinal study designs enabled changes in psychosocial functioning to be measured over time (e.g., Lakeman et al. 1992). The use of researchers who had completed their own research enabled to be acquired by the researchers (e.g., Becker et al. 1994). The use of researchers who had completed their own research enabled to be acquired by the researchers (e.g., Becker et al. 1994).
Results

The impact of carrier testing for cystic fibrosis was the condition most commonly investigated, with ten studies focusing on this condition, followed by carrier testing for fragile X (five studies), Tay Sachs (one study) and hemophilia A and B (one study). The focus of the remaining three studies was the effects of carrier testing for a number of conditions. No studies which assessed the impact of carrier testing on carriers of chromosomal abnormalities were identified from the literature review. Carrier testing for people who had a family history of a genetic condition (and were therefore at an increased risk) was assessed in 11 studies, risk in the general population was assessed in seven studies, and in two studies people in both groups were assessed. Only three of the studies included in the systematic review were intervention studies (Callanan et al. 1999; Cheuvront et al. 1998; Newman et al. 2002). All three compared levels of anxiety related to home education and testing with clinic education and testing. A number of overarching themes were identified. The most prominent were anxiety, guilt, relief, effect on self image, active coping mechanisms, impact on reproductive issues and disclosure of test results (Table 2).

Anxiety

Two categories of anxiety emerged; one related to testing and the other related to child health. In relation to testing, all longitudinal studies investigating patient anxiety over time either found no significant difference in anxiety between carriers and non carriers (Honnor et al. 2000), or found that any anxiety experienced by carriers upon first receiving their test result had, for the vast majority, dissipated by six months as assessed by the state STAI (Bekker et al. 1994; Callanan et al. 1999; Cheuvront et al. 1998; Lakeman et al. 2008; Watson et al. 1992), the Fragile X Visual Analog Scale (VAS) (McConkie-Rosell et al. 2001), or qualitative interviews (Anido et al. 2007; Anido et al. 2005).

Carrier anxiety dissipated for a number of reasons. Watson et al. (1992) found that the provision of written information and genetic counseling was helpful for most participants (92% and 97%, respectively). Bekker et al. (1994) found that the passage of time appeared to dissipate anxiety. Gender was also an issue discussed in relation to anxiety, in a number of studies. Newman et al. (2002) and Henneman et al. (2002) found that women reported higher anxiety than men while waiting for their test results (mean= 16.5 and 14.6, respectively on the STAI in the Newman study, p<0.001; and 24% versus 13%, p<0.001 measured on a five-point Likert scale in the Henneman study); however there was no significant difference between the genders once the test results had been received. Lakeman et al. (2008) found that Western participants generally reported lower levels of anxiety compared with non-Western participants (General Linear Model analysis at 4 time points, p<0.001).

Anxiety did however appear to be an issue for both carrier and non-carrier siblings of people with cystic fibrosis, in the interview-based study conducted by Fanos and Johnson (1995b). Identified carriers and non-carriers were equally likely to have moderate or severe anxiety around their child’s health. Forty-one percent had had their
Table 2  Themes by mode of inheritance

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<thead>
<tr>
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<th>Autosomal recessive</th>
<th>Population</th>
<th>X linked</th>
<th>Population</th>
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<tr>
<td>Guilt</td>
<td>Williams 1997</td>
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<tr>
<td>Evidence of self-stigmatisation</td>
<td>Gordon 2003</td>
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<tr>
<td>Evidence of social-stigmatisation</td>
<td>Gordon 2003</td>
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<tr>
<td>Impact on reproductive plans</td>
<td>Callanan 1999</td>
<td>Henneman 2002; Watson 1992; Lakeman 2008</td>
<td></td>
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<tr>
<td>No impact on reproductive plans</td>
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Family History—Participants with a family history of the condition
Population—Participants identified from the general population

* Cohort included participants with affected children

children sweat-tested to rule out the condition, nine percent had their child tested for carrier status, and 55% planned to do so before their child reached 18 years of age. Siblings who had had their children sweat-tested or tested for carrier status were equally divided between those who knew their own carrier status and those who did not.

