Classification, Comorbidity, Heredity, and Risk Factors of

Female Sexual Dysfunctions

Katarina Witting

Academic Dissertation

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The opponent appointed by the Faculty of Arts is Professor Julia Heiman,
Director of the Kinsey Institute for Research in Sex, Gender,
and Reproduction, Indiana University Bloomington, Indiana, USA.
Professor Pekka Santtila acts as custos.

Center of Excellence in Behavior Genetics
Department of Psychology
Åbo Akademi University

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ACADEMIC DISSERTATION

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Katarina Witting

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following publications, which are referred to in the text by their Roman numerals:

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II Witting, K., Santtila, P., Alanko, K., Harlaar, N., Jern, P., Johansson, A., von der Pahlen, B., Varjonen, M., Ålgars, M., & Sandnabba, N. K. (2008). Female sexual function and its associations with number of children, pregnancy, and relationship satisfaction. *Journal of Sex and Marital Therapy, 34,* 89–106.

III Witting, K., Santtila, P., Rijsdijk, F., Varjonen, M., Jern, P., Johansson, A., von der Pahlen, B., Alanko, K., & Sandnabba, N. K. (2008). Correlated and non-shared environmental influences account for the comorbidity between female sexual dysfunctions. *Psychological Medicine, 38,* 1–13. doi:10.1017/S0033291708003206

IV Witting, K., Santtila, P., Varjonen, M., Jern, P., Johansson, A., von der Pahlen, B., & Sandnabba, K. (2008). Female sexual dysfunctions, sexual distress and compatibility with partner. *Journal of Sexual Medicine, 5,* 2587–2599.

SAMMANFATTNING

Kvinnliga sexuella dysfunktioner inkluderar problem med lust, upphetsning, förmåga att få orgasm samt smärta vid samlag. Prevalensen av sexuella dysfunktioner är hög och de förekommer hos kvinnor i alla världsdelar. Fortfarande är orsaker till sexuella dysfunktioner relativt okända men associationer med bland annat hälsa, ålder, psykiatriska symptom och olika aspekter av partnerförhållande har rapporterats. Den individuella variationen i orgasmfunktion har till en del förklarats av genetiska effekter men för de andra typerna av sexuella problem har inga kvantitativa genetiska analyser utförts. Förutom att undersöka hur stark effekt gener har på variationen i en viss fenotyp kan kvantitativ beteendegenetik användas för att undersöka orsaken till samvariation mellan två fenotyper, det vill säga i det här fallet samvariation mellan olika sexuella problem. Mer kunskap om bakomliggande orsaker är nödvändig för att förbättra behandling och klassificering av sexuella dysfunktioner, som båda debatteras livligt.

Målet med den föreliggande avhandlingen var att genom enkätundersökningar riktade till tvillingar och deras syskon från två stora populationsurval utforska kvinnliga sexuella funktioner. Först evaluerades de psykometriska egenskaperna av en finskspråkig version av ett bedömningsformulär för kvantifiering av kvinnors sexuella funktioner (Female Sexual Function Index; FSFI). FSFI är ett ofta använt instrument för att mäta sexuella funktioner hos kvinnor och har i tidigare studier rapporterats ha hög reliabilitet och validitet. För det andra undersöktes prevalensen av och samvariationen mellan olika sexuella problem och utgående från resultaten diskuterades den gällande klassificeringen av sexuella dysfunktioner. För det tredje, analyserades genetiska och omgivningsmässiga effekters inverkan på variationen i sexuella funktioner samt till hur stor del samvariationen mellan olika sexuella funktioner kan förklaras av delade genetiska eller omgivningsmässiga faktorer, det vill säga i vilken utsträckning beror den fenotypiska korrelationen på delade genetiska faktorer och till hur stor del beror den på delade omgivningsfaktorer. Slutligen undersöktes förhållandet mellan sexuella funktioner och olika biologiska, psykologiska och sociala faktorer.

Undersökningsgruppen bestod av ett populationsbaserat urval av finska kvinnor som antingen själva var tvillingar eller syskon till tvillingar. Data insamlades i två olika faser. Den första datainsamlingen riktades till 5000 tvillingar i åldern 33–43 år och den andra datainsamlingen riktades till 7680 tvillingar i åldern 18–33 år samt deras kvinnliga syskon som var äldre än 18 år ($n = 3983$). Den totala svarsprocenten för de båda datainsamlingarna var 53 % ($n = 8868$), med en något högre

svarsprocent i den andra datainsamlingen (57 %) jämfört med den första (45 %). FSFI användes för att kvantitativt mäta sexuella funktioner. FSFI mäter kvinnliga sexuella funktioner under de senaste fyra veckorna och består av 19 frågor uppdelade på sex olika underkategorier. Dessa kategorier är lust, subjektiv upphetsning, lubrikation, orgasm, sexuell tillfredsställelse och smärta.

Resultaten av evalueringen av den finska versionen av FSFI stödde liksom tidigare studier en lösning med sex skalor. Den interna reliabiliteten för de sex skalorna varierade från god till utmärkt. Prevalensen av sexuella dysfunktioner *per se* varierade från 11 % för lubrikation till 55 % för lust. Förekomsten av sexuella störningar, det vill säga sexuell dysfunktion i kombination med personligt upplevt missnöje, var däremot betydligt lägre och varierade mellan 7 % för lubrikationsstörning och 23 % för luststörning. Korrelationerna mellan dysfunktionerna var hög vilket visar på att förekomsten av en dysfunktion ofta innebär närvaro av en eller flera andra dysfunktioner. Den högsta korrelationen var mellan subjektiv upphetsning och lubrikation.

Den genetiska influensen på den individuella variationen i sexuell funktion var måttlig men signifikant och varierade mellan 3–11 % för additiva genetiska effekter och 5–18 % för dominanta genetiska effekter, beroende på funktionstyp. Resten av variationen i de sexuella funktionerna förklarades av individspecifika omgivningsfaktorer. Av de multivariata modellerna passade modellen med korrelerade individspecifika omgivningsfaktorer, additiva genetiska och dominanta genetiska faktorer bäst. De individspecifika faktorerna samt majoriteten av de genetiska faktorerna var signifikant korrelerade vilket indikerar att samvariationen i de sexuella funktionerna delvis förklaras av samma bakomliggande faktorer.

Sexuella dysfunktioner var associerade med psykiatriska problem, missnöje med partnerförhållandet, sexuellt missnöje och dålig kompatibilitet med partnern. Den sexuella lusten och tillfredsställelsen avtog med åldern medan orgasmfunktionen blev bättre. Även smärta vid samlag minskade med tilltagande ålder. Dessa effekter var signifikanta även när effekten av förhållandets längd beaktades. Generell alkoholkonsumtion var relaterad till mer lust, subjektiv upphetsning, lubrikation och orgasmfunktion. Kvinnor gravida med sitt första barn hade mindre smärtproblem än icke-gravida barnlösa kvinnor. Däremot hade gravida kvinnor som redan hade barn mer orgasmproblem än icke-gravida kvinnor med barn. Kvinnor som hade barn hade mindre orgasm- och smärtproblem jämfört med barnlösa kvinnor.

Slutsatserna som drogs var således att lust, subjektiv upphetsning, lubrikation, orgasm, sexuell tillfredsställelse och smärta är separata enheter som är specifikt associerade med olika biopsykosociala faktorer.

Samvariationen i förekomsten av dysfunktionerna är dock ansenlig och förklaras av delade individspecifika omgivningsfaktorer samt additiva och dominanta genetiska faktorer. Dysfunktionerna är ofta förekommande men är inte alltid associerade med personligt upplevt missnöje vilket kan bero på att associationen modereras av ett bra förhållande och god kompatibilitet med partnern. Resultaten från föreliggande undersökning ger stöd för att subjektiv upphetsning och lubrikation bör klassificeras som två separata underkategorier av sexuella dysfunktioner och att smärtproblem vid samlag fortsättningsvis borde betraktas som en sexuell dysfunktion.

ABSTRACT

Female sexual dysfunctions, including desire, arousal, orgasm and pain problems, have been shown to be highly prevalent among women around the world. The etiology of these dysfunctions is unclear but associations with health, age, psychological problems, and relationship factors have been identified. Genetic effects explain individual variation in orgasm function to some extent but until now quantitative behavior genetic analyses have not been applied to other sexual functions. In addition, behavior genetics can be applied to exploring the cause of any observed comorbidity between the dysfunctions. Discovering more about the etiology of the dysfunctions may further improve the classification systems which are currently under intense debate.

The aims of the present thesis were to evaluate the psychometric properties of a Finnish-language version of a commonly used questionnaire for measuring female sexual function, the Female Sexual Function Index (FSFI), in order to investigate prevalence, comorbidity, and classification, and to explore the balance of genetic and environmental factors in the etiology as well as the associations of a number of biopsychosocial factors with female sexual functions.

Female sexual functions were studied through survey methods in a population based sample of Finnish twins and their female siblings. There were two waves of data collection. The first data collection targeted 5,000 female twins aged 33–43 years and the second 7,680 female twins aged 18–33 and their over 18–year-old female siblings (*n* = 3,983). There was no overlap between the data collections. The combined overall response rate for both data collections was 53% (*n* = 8,868), with a better response rate in the second (57%) compared to the first (45%). In order to measure female sexual function, the FSFI was used. It includes 19 items which measure female sexual function during the previous four weeks in six subdomains; desire, subjective arousal, lubrication, orgasm, sexual satisfaction, and pain.

In line with earlier research in clinical populations, a six factor solution of the Finnish-language version of the FSFI received supported. The internal consistencies of the scales were good to excellent. Some questions about how to avoid overestimating the prevalence of extreme dysfunctions due to women being allocated the score of zero if they had had no sexual activity during the preceding four weeks were raised.

The prevalence of female sexual dysfunctions *per se* ranged from 11% for lubrication dysfunction to 55% for desire dysfunction. The prevalence rates for sexual dysfunction with concomitant sexual distress, in other words, sexual disorders were notably lower ranging from 7% for

lubrication disorder to 23% for desire disorder. The comorbidity between the dysfunctions was substantial most notably between arousal and lubrication dysfunction even if these two dysfunctions showed distinct patterns of associations with the other dysfunctions.