Guilt

Guilt was a prominent theme in the data. Feelings of guilt associated with carrier status were cited as findings in five studies. These results were identified through interviews (Anido et al. 2005; McConkie-Rosell et al. 1997; Williams and Schutte 1997), an open-ended questionnaire (Dunn et al. 2008), a VAS (James et al. 2006; McConkie-Rosell et al. 1997) and the guilt subscale of the Multiscore Depression Inventory (sMDI) (James et al. 2006). Guilt is also an issue found to be closely associated with gender, mode of inheritance, and whether the participants had affected children. In the study conducted by Dunn et al. (2008) in which 81% of respondents had a son with hemophilia, 18 of 48 (38%) female carriers reported the timing of testing as negative. Reasons cited for the timing being negative included feeling blamed by their partner and a prolonged sense of guilt. James et al. (2006) found that mothers who were carriers of X-linked conditions felt substantial guilt and self-blame related to their child’s condition. When measured on the VAS, mothers of children with X linked conditions had significantly higher levels of guilt than mothers of children with recessive conditions (p<0.01) and were more likely to blame themselves (p<0.001). A similar finding was identified in the Williams and Schutte study, in which it was found that many of the participants who expressed feelings of grief and guilt were women who were carriers of fragile X or Duchenne muscular dystrophy. Anido et al. (2005) also found that in families affected by fragile X, even those women without affected children experienced guilt to some extent, by virtue of the condition being in the family.

In one study (Gordon et al. 2003) there was no significant difference evident between carriers and non-carriers on the “guilt” scale (as measured by the HOS). The participants were from the general population, were
screened for cystic fibrosis, and did not have a family history of the condition.

Relief

Anido et al. (2005), McConkie-Rosell et al. (1997) and Lakeman et al. (2008) all identified that relief was an emotion experienced by carriers. In the study conducted by Anido et al. reactions of relief were expressed equally as strongly as reactions of guilt, with nearly all carriers expressing this emotion during interviews. For these individuals, finding out their carrier status was an inevitable result of finding a diagnosis for their child. Similarly, in the study by McConkie-Rosell et al. (1997), participants’ responses indicated that while they felt angry or depressed about their carrier status, there was an “emotional relief in finding out the cause of the mental retardation in the family” (p. 65). Lakeman et al. (2008) found that 68% of participants, including seven out of ten carriers, felt relief one week after receiving their test results, as measured on a structured questionnaire assessing emotional outcomes.

Effect on Self-image

Three main issues arose within this theme: perception of health, self-stigmatization and social-stigmatization.

Perception of Health

Of the seven studies in which perception of health was measured, findings from three studies indicate that some carriers believed their current or future health to be significantly poorer after learning their carrier status (Fanso and Johnson 1995b; Henneman et al. 2002; Marteau et al. 1992). Seven out of 17 carriers (41%) in the study conducted by Henneman et al. (2002) felt less healthy (measured on a multiple-choice questionnaire) due to their test results, despite being informed both verbally and by letter that their carrier status would have no effect on their own health. Marteau et al. (1992), also using a multiple-choice questionnaire which measured perceived health from three time perspectives, identified that carriers of Tay Sachs held the least optimistic view of future health compared with non-carriers and the control group ($p<0.01$) and Fanso and Johnson (1995b) reported that during interviews, sibling carriers retrospectively redefined health problems as related to cystic fibrosis, although the authors do not report report how many.

Authors of four studies found that perception of health did not alter after learning one’s carrier status, using measures such as the Tennessee Self Concept Scale (McConkie-Rosell et al. 2000), a multiple choice questionnaire (Bekker et al. 1994), the HOS (Gordon et al. 2003) and a five point Likert-scale (Lakeman et al. 2008). However, both McConkie-Rosell et al. and Bekker et al. do provide some anecdotal evidence to suggest that carriers might attribute previous health problems to their carrier status. McConkie-Rosell et al. found that 12% of participants at Time 1 and 20% of carriers at Time 2 reported feeling they had mild clinical features of fragile X. They felt that perhaps if they were carriers it would explain why they had to “study hard in school” (p. 340). A participant in the Bekker et al. cohort wondered whether her allergies and chest colds were in some way linked to her carrier status. Therefore, even though perception of health did not alter when measured quantitatively, during qualitative interviews there were some indications that it did in fact occur in a small number of cases. In fact, in the case of fragile X, it is possible that carriers did experience a mild manifestation of the disease due to skewed X-inactivation (Skirton et al. 2005). Furthermore, this finding may also be attributable to the repeat length itself which appears to be associated with toxicity due to elevated mRNA levels (Koldewyn et al. 2008).

Self-stigmatization

There is evidence from four studies to indicate that self-stigmatization occurred in carriers to some extent (Gordon et al. 2003; James et al. 2006; McConkie-Rosell et al. 1997, 2000). Gordon et al. identified that carriers experienced less positive feelings; more afraid, worse, weaker, less relieved, less happy, more marked (although the authors do not explain what is meant by this) and angrier, compared to those who tested negative, on the HOS. Similarly, James et al. found that carrier status is associated with stigma and is significantly associated with mode of inheritance using the same scale. The only other study (Pastore et al. 2008) specifically looking at stigma using the HOS consisted of just one carrier, and therefore findings were not significant. Stigma was also evident in two of the qualitative studies. Just under half (9/19) of the fragile X carriers in one study (McConkie-Rosell et al. 1997) indicated that there had been a negative change in the way that they viewed themselves. One reason cited for this change was a “feeling of being abnormal or inferior” (p. 64), a statement indicative of self-stigmatization.

Social Stigmatization

Evidence of social stigmatization was evident in two studies, one quantitative (Gordon et al. 2003) and one mixed methods (McConkie-Rosell et al. 2001). Gordon et al. found that carriers and non-carriers attributed significantly more negative feelings to cystic fibrosis carrier status than non-carrier status. This finding was significant for all emotional scales on the HOS ($p<0.001$).
Active Coping Mechanisms

Use of active coping mechanisms was identified in five studies, out of a possible seven studies in which qualitative research techniques were employed. These studies included participants from the general population without affected children (Anido et al. 2007) and participants with a family history (Anido et al. 2005; McConkie-Rosell et al. 1997, 2000, 2001). McConkie-Rosell et al. (2001) found no change in the level of distress or perceived seriousness of fragile X when women were “at risk” of being a carrier as when they were found to be carriers. The increase in perception of seriousness only occurred in the non-carriers when the threat was no longer present. This possibly indicates that “threat minimization” was used by the participants as an active coping mechanism in both situations. McConkie-Rosell et al. (2001) also found, during in-depth interviews, that 11 out of 20 (55%) carrier women used spontaneous coping statements such as “life goes on” (p.41) and “If I am, I am. I’ll deal with it” (p.41). Coping behavior statements were also evident during interviews in the study conducted by Anido et al. (2007).

For carriers identified in the study by Anido et al. (2007), most appeared to be considering their carrier status over the course of the interview, having not given the subject much thought previously. The authors postulated that this attitude is consistent with the coping mechanism known as “just-in-time” learning, as described in Adult Learning Theory (Wlodkowski 1999), wherein adult learners process information which is relevant and applicable to them at the time they need it.