Genetic influences on individual variation in the six subdomains of FSFI were modest but significant ranging from 3–11% for additive genetic effects and 5–18% for nonadditive genetic effects. The rest of the variation in sexual functions was explained by nonshared environmental influences. A correlated factor model, including additive and nonadditive genetic effects and nonshared environmental effects had the best fit. All in all, every correlation between the genetic factors was significant except between lubrication and pain. All correlations between the nonshared environment factors were significant showing that there is a substantial overlap in genetic and nonshared environmental influences between the dysfunctions.

In general, psychological problems, poor satisfaction with the relationship, sexual distress, and poor partner compatibility were associated with more sexual dysfunctions. Age was confounded with relationship length but had over and above relationship length a negative effect on desire and sexual satisfaction and a positive effect on orgasm and pain functions. Alcohol consumption in general was associated with better desire, arousal, lubrication, and orgasm function. Women pregnant with their first child had fewer pain problems than nulliparous nonpregnant women. Multiparous pregnant women had more orgasm problems compared to multiparous nonpregnant women. Having children was associated with less orgasm and pain problems.

The conclusions were that desire, subjective arousal, lubrication, orgasm, sexual satisfaction, and pain are separate entities that have distinct associations with a number of different biopsychosocial factors. However, there is also considerable comorbidity between the dysfunctions which are explained by overlap in additive genetic, nonadditive genetic and nonshared environmental influences. Sexual dysfunctions are highly prevalent and are not always associated with sexual distress and this relationship might be moderated by a good relationship and compatibility with partner. Regarding classification, the results supports separate diagnoses for subjective arousal and genital arousal as well as the inclusion of pain under sexual dysfunctions.

INTRODUCTION

Modern research into female sexuality started with the groundbreaking work of Alfred Kinsey in the 1950's (Kinsey, Pomeroy, Martin, & Gebhard, 1953). Since then, a large number of studies on different aspects of female sexuality, the prevalence of female sexual dysfunctions and the mechanisms behind them have been published. In general, the reported prevalence rates of female sexual dysfunctions are high and even if the variation in the rates is large (Hayes, Bennett, Fairley, & Dennerstein, 2006), sexual dysfunctions are throughout more frequently reported among women than men.

After more than half a century of research there are still, however, numerous questions that have not been answered. Female sexual dysfunctions are complex in nature and the mechanisms behind them are to a large extent unknown. Sexuality is a natural part of intimate relationships and thus sexual dysfunctions are reciprocally connected to relationship factors and partner. They seem further to be affected by diverse biological, psychological, and social factors. The genetic makeup constitutes the fundamentals of biological factors while psychological and social factors can be regarded as more environmental. So far, limited focus has been on the balance between genetic and environmental factors influences on female sexual functions. However, the division of factors affecting female sexual functions into genetic and environmental is complicated by the possibility of interactions and correlations between genes and environment. In addition, the conceptualization of female sexual dysfunctions is somewhat unclear and the labeling of variations in sexual function as dysfunctions has also been criticized (Bancroft, Loftus, & Long, 2003; Graham & Bancroft, 2006).

The present thesis aimed at exploring female sexual functions in two large population based samples of twins and their siblings through survey methods. First, the psychometric properties of a Finnish-language version of a commonly used questionnaire for measuring female sexual function were investigated. Second, the prevalence and the classification of female sexual dysfunctions and disorders were addressed. Third, genetic and environmental influences on the variation in female sexual functions were analyzed as well as to what extent different types of sexual functions share the same genetic and environmental factors. That is, to what extent is the phenotypical correlation between the dysfunctions dependent on shared genetic and environmental factors? Finally, the associations between several biological, psychological, and social factors with female sexual dysfunctions were explored.

REVIEW OF THE LITERATURE

The review of literature consists of three parts. First, the classification and prevalence of female sexual dysfunctions as well as the inclusion of sexual distress as a criterion in sexual disorder diagnoses will be addressed. Second, research on the genetics and environmental factors associated with female sexual functions will be presented. Finally, the questionnaire used to measure female sexual function is described.

2.1 Female Sexual Dysfunctions and Sexual Distress

2.1.1 Female Sexual Dysfunctions
– Classification and Prevalence

Female sexual dysfunctions are classified both by the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR, APA, 2000) and the International Classification of Diseases (ICD-10, WHO, 1992) into four categories: desire, arousal, orgasm, and pain disorders. DSM-IV requires in addition that the sexual function problems are "accompanied by marked distress or interpersonal difficulty" (p. 538) in order to be diagnosed as actual sexual disorders. Consequently, sexual dysfunctions not experienced as distressing or causing problems in relation to others (partner) are according to DSM-IV not considered disorders. Recommendations by the International Consensus Conference on Women's Sexual Dysfunction (Basson et al., 2000) have also included the distress criterion. ICD-10, on the other hand, does not require that the dysfunctions cause distress or interpersonal difficulties and there is an ongoing discussion on how sexual dysfunctions should be defined, along with suggestions that current definitions of sexual dysfunctions require improvement (e.g. Althof et al., 2005; Basson et al., 2000; Basson, 2001a, 2002a; Basson et al., 2003; Binik, 2005; Meston & Bradford, 2007).

In addition to the debate on whether sexually related distress should be a criterion for diagnosing sexual disorders (Althof, 2001; Basson et al., 2000), other issues that have been addressed are the inclusion of pain disorders among sexual disorders (e.g. Binik, 2005; Binik et al., 2002; Meana, Binik, Khalife, & Cohen, 1997; Weijmar Schultz et al., 2005), the division of arousal into subjective and physiological components (Basson, Brotto, Laan, Redmond, & Utian, 2005; Brotto, Basson, & Gorzalka, 2004; Graziottin, 2001; Rellini, McCall, Randall, & Meston, 2005), and whether sexual (dis)satisfaction should be included as a disorder (Basson et al., 2000; McCabe, 2001). Regarding sexual pain disorders, the issues under discussion relate to whether these should be regarded as pain

syndromes or sexual problems and whether their etiology is biological or psychological (Meana et al., 1997; Weijmar Schultz et al., 2005).

Yet another problem is whether and when the terms "sexual function problems", "sexual dysfunctions", and "sexual disorders" are to be used (Bancroft et al., 2003; Graham & Bancroft, 2006). In the present thesis the label sexual dysfunctions and sexual function problems will be used interchangeably when describing sexual problems *per se* without concomitant distress while the label sexual disorders will be used for sexual dysfunctions in combination with distress. The reason for using sexual dysfunctions and sexual function problems interchangeably is twofold. First, some of the studies referred to in the literature review use sexual dysfunction, yet others use sexual function problems. Second, the publications upon which this thesis rests have looked at both continuous and dichotomized sexual dysfunction variables. Using continuous variables in the analyses assumes a normal distribution of the sexual function variable with low sexual function at one end and high sexual function at the other without qualitatively different disorders at the low end.

Despite this conceptual and diagnostic confusion, there is an agreement among scientist that sexual function problems are common worldwide (Fugl-Meyer & Fugl-Meyer, 2006; Kang, Laumann, Glasser, & Paik, 2006; Paik & Laumann, 2006), although reported prevalence rates between studies vary considerably, probably mostly due to differences in methodological approaches (Dunn, Jordan, Croft, & Assendelft, 2002). A frequently reported approximate prevalence rate for sexual function problems in adult women is 40% with low sexual desire (Abdo, Oliveira, Moreira, & Fittipaldi, 2004; Kadri, Alami, & Tahiri, 2002; Laumann, Paik, & Rosen, 1999; Nobre, Pinto-Gouveia, & Gomes, 2006) and orgasmic problems (Ponholzer, Roehlich, Racz, Temml, & Madersbacher, 2005; Shokrollahi, Mirmohamadi, Mehrabi, & Babaei, 1999) being the most common types of sexual function problems. Moreover, comorbidity is frequently reported (Johnson, Phelps, & Cottler, 2004; King, Holt, & Nazareth, 2007). Prevalence estimates of sexual disorders according to the DSM-IV criteria are typically lower ranging between 6–15% depending on the type of disorder (Dennerstein, Koochaki, Barton, & Graziottin, 2006; Öberg, Fugl-Meyer, & Fugl-Meyer, 2004). King et al. (2007) reported a prevalence rate of 38% for at least one sexual dysfunction according to the ICD-10 criteria but this was reduced to 18% when the agreement by the women themselves was considered. *In this thesis the prevalence rate of sexual dysfunctions in the Finnish sample and the phenotypical correlations between sexual dysfunctions were investigated.*

2.1.2 Sexually Related Distress

The few studies that have included the distress criterion have thus throughout showed lower prevalence estimates of sexual disorders compared to sexual dysfunctions *per se* (Bancroft et al., 2003; Dennerstein et al., 2006; Öberg et al., 2004). Bancroft et al. (2003) have shown that sexually related personal distress is not necessarily strongly predicted by sexual function problems. Instead, the best predictors were general emotional well-being as well as the quality of the emotional relationship with partner during sexual activity. King et al. (2007) compared to what extent women agreed with clinical diagnoses that had been given according to ICD-10 criteria. Of the 401 women, 18% were classified as having at least one sexual dysfunction and agreed with it, 20% were assigned a diagnosis but did not agree, 19% reported sexual problems but did not fulfill the criteria for a diagnosis, and the rest (42%) had neither diagnosis nor reported a problem. The largest disagreement was found for arousal disorder and lack or loss of desire. Further, one study investigated sexual function using the FSFI and found no association between any sexual dysfunction and the women's self-perception of satisfaction with sexual life (Ferenidou et al., 2008). Similar findings were reported from a large study conducted in the Boston area. In this study, 38.4% of the women reported sexual problems but of these, only 34.9% reported that they were dissatisfied with their sex life (Lutfey, Link, Rosen, Wiegel, & McKinlay, 2008). *The prevalence rates of female sexual dysfunctions in combination with sexual distress were explored in the present thesis.*

The reasons why sexual dysfunctions may exist without concomitant sexual distress and vice versa are not clear but as indicated by the results by Bancroft et al. (2003) the occurrence of sexual distress is closely linked to the quality of the relationship with partner. Evidence for the importance of emotional and relationship factors for experience of sexual distress have been found in several studies. In the King study (2007), women themselves attributed their sexual problems most often to emotional and relationship difficulties. Hayes et al. (2008) found sexual distress to be closely linked with poor communication of sexual needs to one's partner and Öberg and Sjögren Fugl-Meyer (2005) found a relationship between distressing sexual dysfunctions and partner's sexual dysfunctions, especially erectile dysfunction. They also reported an association between satisfaction with partner relationship and sexual interest, lubrication, and orgasm. Regarding sexual dysfunctions *per se*, Dunn, Croft, and Hackett (1999) reported that arousal and orgasm problems were strongest associated with marital difficulties. *Based on these findings, the associations between sexual distress and age, relationship duration, and partner compatibility were analyzed.*

2.2 Factors Contributing to Variation in Female Sexual Function

As noted above sexual function problems or sexual dysfunctions may exist *per se* without causing personal distress. Many factors have been associated with variation in female sexual functions. A biopsychosocial model that integrates biological, psychological, and social perspectives has been proposed as a theoretical foundation for viewing and understanding female sexual functions (DeLamater & Sill, 2005; Lindau, Laumann, Levinson, & Waite, 2003). The model emphasizes (1) an orientation toward health rather than illness (2) measured outcome may be health or illness (3) biological, psychological, and social factors all contribute to health or illness (4) bidirectional causality between the three domains (5) health or illness is dependent not only on intraindividual factors but on interindividual interactions and social networks (6) interdependency between the dynamics of life and the social environmnet (7) biopsychosocial factors may all act as dynamic assets or liabilities to health.