Impact on Reproductive Issues

The impact of carrier status on participants’ views on reproductive issues varied depending on their life stage, their views on prenatal testing and abortion, whether their partners were also carriers, and whether they were carriers of an X-linked or recessive condition. Authors of four studies (Callanan et al. 1999; Henneman et al. 2002; Lakeman et al. 2008; Watson et al. 1992) of cystic fibrosis carriers identified from both risk groups and the general population who did not have affected children, all reported that the majority of carriers showed no change in reproductive plans after testing, as measured on questionnaires which included multiple-choice options (Callanan et al. 1999; Watson et al. 1992) or a five point Likert-scale (Henneman et al. 2002; Lakeman et al. 2008). Reasons given included the availability of prenatal diagnosis (Henneman et al. 2002; Lakeman et al. 2008; Watson et al. 1992) and having completed their families (Watson et al. 1992). Furthermore, in two of the studies (Cheuvront et al. 1998; Henneman et al. 2002), only carrier by non-carrier couples were included. If one partner tests positive and the other negative, the risk of having a child with CF is about 1 in 640 (Watson et al. 1992).

However, in two interview-based studies, females carrying X-linked mutations, many of whom were mothers of affected children, were more likely to indicate their carrier status had caused a change to their reproductive plans (Anido et al. 2005; McConkie-Rosell et al. 1997). In the study conducted by McConkie-Rosell et al. (1997) 19 out of 28 (67%) fragile X carriers stated that they would not have any more children because of their carrier status, and 25 out of 28 (89%) would have either reduced the size of their families or not had any biological children, if they had known earlier. Anido et al. (2005) also found through in-depth interviews that many women with fragile X children stopped planning to have more children after receiving their test results. Furthermore, those without affected children expressed a strong desire “to figure out a way to end it with me” (p. 301). Dunn et al. (2008) also reported findings from open-ended questions that revealed some respondents felt they might not have had as many children if they had known their carrier status earlier.

Findings differed however, in the study conducted on fragile X carriers identified from the general population (Anido et al. 2007). Many carriers expressed that although the information could be relevant in the future, it was not relevant at this stage of their lives in terms of family planning. Some had not really considered the implications for family planning and their thoughts about prenatal testing, but for those that had, carrier status did not have an apparent effect on their attitudes about termination. The issue of premature ovarian failure appeared to be more prominent than the risk of having children affected with fragile X.

Disclosure of Test Results and Family Relationships

In six studies in which disclosure of test results was assessed, the researchers found that participants did share their test results with others, although this disclosure was selective (Anido et al. 2007; Dunn et al. 2008; Henneman et al. 2002; McConkie-Rosell et al. 1997; Watson et al. 1992; Williams and Schutte 1997). Anido et al. (2007) found that providing information to partners primarily depended on the seriousness of the relationship. Watson et al. (1992) found that 89% (47/53) of CF carriers informed their partners of their test results, 83% told their parents, 82% their siblings and 48% told other relatives. Henneman et al. (2002) reported that most CF carriers shared the information with parents and siblings. All but one of the carriers whose parents were still alive had told them about their test results. Ten carriers had shared the information
with their brothers and sisters, but two had not. With respect to participants who did not disclose carrier information to other family members, their reasons included not wanting to disclose results to relatives who had affected siblings, and not wanting to cause feelings of guilt (Williams and Schutte 1997).

The effects of sharing information about one’s carrier status with a partner and/or family members varied across the studies. Positive experiences related to disclosure of test results were documented by Dunn et al. (2008) and McConkie-Rosell et al. (1997). Of the 18 carriers who indicated in a change in their relationship with their husband in the McConkie-Rosell et al. (1997) study, 13 carriers (72%) indicated this change had been positive. Seventeen (61%) felt that there had been an improvement in their relationship with their siblings. Difficult or distressing experiences were highlighted in three studies (Dunn et al. 2008; McConkie-Rosell et al. 1997; Williams and Schutte 1997). Dunn et al. and McConkie-Rosell et al. identified a negative effect on the relationship with the partner in 13/31 (42%) and 5/18 (27%) of cases, respectively. Reasons cited included anxiety and anger from the male partner (Dunn et al.) and feeling blamed by their spouse (McConkie-Rosell et al.). In cases where the experience had a positive effect on the relationship (in 4/31 and 13/18 of cases respectively), the carrier felt completely accepted by her partner (Dunn et al. 2008) and there was an increase in understanding and communication. Henneman et al. (2002) found the majority of participants (98%) perceived no impact of carrier testing results on the relationship with their partner. For the majority of participants in the Anido et al. (2007) study, providing information about fragile X carrier status to family members was not problematic. However, providing the information to partners depended on the seriousness of the current relationship.