2.2.1 Genetics of Female Sexual Functions

A starting point for finding out the biological basis of any trait is to investigate the genetic influence on that particular trait. During the past ten years, there has been a growing interest in understanding the contribution of genetic and shared environmental influences to sexual dysfunction problems. There are two basic genetic methods: quantitative genetics and molecular genetics. Adoption and twin design are the methods used in quantitative genetics for studying human behavior. The rationale behind the twin design is based on the difference in the genetic relatedness between monozygotic (MZ) and dizygotic (DZ) twins. MZ twins share all of their genes while DZ twins on average share half (50%) their genes. If a trait is heritable, MZ twins should be more similar to each other on that particular trait compared to DZ twins assuming the equal environments assumption (EEA). The EEA states that both types of twins experience equally correlated environments of etiological importance for the trait under investigation. Using quantitative genetic techniques such as the twin design, it is possible to decompose individual differences in behavioral phenotypes such as sexual behavior into genetic and environmental effects. Genetic influences may further be divided into additive (A) and nonadditive (D) genetic influences while environmental influences can be divided into shared (C) and nonshared influences (E). Additive genetic influence refers to the total effect of multiple alleles on the phenotype and nonadditive genetic influence refers to the interactive effect among multiple alleles (i.e. dominance) and mul-

tiple genes (i.e. gene-gene interaction) on the phenotype. By definition, shared environmental influences are nongenetic influences that contribute to familial resemblance among relatives and nonshared influences are factors which uniquely influence individuals.

The overlap and independence of different sexual behavior variables can also be examined using multivariate quantitative genetics designs that estimate the extent to which the same genetic or environmental effects underlie the covariance between two or more phenotypic traits (Plomin, DeFries, McClearn, & McGuffin, 2001). The classical twin design includes twins only but an extended design including siblings is even more powerful, especially for detecting nonadditive genetic or common environmental influences (Posthuma & Boomsma, 2000).

Exploring the shared genetic and environmental factors influencing the different sexual dysfunctions is an important step in clarifying the etiology with implications for classification of sexual dysfunctions. Finding genetic influences for female sexual dysfunctions provides a rationale for molecular genetic research that seeks to detect which genes underlie the genetic effects. The basic of the molecular genetic methods is that polymorphisms (i.e. variations of the DNA code) are tied to variations in a trait or behavior (Jang, 2005).

Moderate heritability for individual differences in orgasm during intercourse or masturbation has been found in two twin studies using quantitative genetic analyses (Dawood, Kirk, Bailey, Andrews, & Martin, 2005; Dunn, Cherkas, & Spector, 2005). The British study included 683 MZ twin pairs and 714 DZ pairs and found heritability estimates of .34 for orgasm during intercourse and .45 for orgasm during masturbation (Dunn et al., 2005). The Australian study reported heritability estimates of .29 for orgasm during sexual intercourse and .40 for orgasm during masturbation (Dawood et al., 2005). For orgasm during sexual activity other than intercourse with partner the genetic influences were .20 for additive genetic influences and .18 for nonadditive. The nonadditive genetic influences could, however, be excluded from the model without a significant decrease in model fit. In both studies the rest of the individual variance was due to nonshared environmental influences.

Another study of 1,600 female twin pairs found heritability estimates of .41 for infidelity and .38 for number of sexual partners with a strong genetic correlation between the two traits (Cherkas, Oelsner, Mak, Valdes, & Spector, 2004).

Molecular genetic research has also started in this area. Polymorphisms in the gene encoding for Interleukin-1 receptor antagonist (Jeremias, Ledger, & Witkin, 2000) and in the Interleukin-1β gene (Gerber, Bongiovanni, Ledger, & Witkin, 2003) have been associated with vul-

var vestibulitis syndrome, now called provoked vestibulodynia. Provoked vestibulodynia is a major cause of dyspareunia in premenopausal women at least for a subgroup of dyspareunia (Meana et al., 1997; Payne, Bergeron, Khalife, & Binik, 2006).

Further, dopamine has been found to have a facilitatory effect on female sexual behavior (Segraves et al., 2001; Shen & Sata, 1990) and polymorphisms associated with the dopamine system may be candidates for explaining observed genetic variation in female sexual function. Some preliminarily evidence for associations between polymorphisms in the D2 receptor gene and age at first sexual intercourse (Miller et al., 1999) and variation in self-reported number of sex partners over the past twelve months (Halpern, Kaestle, Guo, & Hallfors, 2007) has been found. The former study did however show a stronger relationship for men and the latter was based on samples including both males and females. In another study of 148 college students, including both sexes, associations between five different functional polymorphisms in dopamine D4 receptor gene and desire, arousal, and sexual function was found (Ben Zion et al., 2006). Interestingly, a recently published study reported that the women's perception of the quality of their marital relationship was influenced by which polymorphism of the gene coding for Arginine vasopressin receptor subtype *V1aR* their husband was carrying (Walum et al., 2008).

In conclusion, both twin and molecular genetic research on female sexual functions and dysfunctions has begun to show the role of genetics, however, it has failed to consider all the types of sexual dysfunctions that may be experienced as well as their possible shared etiology.

The aim in the present thesis was to explicitly investigate to what extent the variation in desire, arousal, lubrication, orgasm, sexual satisfaction, and pain are explained by genetic and environmental influences, respectively. We also explored whether there is an effect of age on genetic and environmental influences, that is, is the etiology of sexual dysfunctions the same for younger (18–33) and older (34–49) women. Finally, we explored whether there is shared etiology between the dysfunctions and if this is the case, is it due to genes, environmental factors, or both.

2.2.2 Environmental Factors Associated with Female Sexual Dysfunctions

Hereafter follows a review of literature concerning some biopsychosocial factors associated with female sexual dysfunctions addressed in the present work. The division into biological and psychosocial factors is not to be seen as suggesting that these factors would be either under purely genetic or environmental influence. Most likely each of them are

under the influence of both genes and environment with both affecting one another. *In the present thesis, the associations between sexual functions and age, relationship duration, relationship satisfaction, partner compatibility, pregnancy, number of children, psychological problems, and alcohol use were investigated.*

2.2.2.1 Age

Sexual functioning is dynamic and changes throughout life with transitions such as first intercourse, being pregnant, having children, and partner availability. Age ultimately affects female sexual functions through processes such as menopause and decreasing health with increasing age (Wince, Bach, & Barlow, 2008). Women aged 26–40 have been reported to have slightly lower sexual desire and fewer pain problems compared to women aged 18–25 (Abdo et al., 2004) but generally, age does not seem to have a large effect in premenopausal women (Laumann et al., 1999; Öberg et al., 2004) even if the findings are somewhat inconsistent. The most reliable findings are a slight decrease in sexual desire and pain problems with age (Abdo et al., 2004; Laumann et al., 1999). Age is confounded with relationship length and number of children with increasing likelihood of longer relationship and more children with increasing age.

2.2.2.2 Relationship Length

The literature concerning the association between relationship duration and sexual functions is scarce. Most studies which have included relationship length have focused on frequency of intercourse, showing a decline in frequency with increased relationship duration (Blumstein & Schwartz, 1983; Call, Sprecher, & Schwartz, 1995; Christopher & Sprecher, 2000; Greenblat, 1983; Klussmann, 2002). After 10 years of marriage, 63% of the couples engaged in sex at least once a week (Blumstein & Schwartz, 1983). Higher frequency of sexual intercourse has been found to be associated with higher sexual and life satisfaction (Dunn et al., 1999), however, once the frequency reached 3–5 times per month increasing frequency after that was not associated with further positive effects (Långström & Hanson, 2006).

2.2.2.3 Relationship Satisfaction

Sexuality is a fundamental factor in intimate relationships (e.g. Christopher & Sprecher, 2000; Haavio-Mannila & Kontula, 1997; Lawrance & Byers, 1995), with general relationship satisfaction being positively correlated with sexual satisfaction (Blumstein & Schwartz, 1983; Byers, 2005; Dunn et al., 1999; Sprecher, 2002). In addition, lower sexual desire

has been associated with marriage dissatisfaction regardless of sexual satisfaction (Hurlbert, Apt, Hurlbert, & Pierce, 2000). Marital difficulties have also been associated with arousal and orgasm problems (Dunn et al., 1999; Hurlbert et al., 2000). Furthermore, Meana et al. (1997) reported that women who suffered from dyspareunia without physical explanatory findings had higher levels of relationship maladjustment compared to matched controls. Overall, women with sexual dysfunctions have been found to report more relationship problems (McCabe & Cobain, 1998).

2.2.2.4 Compatibility with Partner

As already noted, relationship satisfaction, sexual dysfunctions, and sexual distress have been shown to be associated with each other. Most likely these three factors are also influenced by compatibility with one's partner and the partner's sexual problems. For example, women themselves have attributed their sexual function problems to conflict with and sexual dysfunctions of their partner (Kadri et al., 2002). Compatibility in sexual preferences, an ability to communicate one's needs, sharing and understanding of emotions and cognitions have all been found to be associated with women's sexual satisfaction, motivation, and sexual dysfunctions (Hurlbert et al., 2000; Kelly, Strassberg, & Turner, 2006; MacNeil & Byers, 1997; Offman & Matheson, 2005; Purnine & Carey, 1997). For example, Byers (2005) found in a sample of both males and females, poor intimate communication to be associated with a decrease in both relationship and sexual satisfaction over a time period of 18 months.