**Discussion and Conclusion**

**Discussion**

This review is useful in that it identifies a number of factors that seem to influence the emotional consequences of carrier testing. These include population group, whether the carrier has an affected child, stage of life, psychological coping mechanisms, and mode of inheritance. In this respect the results of this systematic review provide some interesting insights into how genetic testing for different conditions may have a varying psychological impact that is dependent on the context in which testing occurs.

Anxiety, an emotion frequently measured in studies investigating the impact of carrier testing on individuals, dissipated in the long term for the majority of participants in all studies. In addition, the reasons suggested by authors, another reason may have been because none of the participants were pregnant at the time of receiving their carrier test results and were therefore not anxious about the possibility that the fetus was affected. For carriers, knowledge that reproductive options were available to them if there was a risk of having an affected child may also have overridden any initial anxiety. Furthermore, good quality genetic counseling services may have lessened the impact of the test results.

Variables including mode of inheritance, gender and whether the carrier already had a child affected by the condition appear to be strongly linked to the issue of guilt. The finding that guilt was more dominant in women than men, indicates that it may be strongly connected with what Peters and Jackson (2009) describe as a unique emotion concerning a mother’s relationship with her affected child. Guilt also appeared to be more commonly reported by mothers of children with X-linked conditions. One possible explanation lies in the close association of guilt and blame. In the case of X-linked conditions, it only takes a carrier mother to pass along an X-linked condition rather than having both parents contribute the “faulty” gene. Therefore the burden of having passed on a faulty gene cannot be shared with a partner. In these cases men may “externalize their emotional response to devastating news and blame, while women are likely to internalize their responses and to accept this blame” (James et al. 2006). Mothers are also more likely to self blame (Peters and Jackson 2009).

Guilt may also be an emotion linked to family history. Anido et al. (2005) found that women who did not have affected children but had the condition in the family, expressed feelings of guilt, which may indicate a form of “survivor guilt.” Survivor guilt has also been identified in CF families. In a study (which was excluded from this review as it contained women who were pregnant at the time of testing) in which barriers to carrier testing for adult cystic fibrosis siblings were identified, carrier status served an important function in binding guilt, with 15% of siblings either hoping they were carriers or feeling guilty they were not (Fanos and Johnson 1995a).

There are conflicting results in the literature regarding the issue of perceptions of health. Yet even those studies in which carriers did not indicate feeling less healthy on surveys or questionnaires, during in-depth interviews, some participants reported clinical features of the disorder for which they were being tested or for which they were found to be a carrier. In the case of fragile X, it is possible that carriers did experience a mild manifestation of the disease due to skewed X-inactivation (Skirton et al. 2005). Furthermore, this finding may also be attributable to the repeat length itself which appears to be associated with
toxicity due to elevated mRNA levels (Koldewyn et al. 2008). However this finding also suggests that participants may have been seeking support for beliefs they held about themselves.

In interpreting this finding, McConkie-Rosell et al. (2000) refer to the theory of self-concept as described by Shavelson et al. (1976). Shavelson et al. hypothesize that self-concept is hierarchical, with perception of personal behavior in specific situations at the base of the hierarchy, inferences about the self in broader domains (e.g., social, physical) at the middle, and a global, general self-concept at the apex. Global self-concept is stable, but as one descends the hierarchy self-concept becomes increasingly situation specific and less stable. Seeking clinical features related to actual or possible carrier status might be indicative of situation-specific changes in feelings about self. Additionally, it may be the case that scales such as the HOS (used by Gordon et al. 2003) and TSCS (used by McConkie-Rosell et al. 2000) are not sensitive enough to detect the subtleties concerning how carriers perceive their own health, which are more likely to be expressed during in-depth interviews.