Women with a male partner suffering from a sexual dysfunction have themselves a higher prevalence of sexual dysfunctions and distress and their sexual interest and satisfaction are negatively affected (Byers & Grenier, 2003; Çayan, Bozlu, Canpolat, & Akbay, 2004; Chevret, Jaudinot, Sullivan, Marrel, & Solesse de Gendre, 2004; Patrick et al., 2005; Riley, 2002; Öberg & Sjögren Fugl-Meyer, 2005). Öberg and Sjögren Fugl-Meyer (2005) found erectile dysfunction and early ejaculation to be associated with distressing orgasm problems and delayed ejaculation to be associated with distressing lubrication problems. In addition, Patrick et al. (2005) as well as Byers and Grenier (2003) found early ejaculation to be associated with decreased sexual satisfaction. Çayan et al. (2004) used the FSFI in their study of women with male partners with erectile dysfunction and found all domains except desire to be negatively associated with erectile dysfunction. The associations are thus quite well established but little research has been undertaken into the reason for these associations. In the FEMALES study the impact of the men's erectile dysfunction on their female partners' sexual experiences was inves-

tigated (Fisher, Rosen, Eardley, Sand, & Goldstein, 2005). The women reported a decline in sexual activity after their partner developed erectile dysfunction as well as a decline in sexual desire, arousal, and orgasm function and decreased sexual satisfaction. In addition, the severity of the men's erectile dysfunction was associated with the frequency of orgasm and sexual satisfaction for the woman. The women whose partner also suffered from early ejaculation reported less frequent orgasm. Based on these results, it can be hypothesized that having a partner who suffers from erectile dysfunction leads to decreased sexual function and sexual satisfaction, in part due to decreased sexual activity and thereby loss of important intimacy. It has been speculated, as pointed out by Heiman et al. (2007) that the decrease in women's sexual function and satisfaction in response to the partners ED might be due to the man withdrawing or the woman blaming herself, feeling less attractive and self-confident, or worrying about him having an affair.

2.2.2.5 Pregnancy and Number of Children

Being pregnant impinges changes on a woman's life, both physiological including hormonal alterations as well as psychological changes. However, between-person variation in sexual functioning during pregnancy is large in addition to within-person variation between the trimesters (Elliott & Watson, 1985; von Sydow, 1999). The most robust finding is a decrease in sexual interest and activity during the last trimester which extends a couple of months postpartum.

The potential problems caused by pregnancy, birth and lactation are commonly apparent during a specific period of time, with sexual intercourse resuming 1–3 months after birth where after sexual activity increases (von Sydow, Ullmeyer, & Happ, 2001). However, becoming a parent also involves changes on an emotional and psychosocial level leading to new ways of acting as a couple (Bitzer & Alder, 2000). These processes might be stressful for the relationship and thus affect sexual function.

Few studies have looked at the impact of number of children on sexual functioning and the results from these studies are not in agreement. Fischman et al. (1986) found that it took longer for first-time mothers to resume intercourse postpartum compared to mothers who previously had given birth. A couple of studies have found that having children is associated with decreased intercourse frequency regardless of number of children (Greenblat, 1983; Jasso, 1985) while yet another found childless and multiparous couples to be similar and higher in coital frequency compared to primiparous couples (Rao & DeMaris, 1995). One study reported decreased desire in women with four or more children

compared to women with fewer children (Kadri et al., 2002) while other studies have found no association between number of children and sexual satisfaction, desire, and coital orgasm or pain (Gruszecki, Forchuk, & Fisher, 2005; Hyde, DeLamater, Plant, & Byrd, 1996).

Having children might also be correlated with sexual function indirectly through its association with relationship satisfaction (Guo & Huang, 2005; Twenge, Campbell, & Foster, 2003). This association is also uncertain with some finding a positive (Guo & Huang, 2005) yet others a negative correlation (Twenge et al., 2003) between having children and relationships satisfaction. There is, however, some evidence of consistency in relationship satisfaction during transition to parenthood (Cowan et al., 1985). For instance, couples expressing a high level of relationship satisfaction tend to do so also as parents.

2.2.2.6 Psychological Problems

Female sexual dysfunctions have repeatedly been shown to correlate with psychological distress such as depression (Baldwin, 2001; Bonierbale, Lancon, & Tignol, 2003; Clayton, 2001; Dunn et al., 1999; Kennedy, Dickens, Eisfeld, & Bagby, 1999). Elevated rates of sexual problems have been reported in women diagnosed with panic disorder (Figueira, Possidente, Marques, & Hayes, 2001) and anxiety disorders (Dunn et al., 1999). Moreover, Laumann et al. (1999) found that emotional or stress related problems were positively associated with sexual dysfunctions.

Depression has been associated with both decreased lubrication (Dunn et al., 1999; Frohlich & Meston, 2002) and decreased sexual satisfaction (Dunn et al., 1999; Frohlich & Meston, 2002), increased pain during intercourse or sexual activity (Abdo et al., 2004; Dunn et al., 1999; Frohlich & Meston, 2002; Kadri et al., 2002), and more orgasmic problems (Dunn et al., 1999; Frohlich & Meston, 2002). In particular, depression has been linked to reduced desire (Bonierbale, Lancon, & Tignol, 2003; Clayton, 2001, 2002; Dunn et al., 1999; Kennedy et al., 1999). However, some studies have found no association or the opposite (Abdo et al., 2004; Frohlich & Meston, 2002). In fact, a study which compared depressed nonmedicated college women to a matched control group of non-depressed college women reported an elevated level of sexual desire for sexual activity alone and no difference in sexual desire for sexual activity with partner (Frohlich & Meston, 2002).

In addition to the association with psychological problems *per se*, anti-depressant medication is known to provoke sexual problems, especially selective serotonin reuptake inhibitors (SSRI; Baldwin, 2001; Clayton, 2002). The effects of the medication might be difficult to separate from the effects of the depression itself. In a large sample of depressed male

and female patients without sexual problems prior to the onset of the depression, 71% of those treated with antidepressants and 65% without antidepressants complained of sexual problems, particularly reduced sexual desire (Bonierbale et al., 2003).

2.2.2.7 Alcohol

Alcohol consumption may be directly associated with a decrease in sexual function due to inhibition of genital response (Covington & Kohen, 1984; George & Stoner, 2000) or indirectly through decreasing negative emotions such as anxiety or depression which may either enhance or reduce sexual functioning (Leonard & Follette, 2002) as well as relaxing sexual inhibitions (Covington & Kohen, 1984; George & Stoner, 2000). Alcohol asserts its effect directly through pharmacological mechanisms but also indirectly through expectancies and beliefs (Beckman & Ackerman, 1995; George & Stoner, 2000). In addition, the severity of the alcohol consumption is of importance. Moderate drinkers have been found to have less sexual dysfunctions compared to both light and heavy drinkers (Klassen & Wilsnack, 1986) while women who met the criteria for heavy alcohol use were more likely to report problems with inhibited orgasm and inhibited sexual excitement (Johnson et al., 2004). In a five year longitudinal study sexual dysfunctions were found to be the strongest predictor of chronic problem drinking (Wilsnack, Klassen, Schur, & Wilsnack, 1991). Yet other studies have not found an association (Laumann et al., 1999). Moreover, there may be a distinction in the effects on sexual function and behavior between acute and chronic alcohol use.

2.3 The Female Sexual Function Index

The basic of research are valid and reliable measures. A number of self-administered questionnaires have been developed in order to measure female sexual function. One highly regarded (Daker-White, 2002; Meyer-Bahlburg & Dolezal, 2007) and widely used is the Female Sexual Function Index (FSFI; Rosen et al., 2000). It has since its publication been translated into several languages (MAPI-institute Mapi Research Trust, retrieved 16.6.2008, http://www.proqolid.org/instruments/female_sexual_function_index_fsfi) repeatedly demonstrating good psychometric properties (Masheb, Lozano-Blanco, Kohorn, Minkin, & Kerns, 2004; Meston, 2003; Rosen et al., 2000; Sidi, Abdullah, Puteh, & Midin, 2007; Ter Kuile, Brauer, & Laan, 2006; Wiegel, Meston, & Rosen, 2005). The FSFI includes 19 items which measure female sexual function during the previous four weeks in six subdomains; desire, subjective arousal, lubrication, orgasm, sexual satisfaction, and pain. Some statistical and conceptual problems concerning the FSFI have been raised (Meyer-

Bahlburg & Dolezal, 2007), among others, the scoring of no sexual activity as zero and the inclusion of these zero responses in the calculation of both the domain scores and the full scale score might overestimate the occurrence of sexual function problems. *The aim was to investigate the psychometric properties of a Finnish-language version of the Female Sexual Function Index (Rosen et al., 2000).*

AIMS OF THE PRESENT STUDY

The general purpose of the thesis was to investigate female sexual functions in a population based sample of Finnish women using the Female Sexual Function Index (Rosen et al., 2000). The FSFI includes 19 item which measures female sexual function during the previous four weeks in six subdomains; desire, subjective arousal, lubrication, orgasm, sexual satisfaction, and pain. The psychometric properties of the Finnish-language version of the FSFI were investigated in order for it to be included in the subsequent studies. The genetic and environmental influences on desire, arousal, lubrication, orgasm, sexual satisfaction, and pain were studied as well as associations of female sexual dysfunctions with age, relationship length, relationship satisfaction, partner compatibility, pregnancy, number of children, psychological problems, and alcohol. These biopsychosocial factors were chosen based on them having been reported to be associated with female sexual functions in the literature (Abdo et al., 2004; Dunn et al., 1999; Fisher, 2005; George & Stoner, 2000; Hurlbert et al., 2000; Kadri et al., 2002; von Sydow, 1999). Other considerations were that the factors should be quite common, important to most women, represent major transitions in life, or be possible candidates for gene-environment interactions.

The specific questions studied were as follows:
1. Are the psychometric properties of a Finnish-language version of the Female Sexual Function Index (Rosen et al., 2000) satisfactory and comparable to other studies and an appropriate measure for female sexual functions in the present sample?
2. What is the prevalence rate of sexual dysfunctions in the Finnish sample?
3. How strong are the phenotypical correlations between sexual dysfunctions?
4. What is the association between sexual dysfunctions and distress, that is, what are the prevalence rates of female sexual dysfunctions in combination with sexual distress?
5. Is sexual distress associated with age, relationship duration, and partner compatibility?
6. To what extent is the variation in female sexual dysfunctions explained by genetic and environmental influences, respectively?
7. Is there an effect of age on genetic and environmental influences, that is, is the etiology of sexual dysfunctions the same for younger (18–33) and older (34–49) women?
8. Is there shared etiology between the dysfunctions and if this is the case, is it due to genes, environmental factors or both?

9. Is there an effect of age on the sexual dysfunctions on a phenotypic level?
10. Are partner relationship variables such as relationship length, relationship satisfaction, and partner compatibility connected to sexual dysfunctions?
11. Do pregnancy and number of children have an effect on sexual functions?
12. Are psychological problems such as depression, somatization, and anxiety, associated with sexual dysfunctions?
13. Is alcohol consumption associated with sexual dysfunctions and is there a difference between the effects of acute and chronic alcohol use?

METHOD

4.1 Participants

This study was part of a larger project "The Genetics of Sex and Aggression Study" at the Center of Excellence in Behavior Genetics at Åbo Akademi University. The participants were a subset from the Genetics of Sex and Aggression (GSA) sample. The median age of menopause for women in Finland is 51 (Luoto, Kaprio, & Uutela, 1994) and the sample was chosen as likely to be premenopausal. The main GSA sample consists of two data collections. The first data collection was carried out in 2005 and targeted 33–43-year-old twins. Questionnaires, followed by a reminder letter and later a new questionnaire were sent to a total of 10,000 individuals, of which 5,000 were females. The questionnaires were finally returned by 2,267 females, resulting in a response rate of 45%.

The second data collection was carried out in 2006 (there was no overlap between the samples) and targeted twins aged 18–33 years and their over 18-year-old siblings. A total of 23,577 individuals, 7,680 of them female twins and 3,983 female siblings, were contacted by post and asked if they would be interested in completing a sexuality-related questionnaire. Participants who consented to participate were given the option of completing the questionnaire by post or online through a secure webpage. Next, the questionnaire was sent, followed by a reminder letter. A total of 6,601 females responded to the survey. The response rates were 58% for the female twins (n = 4,425) and 55% for the female siblings (n = 2,176); of these, 6% (n = 428) had incomplete data. When both data collections were combined, a total response rate of 53% (n = 8,868) was achieved. All twins and siblings in both data collections were identified from the Finnish Central Population Registry. All participants were native speakers of Finnish. The questionnaires were extensive and covered a broad range of sexual behavior and attitudes, childhood experiences, aggression, and alcohol use. The purpose of the study was clearly described and the voluntary and anonymous nature of the participation emphasized.

Studies I and II were based on the first data collection, Study III on both data collections and Study IV on the second data collection. The women included in the analyses had reported some sexual activity during the past four weeks and in addition, did not have more than five responses of the 19 items of the Female Sexual Function Index (Rosen et al., 2000) missing. The remaining missing values were replaced with item specific means separately for each age group. The numbers of women included in each study are reported in Table 1.

Table 1

An Overview of Questions Studied, Data Collections, and Participants in the Original Studies.

Study	Questions studied	Data collection	Participants (N)	Age of participants
I	Psychometrics of FSFI Prevalence of FSD Phenotypical associations with age, psychological problems, alcohol	I	2,081 twin individuals	33–43
II	Phenotypical associations between FSD, relationship satisfaction, number of children, and pregnancy	I	2,081 twin individuals	33–43
III	Psychometrics of FSFI Genetic and environmental influences on FSD, including age effects Shared genetic and environmental influences between the FSD	I and II	5,791 twin individuals 1,778 siblings 712 full MZ pairs 559 full DZF pairs 1,050 twin-sibling pairs 344 sibling-sibling pairs	Twins: 18–43 Siblings: 18–49
IV	Diagnostics of FSD Prevalence of FSD *per se* and in combination with sexual distress Associations of FSD with age, sexual distress relationship length, and partner compatibility	II	3,704 twin individuals 1,759 siblings	Twins: 18–33 Siblings: 18–49

FSFI = Female Sexual Function Index
FSD = female sexual dysfunctions

4.2 Measures

A short description of the main measures used in the present study appears below. In addition, the women were asked about current relationship length if in one, whether they were pregnant or not, and number of children. The categories of relationship length were (1) less than a month (2) 2–6 months (3) 7–12 months (4) 1–3 years (5) 4–10 years (6) more than 10 years. All measures were translated into Finnish.

4.2.1 Female Sexual Function Index (Studies I–IV)

The multidimensional Female Sexual Function Index (FSFI; Rosen et al., 2000) includes 19 items which measure female sexual function during the past four weeks. In addition to an overall measure of sexual function, FSFI provides measures for six subscales; desire, arousal, lubrication, orgasm, satisfaction, and pain. The answers are scored on Likert-type scales ranging from 0–5 or 1–5 with higher scores indicating better sexual functioning. The questionnaire was psychometrically further evaluated by Wiegel et al. (2005) and a diagnostic cut-off score was developed for differentiating women with and without sexual dysfunction. This optimal cut-off point for the total score of FSFI (tot-FSFI) was found to be 26.55. In the present studies, the response option "no partner" was added to question 15: "Over the past 4 weeks, how satisfied have you been with your sexual relationship with your partner?" which, analogous with the response options of other questions, was given the value of zero. This improvement has also been suggested by others (Meyer-Bahlburg & Dolezal, 2007).

4.2.2 Female Sexual Distress Scale (Study IV)

The unidimensional Female Sexual Distress Scale (FSDS; Derogatis, Rosen, Leiblum, Burnett, & Heiman, 2002) was developed in order to assess sexually related personal distress, a necessary criterion in diagnosing female sexual disorders. It consists of 12 items with answers made on a 5-point scale ranging from never to always with a higher score indicating more distress. It has been shown to meet high psychometric standards and to be robust and generalizable across populations investigated (Derogatis et al., 2002; Derogatis, Clayton, Lewis-D'Agostino, Wunderlich, & Fu, 2008; Ter Kuile et al., 2006). Derogatis et al. (2002) reported a cut-off score of 15 for the 12-item sexual distress scale for differentiating between women with and without sexual dysfunctions. In the present study, the respondents were asked to fill in seven of the original items, all beginning with the same preamble: How often did you, during the last 30 days, feel

(1) distressed about your sex life, (2) guilty about sexual difficulties, (3) stressed about sex, (4) sexually inadequate, (5) regrets about your sexuality, (6) embarrassed about sexual problems, (7) dissatisfied with your sex life?

4.2.3 Perceived Relationship Quality Components Inventory (Study II)

The Perceived Relationship Quality Components Inventory (PRQC; Fletcher, Simpson, & Thomas, 2000) is an 18 item self-report scale which evaluates relationship quality over six dimensions: satisfaction, commitment, intimacy, trust, passion, and love, each subscale consisting of three items. However, in order to assess global perceived relationship quality, the authors suggested a short form comprising six items, one item from every subscale. The short version was used in the present study.

4.2.4 Compatibility with Partner (Study IV)

The women who were in a steady relationship were asked about their sexual compatibility with their partner. The question was "What kind of recurrent sexual problems do you experience in your relationship (you can choose multiple items)? The options were:
(1) too little foreplay before intercourse *(too little foreplay)*
(2) too much foreplay before intercourse *(too much foreplay)*
(3) your partner is more interested in sex than you are *(partner more interested)*
(4) in your opinion, your partner cannot do things in the right way during sexual activity *(partner cannot do)*
(5) in your partner's opinion, you cannot do things in the right way during sexual activity *(you cannot do)*
(6) your partner has sexual needs that you do not want to satisfy *(you do not want to)*
(7) you have sexual needs that your partner does not want to satisfy *(partner does not want to)*
(8) in your opinion, your partner is not attractive enough *(partner unattractive)*
(9) you can not talk openly about sex *(poor communication)*
(10) your partner has erection problems *(erection problems)*
(11) your partner has problems with early (premature) ejaculation *(early ejaculation).*

4.2.5 Brief Symptom Inventory-18 (Study I)

The Brief Symptom Inventory-18 (BSI 18; Derogatis, 2000) assesses psychological distress within the past seven days on three dimensions: so-

matization, depression, and anxiety. This was developed for screening in community and medical populations and contains 18 items, six for each dimension and the answers are scored on a 5-point Likert scale ranging from *Not at all* to *Extremely,* with higher scores indicating more distress. In addition to scores for the three scales, a Global Severity Index (GSI) score based on the 18 items is obtained. Based on an exploratory factor analysis 17 of the 18 items loading on 4 factors (depression, anxiety, panic, and somatization) were used in the present study. This division of the anxiety scale into anxiety and panic scales is supported in the manual (Derogatis, 2000).

4.2.6 Alcohol Use Disorders Identification Test (Study I)

The first three items (frequency of drinking, typical quantity, frequency of heavy drinking) of the Alcohol Use Disorders Identification Test (AUDIT; Babor, Higgins-Biddle, Saunders, & Monteiro, 2001) were used for measuring hazardous alcohol use. Each item's response option ranged from 0 to 4, with a higher score indicating more alcohol use. In addition to the AUDIT, a question which investigated the amount and frequency of alcohol usage in connection to sexual intercourse was used. A higher score indicates greater alcohol consumption on both AUDIT as well as on the single question.

4.3 Zygosity Determination

Zygosity of the twins was determined using three questionnaire items (Sarna, Kaprio, Sistonen, & Koskenvuo, 1978) which have been shown to be 95% accurate in zygosity determination compared with blood typing analyses (Eisen, Neuman, Goldberg, Rice, & True, 1989)

4.4 Statistical Analyses

The basic statistical analyses were performed using SPSS 13.0. The exploratory factor analyses (EFA) were conducted using maximum likelihood extraction with oblimin rotation. A factor loading > .50 for the intended factor was considered good. In order to achieve a simple factor structure it is desirable that an item does not have a factor loading > .30 on any other factor than the intended one. The confirmatory factor analyses (CFA) were performed using AMOS Graphics 5.0.1. and the models were estimated using maximum likelihood. Due to the fairly large sample and given the potential limitations of the χ^2 test (Mulaik et al., 1989; Thompson, 2004), we chose to report and consider five additional measures of model fit: the normed-fit index *(NFI),* the goodness-of-fit index *(GFI),* the root-mean-square error of approximation *(RMSEA),* the

Akaike information criterion *(AIC),* and Hoelter's "critical *N.*" The fit of the model was considered to be supported if the *NFI* was greater than .95 (Thompson, 2004), if *GFI* was greater than .90 (Arbuckle & Wothke, 1999), if *RMSEA* was roughly equal to or less than .06 (Thompson, 2004), and Hoelter's "critical *N*" was greater than 200 (Arbuckle & Wothke, 1999). The *AIC* was used for comparing models, with a lower value indicating better fit. In order to avoid dependence, members of a twin pair were included in separate factor analyses or only one randomly chosen member of a family was included.