Reproductive intent also appeared to be closely linked to mode of inheritance, stage of life and whether the participant already had an affected child, with the greatest impact being identified for carriers of X-linked conditions with affected children. This group was most likely to refrain from having more children. One possible reason involves the documented psychological difficulties of raising a child with fragile X (Abbeduto et al. 2004; Lewis et al. 2006). When Anido et al. (2007) interviewed fragile X carriers who did not have affected children and were from the general population, the information did not appear to have an impact on family planning with many not having considered the issue. This is likely to be because they did not have any experience, either themselves or through other family members, of raising a child with the condition. It may be that these carriers would experience increased distress as they consider reproduction more seriously. Similarly, carriers of cystic fibrosis in the general population did not change their reproductive plans as a result of their carrier status. Participants in these studies did not have affected children, and even as a carrier, there would only be a risk to future children if the partner was also a carrier.

Active coping mechanisms, such as “threat minimization,” significant changes to reproductive intentions and the use of active coping statements, were identified in those participants at an increased risk of carrying the fragile X gene. Lazarus and Folkman (1984) describe coping as consisting of two different strategies, problem-focused coping and emotional-focused coping. The findings from this systematic review suggest that women at high risk of being a carrier of fragile X engaged in problem-focused coping by managing their health threat through genetic testing, and if found to be carriers, by changing their reproductive intentions. They engaged in emotional-focused coping through threat minimization and active coping statements.

In addition to these coping strategies aimed at lessening distress, Lazarus and Folkman describe a smaller group of cognitive strategies directed at increasing distress. For some individuals, there is a need to feel worse before they can feel better. Self-blame, a coping mechanism found to be used by carriers of X-linked conditions, is one such form of self-punishment individuals may use. This deliberate emotional distress may mobilize individuals into action. Evidence that women use self-blame as a coping strategy has been identified in other studies; for example, self-blame was found to be significantly correlated with both problem-focused and emotional-focused coping strategies in a study of patients with diabetes (Tuncay et al. 2008). Self-blame was also used as a strategy to cope with depression in a study of how primary care patients manage their illness (Brown et al. 2007).

Other studies, in which participants became aware of their carrier status through family history or newborn screening, have identified similar psychosocial issues to those in this review. Fanos and Mackintosh (1999) recognized a number of coping mechanisms used by parents of children with ataxia-telangiectasia, including rationalizing their child’s condition as a “statistical quirk” (p.417), and imbuing the occurrence with meaning and significance through connecting it with the wider sphere of human suffering or to the spiritual world. Guilt was not however a common finding in their study, and surprisingly when it was mentioned, it was in reference to fathers. Undue concerns about the health of carriers was also identified in a minority of parents in a study assessing the impact of carrier status information following newborn screening (Kai et al. 2009), as was a sense of responsibility to share carrier status information with extended families. Stigmatization was also evident in a study which included participants from high risk CF families who did not want to learn their carrier status (Fanos and Johnson 1995a). For example, one untested woman was worried that she would be “less desirable” (p. 88) to men if they knew she was a carrier.

While this review provides an overview of the psychosocial experience of living as a carrier, it is important to keep in mind the limitations of making comparisons across different conditions, in particular cystic fibrosis and fragile X (the major conditions included in this review). These two conditions vary greatly in terms of their effects on the affected individual, the implications for the health of the carrier, and risk of the carrier having an affected child. Furthermore, variations in study design, the different population subsets compared, and the obvious complexities
of comparing qualitative and quantitative data, mean that
the findings should be interpreted with some degree of
cautions. For example, there were indications from some
studies using validated scales of no changes in perception
of health. However, when the authors used in-depth
interviews, changes in health perception were evident
(Bekker et al. 1994; McConkie-Rosell et al. 2000). Some
authors used the STAI to measure anxiety, whereas others
using qualitative methods relied on participants’ own
terminology. Studies using the HOS were much more likely
to identify evidence of stigmatization that those that did not
use this scale, as this scale specifically measures aspects of
self image. Future systematic reviews may therefore benefit
from the inclusion of samples involving population groups
which are more similar in kind in terms of risk to offspring,
severity of the condition or family history. Future research
studies may be better summarized if the studies focus on
using similar groups of patients and validated tools.