For phenotypic analyses, the Complex Samples procedure in SPSS was used. This procedure allows the data to be correlated and adjusts the estimates of standard errors, thus allowing inclusion of members from the same family simultaneously. The statistical tests used were general linear model, test of independence of rows and columns in a cross-tabulation, and logistic regression. In Study III, the Mx statistical package (Neale, Boker, Xie, & Maes, 2003) was used for analyzing means, variances, phenotypical correlations as well as twin correlations.

Genetic analyses were conducted using the Mx statistical package (Neale et al., 2003). In genetic analyses, models are tested that decompose observed (phenotypic) variation in a variable of interest into additive genetic influences *(A),* nonadditive genetic influences *(D),* shared environmental influences *(C),* and nonshared environmental influences *(E),* which also includes measurement error (i.e., $Vp = A + D + C + E$). Genetic and environmental influences can be separated in the twin design because genetic resemblance varies as a function of zygosity, whereas familial resemblance due to shared environmental influences is assumed to affect MZ and DZ twins equally (Plomin et al., 2001). Specifically, MZ twins are genetically identical, whereas DZ twins on average share 50% of their segregating genes. However, dominant genetic effects and shared environmental effects cannot be estimated simultaneously with twin data only. Depending on the correlations between the MZ and the DZ twins either an *ACE* or an *ADE* model was fitted.

First, univariate models were fitted and, second, three multivariate models were tested: a correlated factors model, an independent pathway model and a common pathway model. The correlated factors model is the least restricted one and the one against which the other multivariate models are tested. It provides estimates of the genetic and environmental correlations among traits. The independent pathway model includes specific as well as common environmental and genetic components. Finally the common pathway model assumes that the covariance in the traits of interest is explained by a latent construct which is under genetic and environmental influences.

Raw variables regressed for age were used in all model-fitting scripts using Mx with maximum likelihood estimation. This method allows inclusion of singletons, that is, when only information from one twin of a twin pair is available, as well as the siblings of twins, thereby increasing the power of the analysis. The fit of the nested models was assessed by the likelihood ratio test by taking the fit function (–2 × log-likelihood of data) and the degrees of freedom of the full model and subtracting it from the fit function and degrees of freedom of the nested restricted models. The subtraction gives a χ^2-value and associated degrees of freedom which can be tested for significance. A non-significant χ^2-value indicates that the more parsimonious model does not have a significant worse fit than the full model and can thus be accepted. In addition, the Akaike information criterion (AIC = χ^2 –2 × degrees of freedom) was considered. A lower value indicates a better fit of the model to the observed data (Akaike, 1987).

In Study IV, the sexual distress and sexual dysfunctions composite scores were dichotomized resulting in yes/no categories by using cut-off points. The means for sexual functional women minus one standard deviation were used as tentative cut-off points. The FSDS scale has cut-off points for categorizing women into sexual functional versus dysfunctional. This was used in the present study but since only seven of the original items were used the cut-off point was adjusted accordingly. For more details see Method section in Study IV.

RESULTS

5.1 Psychometric Properties of FSFI (Studies I and III)

The evaluation of the FSFI was conducted in two different studies (Study I and Study III) with two partly different samples. Study I was based on a sample of female twins aged 33–43. Study III additionally included twins aged 18–33 as well as their female siblings aged 18–49. In Study I the EFA and the CFA were thus conducted with 33–43 year old female twins while in Study III the EFA and CFA were conducted with two age groups: 18–33 and 34–49. Part of the women in Study I were also included in the analyses in Study III, consequently the results are to some extent overlapping.

In all three age groups there were four factors with an eigenvalue > 1, however, the theoretically clearest solution was one with six factors. In the four factor solution, for the age group 18–33, desire and arousal items loaded on one factor, two of the satisfaction items and the pain items on another while orgasm items and lubrication items loaded on separate factors. In the older age group, desire, arousal, and lubrication items all loaded on one single factor while the orgasm, satisfaction, and pain items each loaded on separate factors. A similar pattern was found in the five factor solution. For the age group 18–33, the desire, lubrication, orgasm, satisfaction, and pain items each loaded on separate factors, while the first two arousal items cross loaded on the desire and lubrication factor and the last two arousal items clearly loaded on the lubrication factor. For the older women the lubrication, orgasm, satisfaction, and pain items all loaded clearly on separate factors and all desire and arousal items clearly loaded on one common factor.

For the six factor solution, item 4 had a complex loading and in age group 18–33 (Study III) item 7 had complex loadings. Item 4 had a loading of .38 for the intended factor arousal and a cross loading of .32 on the desire factor. Item 7 had a loading of -.53 on the intended factor lubrication and a cross loading of .42 on the arousal factor. In addition, items 4 and 5 had a weak loading (< .50) for the intended factor in age groups 33–43 (Study I) and 34–49 (Study III). The variance explained by a six factor solution ranged between 72%–77%. Further, the six factor models with all factors allowed to correlate were evaluated using CFA. The models for age groups 18–33 and 34–49 were estimated using multi group CFA while a one group CFA was used in Study I. The fit of the models was good in each instance $CFI \geq .960$, $GFI \geq .924$, $NFI \geq .956$, Hoelter's critical $N \geq 222$, and $RMSEA = .067$ and $PCLOSE = .000$ in age group 33–43 and $RMSEA = .045$ and PCLOSE = 1.000 in the multi group

CFA. The reliability was excellent for all subscales in each analysis (desire, Cronbach's α = .72–.76; arousal, α = .90–.92; lubrication, α = .94–.96; orgasm, α = .90–.91; satisfaction, α = .86–.88; pain, α = .96–.97).

5.2 Classification and Prevalence (Studies I and IV)

When using the previously published cut-off point for the total scale score of the FSFI, the proportions of women classified as sexually dysfunctional *per se* were highly comparable between the two data collections, 33% in the age group 33–43 years (Study I) and 34% in the age group 18–49 years (Study IV). There was no overlap in samples between these two studies. One essential criterion for diagnosing female sexual disorders according to DSM-IV is, however, that the sexual dysfunctions are associated with "marked distress or interpersonal difficulty" (p. 538). Therefore, the associations between sexual dysfunctions and sexual distress were investigated (Study IV).

Based on the cut-off scores, the women were classified as having a sexual dysfunction *per se* or not and feeling sexual distress or not. Thirty-six percent of the women were classified as feeling distress. The dichotomized variables dysfunction *per se* and feeling sexual distress were then cross tabulated in order to get the prevalence estimates for sexual disorders. The women feeling sexual distress in combination with sexual dysfunction were substantially less than those reporting sexual dysfunctions *per se*. The prevalence for sexual dysfunctions *per se* ranged from 11–55% and sexual disorders from 7–23% depending on the type of dysfunction (Table 2).

Table 2

Prevalence (%) of Sexual Dysfunctions per se and Sexual Disorders, that is, Sexual Dysfunction in Combination with Sexual Distress.

	Sexual dysfunctions *per se*	Sexual Disorders	Ratio sexual disorder / sexual dysfunction
Desire	55.4	23.1	0.4
Arousal	18.4	11.9	0.6
Lubrication	11.0	7.0	0.6
Orgasm	31.5	16.3	0.5
Satisfaction	25.0	15.4	0.6
Pain	20.9	11.3	0.5
Tot FSFI	34.4	20.5	0.6

Note. The ratio shows the relationship between the proportions of women reporting sexual disorders compared to the proportion of women reporting sexual dysfunctions *per se*. Sexual distress was overall reported by 36% of the women.

5.3 Comorbidity between Sexual Dysfunctions
(Studies I and III)

In Study I (age group 33–43), the phenotypical correlations between the sexual functions were all significant with the highest correlations between arousal and lubrication (.82) and arousal and orgasm (.81). The lowest correlations were between desire and pain (.31) and orgasm and pain (.36). These estimates are the correlations between the latent factors in the CFA and thus do not include error of measurement.

In Study III, the phenotypical correlations were obtained by using the Mx statistical package which allows for inclusion of related individuals. These correlations include measurement error. The correlations were thus lower than in Study I but were still all significant. The highest correlations were yet between arousal and lubrication (.69) and arousal and orgasm (.60). The lowest were between desire and pain (.18) and orgasm and pain (.21).

In order to further investigate the associations between sexual dysfunctions when dichotomized into no dysfunction versus dysfunction new analyses not included in the published studies were performed by using cross-tabulation. These analyses were based on the same sample and categorization as in Study IV and the correlations are thus between sexual dysfunctions *per se*. The results are shown in Table 3. The strongest association was once again between arousal and lubrication (odds ratio 32.45) and the second strongest was now between satisfaction and pain (odds ratio 13.04). The weakest associations were between desire and orgasm (odds ratio 1.38) and between desire and pain (odds ratio 1.58). The comorbidity was hence considerable.

In conclusion, the correlations between sexual functions were substantial and robust regardless of the method used in the analyses.

Table 3

Odds Ratio (95% Confidence Intervals) from 2-by-2 Tables for Dichotomized Sexual Dysfunction Variables.

	Desire	Arousal	Lubrication	Orgasm	Satisfaction	Pain
Desire	1					
Arousal	4.23 (3.58–5.01)	1				
Lubrication	2.55 (2.11–3.09)	32.45 (25.96–40.56)	1			
Orgasm	1.39 (1.24–1.56)	11.37 (9.67–13.37)	9.80 (7.98–12.03)	1		
Satisfaction	1.88 (1.65–2.13)	8.20 (7.06–9.52)	9.93 (8.17–12.07)	3.24 (2.85–3.67)	1	
Pain	1.58 (1.37–1.81)	4.36 (3.76–5.06)	8.63 (7.20–10.35)	2.22 (1.94–2.55)	13.04 (11.19–15.20)	1

Note. Odds ratio indicates the relative risk of reporting one sexual dysfunction when another sexual dysfunction is present.

5.4 Factors Associated with Sexual Distress (Study IV)

In order to develop effective treatments for female sexual disorders, it is equally important to explore which factors are associated with sexual distress. Three different factors' associations with sexual distress were explored. Sexual distress was not affected by age ($B = 0.01$, $SE\ B = 0.01$, $t\ (3201) = 1.87$, $p > .06$, $R^2 = .001$). Relationship length, on the other hand, was positively associated with sexual distress, that is, the longer the relationship, the more sexual distress. The association remained significant when age was simultaneously entered as a predictor.

Further, the associations between sexual distress and the partner compatibility items were significant. Except for three items *too little foreplay, you do not want to,* and *early ejaculation,* more than double the women feeling sexually distress answered yes to the items compared to women not feeling distress. For example, 31% of the women feeling sexual distress also reported poor communication compared to 9% of the women not feeling sexual distress.

In order to scrutinize the associations further new analyses not included in Study IV but based on the same material were performed. All variables significantly associated with sexual distress were included as predictors in a multiple regression analysis with sexual distress as dependent variable. The significant associations remained except for three variables: lubrication dysfunction, *you do not want to,* and *early ejaculation* (results not shown). The women being in a relationship lasting less than a month were less likely to feel sexually distressed compared to women being in a relationship for more than 10 years. In contrast, the women who had been in their relationship for more than a month but less than half a year felt more sexually distressed compared to women being in a relationship for more than ten years. Sexual dissatisfaction had the highest odd ratio 3.02 (95% CI 2.41–3.80) followed by *partner more interested* 2.74 (95% CI 2.33–3.22), *poor communication* 2.67 (95% CI 2.19–3.26), *erection problems* 2.53 (95% CI 1.72–3.71), *too much foreplay* 2.40 (95% CI 1.46–3.94), pain dysfunction 2.08 (95% CI 1.66–2.61), and *you cannot do* 2.08 (95% CI 1.45–2.97). The remaining variables were significantly associated with an odd ratio > 1.22 but < 2.00. The predictors explained about 36% of the variance in sexual distress (Nagelkerke pseudo $R^2 = .36$). Sexual distress was thus associated with higher levels of sexual dysfunctions but also with relationship length and incompatibility with partner.

5.5 Genetic and Environmental Influences on Female Sexual Dysfunctions (Study III)

There was no significant decrease in model fit when constraining the additive genetic or the shared environmental parameters to be equal across the age groups 18–33 and 34–49. Consequently, the genetic models were fitted to data including the women from both age groups. First, univariate *ACE* and *ADE* models were fitted to the data separately for every dysfunction. Nonadditive genetic effects *(D)* were significant for desire and orgasm whereas there was no significant effect of shared environment for any of the dysfunctions. Hence, secondly, multivariate *ADE*-models were tested starting with a correlated factors model against which the subsequent models, independent pathway model and common pathway model, were tested. The *ADE*-correlated factors model provided the best fit with modest additive genetic and nonadditive genetic effects, 3–11% and 5–18%, respectively, depending on type of sexual dysfunction. Thus, most of the variance in sexual dysfunctions was due to nonshared environmental influences.

The correlated factors model estimates the correlations between the genetic and environmental effects for each factor, that is, to what extent the sexual dysfunctions share the same genetic and environmental etiology. All in all there were 15 correlations. The additive genetic correlations were positive and significant except for four correlations. Eight of the nonadditive correlations were positive and significant while all nonshared environmental correlations were positive and significant. The implication of the correlations being positive is that the same genes and the same environmental factors affect the different sexual functions in the same direction, respectively. The highest additive genetic and nonshared environmental correlations were between arousal and lubrication (.94 and .65 respectively) while the highest nonadditive genetic correlation was between arousal and orgasm (.85). There were no shared genetic factors between pain and lubrication, while the nonadditive genetic correlation between pain and sexual satisfaction was .45. The correlation between the nonadditive genetic factors for desire and arousal was .66.

5.6 Factors Associated with Female Sexual Dysfunctions (Studies I–IV)

As reported above, most of the variation in female sexual dysfunctions was due to nonshared environmental influences, that is, unique experiences and factors that make siblings growing up in the same family different. In the following paragraphs, a summary of some of the supposedly environmental factors, which in the present study were found, to be associated with females sexual function, are presented. Table 4 contains a summary of the associations for women aged 33–43 from Study I and II in which the sexual function variables were continuous. In Table 5 a summary of the associations with dichotomous dysfunction variables are shown including the association with sexual distress.

5.6.1 The Effect of Age (Studies I, III, IV)

Age had an effect only on pain in the age range of 33–43 years (Study I). In the broader age range of 18–49 years, age had a significant effect on every sexual function except sexual satisfaction, when the sexual function variables were used as continuous variables (Study III). Desire and arousal problems increased with age whereas lubrication, orgasm, and pain problems decreased. The variation explained was small ranging between 1–4%. When the sexual function variables were dichotomized into no dysfunction versus dysfunction the effect of age was significant for every dysfunction with similar effects sizes as when using continuous variables (Study IV). However, the effect of age was confounded by relationship length. As expected, age predicted relationship length and explained 20% of the variation in relationship length. When age and relationship length were entered simultaneously as predictors in logistic regression analyses, the effect of age was no longer significant for arousal and lubrication. The effect of age, over and above the effect of relationship length, was negative for desire and sexual satisfaction and positive for orgasm and pain.

5.6.2 Relationship with Partner (Studies II and IV)

In Study II, general satisfaction with the relationship with partner was assessed in women aged 33–43 years. The more satisfied the women were with their relationship the better was every sexual function. The shared variance between relationship satisfaction and sexual satisfaction was 32%. For the rest of the sexual dysfunctions the shared variance ranged between 3% (desire) to 10% (orgasm). Number of children was not associated with relationship satisfaction. However, women pregnant with the first child were slightly more satisfied with their relationship than matched nonpregnant women without children.

In Study IV, the associations between relationship length and continuous dysfunction and distress variables were analyzed using logistic regression. Relationship length was significantly associated with every dysfunction except pain as well as with distress, the longer the relationship, the more distress and sexual dysfunction except for orgasm. These associations were significant both when entered as single predictor as well as when entered wit age simultaneously. The effect sizes were small except for desire (Nagelkerke Pseudo $R^2 = .13$).

Compatibility with partner was assessed in women aged 18–49 (Study IV). The women who were in a relationship *(n = 4501)* were asked to mark which of the partner compatibility statements were true. The proportion of women answering yes to any of these statements ranged between 2% for *too much foreplay* to 42% for *too little foreplay. Partner more interested* was the second most common incompatibility reported by 35% of the women followed by 17% reporting *partner cannot do* and 17% reporting *poor communication.* Regarding partners dysfunctions, 16% of the women reported that their partner had problems with early ejaculation while only 4% reported that their partner had problem with erection. These dichotomous items were analyzed against dichotomous sexual dysfunction variables using cross-tabulation. Cross-tabs give a χ^2-value and an associated significance level for the hypothesis that a row and a column are independent. The only compatibility item not significantly associated with any sexual dysfunction was *too much foreplay.* For all the other compatibility items more women reporting a sexual dysfunction also reported more incompatibility with partner. *Partner cannot do, you cannot do, you do not want to, partner does not want to* were significantly associated with every dysfunction, while *too little foreplay, poor communication* and *erection problems* were associated with every dysfunction except desire. *Early ejaculation* was significantly associated with arousal, lubrication, orgasm, and sexual satisfaction dysfunctions.

5.6.3 Pregnancy and Number of Children (Study II)

The women pregnant with their first child had less pain problems than matched nonpregnant controls. Parous pregnant women, on the other hand, had more orgasm problems than matched parous nonpregnant women.

Women with children, in the age group 33–43 years, had less pain problems and were sexually more satisfied than women without children. In addition, multiparous women had less orgasm problems. On the other hand, women with no children had more desire than women with 2–3 children while women with ≥4 children had a similar level of desire as nulliparous women.

5.6.4 Psychological Problems (Study I)

Depression, anxiety, somatization, and panic were associated with every dysfunction except desire in the age group 33–43 years. All associations were negative, in other words, the more psychological distress, the more sexual function problems. Depression, anxiety, and panic were most strongly associated with sexual satisfaction with a shared variance of 6%, 2%, and 1% respectively. Somatization, on the other hand, was most strongly associated with pain with a shared variance of 2%.

5.6.5 Alcohol (Study I)

For the women aged 33–43 years, alcohol consumption in general was negatively associated (more drinking, less sexual function problems) with every sexual function problem except sexual satisfaction. The shared variance was less than 1% for each dysfunction. The women were also inquired about the frequency of alcohol in connection to sexual intercourse. Based on their answers the women were divided into three categories, those who rarely or never used alcohol (74%), those who drank alcohol sometimes but less than half of the times (18%) and those who drank more than half of the times (8%). The women who used alcohol prior to intercourse less than half of the times reported more desire than those who rarely or never used alcohol. The means for the other sexual dysfunctions were similar for the women in these two groups. On the other hand, the women who more than half of the times drank alcohol prior to intercourse had more arousal, lubrication, and orgasm problems than the women who rarely or never used alcohol. Furthermore, they were less sexually satisfied.

Table 4

A Summary of Main Associations of Female Sexual Functions for Women in the Age Group 33–43 Years.

Independent Variables	Desire	Arousal	Lubrication	Orgasm	Satisfaction	Pain
Age						+
Alcohol consumption						
– in general	+	+	+	+		+
– prior to intercourse	Women drinking sometimes more desire than those drinking rarely or never	Women drinking often less arousal than those drinking rarely or never	Women drinking often less lubrication than those drinking rarely or never	Women drinking often less orgasm than those drinking rarely or never	Women drinking often less satisfied than those drinking rarely or never	
Psychological problems						
– depression		–	–	–	–	–
– arousal		–	–	–	–	–
– panic		–	–	–	–	–
– somatization		–	–	–	–	–
Pregnant vs. nonpregnant						
– nulliparous						+
– multiparous				–		
Number of children	Nulliparous women more desire than women with 2–3 children. Women with ≥ 4 children same level of desire as nulliparous			Multiparous better orgasm function than nulliparous		Parous women less pain than nulliparous
Relationship satisfaction	+	+	+	+	+	+

Note. + indicates that an increase in the independent variable correlates with an increase in the sexual function, i.e. less dysfunction
     – indicates that an increase in the independent variable correlates with a decrease in the sexual function, i.e. more dysfunction
     Empty space means no significant association.