Yet this does not necessarily mean the findings of the
present review fail to provide valuable insight into the
psychosocial experience of living as a carrier. In particular,
the review provides an overview of the commonality of
experiences across conditions with different inheritance
patterns. Furthermore the overview identifies a number of
issues that collectively apply to carriers as a group, because
of the familial nature of genetics.

Strengths and Limitations

As stated previously, findings from the review should be
considered in light of the difficulties and limitations of
combining studies undertaken with different study designs,
subsets of the population, measures and outcomes. These
factors may have diluted the strength of the comparisons.
Furthermore, many of the studies lacked theoretical models or
presentation of a conceptual model to help place the variables
and their possible interactions in context (Henneman et al.
2002; Pastore et al. 2008; Watson et al. 1992). Such
omissions possibly weaken the validity of the results.
Nevertheless, in the present systematic thematic analysis,
the findings were able to be explained within established
theoretical models of coping and self-concept (Lazarus and
Folkman 1984; Shavelson et al. 1976).

The systematic review does have notable strengths. Seven
databases were used to retrieve studies to maximize
the chance of finding all relevant research. In addition,
several iterations of the search were conducted using
different combinations of keywords, to ensure the search
was rigorous. At the present time there does not appear to
be another systematic review in the literature that compares
the psychosocial experience of carrier testing for autosomal
recessive and X linked conditions; thus, this review
provides unique and useful information.

Conclusion

The findings from this systematic review provide insight
into the variety of psychosocial emotions experienced by
individuals undergoing carrier testing and a general
overview of the psychosocial impact of living as a carrier.
Prominent themes that occur in the literature include
anxiety, guilt, relief, effect on self image, active coping
mechanisms, impact on reproductive issues and disclosure
of test results. Variables that influence the psychosocial
effects of carrier testing include whether the carrier has an
affected child, mode of inheritance, genetic counseling and
life stage. A key finding concerns the different emotions
experienced by carriers who already had an affected child
compared with carriers who did not. Studies indicated that
carriers with affected children were more likely to experi-
ence guilt and self-blame. Furthermore, fragile X carriers
with affected children were more likely to indicate that
carrier status had affected their reproductive plans. In
contrast, carriers identified from the general population
did not change their reproductive plans as a result of their
carrier status. Due to the commonality of experiences
identified through this systematic review, it would appear
that we can make certain assumptions about the psychoso-
cial impact of living as a carrier. Yet at the same time it is
important to bear in mind the limitations of making
generalizations across different population groups and
condition types.

Practical implications

Genetic counselors and other health professionals offering
genetic testing should pay attention to the variety and
complexity of psychosocial experiences that may be encour-
tered by individuals undergoing carrier testing. One key
finding from this systematic review is that carriers who
already have an affected child often react differently when
receiving their test results than carriers who do not. For those
carriers who already have an affected child, the impact of
receiving the test results in these cases may reinforce feelings
of guilt, self-blame and maternal blame in the case of X linked
conditions. Counselors therefore need to be aware of these
issues when testing parents of affected children as these
psychological issues may need to be addressed both before
and after testing. In addition, counselors should look to
address misconceptions related to health and carrier status;
some individuals may seek support for beliefs they have about
their health by identifying clinical features of the disorder for
which they are being tested or are found to be a carrier.
Furthermore, while some clients will effectively manage
anxiety and their carrier status through threat minimization
and other active coping mechanisms, professionals should
ensure that those who appear to be managing well do not
minimize their threat to the extent that they disengage from protective health actions, particularly when it comes to reproductive issues.

References


and non-Western participants in a study on preconceptional ancestry-based carrier couple screening for cystic fibrosis and hemoglobinopathies in the Netherlands. Genetics in Medicine, 10 (11), 820–830.