Table 5

A Summary of Main Associations from Univariate Analyses of Female Sexual Dysfunctions for Women in the Age Group 18-49 Years.

Independent Variables	Desire Dysfunction	Arousal Dysfunction	Lubrication Dysfunction	Orgasm Dysfunction	Satisfaction Dysfunction	Pain Dysfunction
Age	+	+	+	−	+	−
Relationship length	+	+	+	−	+	
Sexual Distress	+	+	+	+	+	+
Compatibility items						
Too little foreplay		+	+	+	+	+
Too much foreplay						
Partner more interested	+	+	+	+	+	+
Partner cannot do	+	+	+	+	+	+
You cannot do	+	+	+	+	+	+
You do not want to	+	+	+	+	+	+
Partner does not want to	+		+	+	+	+
Partner unattractive	+	+	+	+	+	+
Poor communication		+	+	+	+	+
Erection problems		+	+	+	+	+
Early ejaculation		+	+	+	+	+

Note. The dysfunction variables, sexual distress and compatibility items were dichotomous.
Note that this table looks at association with dysfunctions while table 4 reported associations with sexual functions.
+ indicates a higher risk off being classified as having the dysfunction
− indicates a smaller risk off being classified as having the dysfunction
   Empty space means no significant association.

DISCUSSION

6.1 Psychometric Properties of FSFI (Studies I and III)

The results from both Study I (age group 33–43) and Study III (age groups 18–33 and 34–49) support earlier findings of a six factor solution for the FSFI, with an acceptable if not excellent fit for all age groups. Some evidence for complex loading was found for items number 4 (Study I) and 7 (Study III age group 18–33). The internal consistencies were in all age groups acceptable for desire and excellent for the other subscales. Since part of the women in Study I were included in the analyses in Study III the results are to some extent overlapping, especially between Study I and the age group 34–49 in Study III. In conclusion, the FSFI seems to function well also in non-clinical samples.

The six factor solution was not supported by the eigenvalues but based on it replicating the theoretical structure of the FSFI as well as based on clinical considerations the six factor solution was retained (Rosen et al., 2000; Wiegel et al., 2005). In Study III, the desire, arousal, and lubrication items were not clearly separated in the four and five factors solutions. In addition, the pattern of loadings differed between younger (18–33) and older women (34–49). DSM-IV-TR makes no distinction between subjective and genital arousal. An international multidisciplinary group, on the other hand, recommended separate diagnoses for (1) sexual interest/ desire disorder, (2) subjective sexual arousal disorder, (3) genital arousal disorder, and (4) combined genital and subjective arousal disorder (Basson et al., 2003). Considering that physiological and subjective arousal repeatedly have been reported to be in poor agreement for women (Graham, Sanders, Milhausen, & McBride 2004; Laan, Everaerd, van der Velde, & Geer, 1995) and that the psychophysiological response patterns to erotic stimuli have been shown to differ between women with genital and subjective arousal (Brotto et al., 2004), the recommendations can be justified. Separating between subjective and genital arousal as well as sexual desire or interest might be therapeutically important in opting for treatment. The fact that the items intended to measure desire, subjective arousal, and genital arousal were intertwined in the four and five factors solutions in the present study most probably reflects their close relationship and that they are not physiologically or psychologically confined to separate stages. Basson (2001b, 2001c, 2002b) has suggested a cyclic model with reciprocal effects of desire and arousal and this model might at least in the long term relationships be more adequate than the linear stage model upon which DSM-IV and ICD-10 rest.

A zero response option was added to item 15, allowing the response "no partner". This change was independently suggested by Meyer-Bahlburg and Dolezal (2007). Since the item asks about sexual satisfaction with partner it seems appropriate that the women are able to answer "no partner". This does not mean, however, that they have not had sexual activity by themselves or with someone whom they consider not to be a regular partner. This leads to another issue concerning the scoring of the FSFI, namely, how to treat the zero responses. In the original FSFI, 15 of the 19 items have a zero response option indicating either "no sexual activity" or "did not attempt intercourse". Assuming that the zero response option is added to item 15, the woman can score 0 points on 16 questions and a maximum of 15 points on the total FSFI. This would classify the woman as having a sexual dysfunction (cut-off point at 26 points). For the time period of four weeks there might, however, be several reasons for not having sexual activity besides sexual function problems. In the present studies, all women who had throughout answered no sexual activity or no partner were deleted which might reduce the bias. On the other hand, it is impossible to know why they did not have any sexual activity. This question has also been raised by Meyer-Bahlburg and Dolezal (2007) who suggested that zero responses should be treated as missing values. However, Meyer-Bahlburg and Dolezal (2007) argue that desire and satisfaction domains can be computed even if the woman has not been sexually active. Another suggestion would be to enquire about whether any sexual activity has taken place during the past four weeks and if not ask the respondent to give the reason for it. Considering the good psychometric properties and the applicability of the FSFI in different samples and cultures, future methodological studies should be conducted in order to address the above raised questions.

6.2 Classification and Prevalence (Studies I and IV)

In the present studies, the prevalence estimate for having any sexual dysfunction as defined by using the cut-off point for the total score of FSFI was approximately 33% which is highly comparable to frequently reported estimates (King et al., 2007; Laumann et al., 1999).

In Study IV, the prevalence estimates for the different dysfunctions were based on cut-off points derived from scale-specific means for women without sexual dysfunction minus one standard deviation as reported in Wiegel et al. (2005). According to the FSFI, more than half of the women (55%) had desire dysfunction *per se*. The lowest prevalence estimate for a sexual dysfunction *per se* was found for lubrication (11%). These estimates are comparable to those reported by Hayes et al. (2006) in their review of prevalence studies based on community samples.

Across the 11 studies included, desire problems were most common followed by orgasm problems. The estimates from the present study were slightly lower than the mean prevalence estimates from the 11 studies; however, the range was wide across the studies.

The prevalence estimates for sexual disorders, that is sexual dysfunction in combination with sexual distress, were considerably lower compared to sexual dysfunctions *per se* which is consistent with previous studies (Bancroft et al., 2003; Dennerstein et al., 2006; King et al., 2007; Öberg et al., 2004). The ratio of sexual disorder to sexual dysfunction was lowest for desire disorder, similar to findings reported by King et al. (2007). The reason for this is unclear. It might be that the current concept and definition of desire is not very well in tune with the woman's own perception of desire and, therefore, the association with distress is lower compared with the other dysfunctions. Questions about the relevance of the current definition of desire has been raised by for example Basson (2002b). According to the FSDS (Female Sexual Distress Scale), 36% were classified as having clinical levels of sexual distress but these women were not exactly the same as those classified as having a sexual dysfunction. So far, the studies that have assessed sexual distress have found two things, women might feel sexual distress without concomitant sexual dysfunction as well as having a sexual dysfunction without distress. As suggested in the literature, the overall emotional and sexual quality of the relationship with partner might be an important factor influencing whether the woman feels distress or not (Bancroft et al., 2003; Hayes et al., 2008; King et al., 2007; Öberg & Sjögren Fugl-Meyer, 2005). Likewise, a poor emotional relationship with partner might lead to distress from sexual activity with partner also in the absence of own sexual function problems. The level (mild or severe) and duration (acquired or lifelong) of the sexual dysfunctions may also be of importance for whether the dysfunction is accompanied with distress. As seen from the results in Study IV sexual distress as measured by FSDS is not the same as sexual dissatisfaction as measured by FSFI, even though they are highly associated. Questions like what sexual distress really implies and why some women are classified as sexually dysfunctional but do not feel distressed by their problems need to be addressed in future studies.

6.3 Comorbidity between Sexual Dysfunctions
(Studies I and III)

Having one sexual dysfunction is commonly associated with a secondary sexual dysfunction (Hartmann, Heiser, Rüffer-Hesse, & Kloth, 2002; King et al., 2007). In the present study, significant comorbidity was found between all dysfunctions, both when the dysfunction variables were treated as continuous and categorical (Study I, III, and unpublished analyses based on the sample from Study IV). The greatest overlap was between arousal and lubrication which calls attention to the fact that they may not be discrete entities. On the other hand, the correlation was not unity which supports earlier literature in that they are not identical. The characteristics of the difference between these two dysfunctions are further illustrated by their respective relations to the other dysfunctions. Arousal was more associated with desire and orgasm, while lubrication was closer related to pain. The division of arousal into subjective and physiological subtypes might thus be clinically very significant.

The comorbidity between pain and sexual dissatisfaction was substantial; in fact pain was the dysfunction most strongly associated with sexual dissatisfaction. The correlations do not imply causality but it is reasonable to assume that suffering from sexual pain results in sexual dissatisfaction. On the other hand, being dissatisfied and anxious about sexual activities or one's sexuality might also result in pain. Pain was furthermore quite highly correlated with lubrication and orgasm. Insufficient lubrication might itself cause pain during vaginal intercourse but also the anticipation of pain might interfere with arousal and lubrication. Although it has been suggested that pain should not be classified as a sexual dysfunction (Binik, 2005; Payne, Reissing et al., 2006; Pukall, Reissing, Binik, Khalifé, & Abbott, 2000) there was nothing in the present results that should suggest pain to be different from the other dysfunctions. One solution might be to keep pain under sexual dysfunctions but with several subgroups based on the etiology. However, it is important to keep in mind that pain and sexual activity are intermingled in a way that makes it very difficult to separate psychological and physiologic causes.

Overall, desire was the dysfunction which had the lowest comorbidity with the other dysfunctions. Hartmann et al. (2002) reported desire disorder to be frequently associated with orgasm and arousal problems; however the association was remarkably lower in women under 39 years than in the age group 40–64 years. In clinical settings, thoroughly applied interviews addressing every sexual function area is in light of these findings extremely important and the possible comorbidity between dysfunctions is likely to be individual and age dependent.

6.4 Factors Associated with Sexual Distress
(Study IV)

As was noted in the discussion of the prevalence of sexual dysfunctions they commonly exist without concomitant personal distress and sexually related personal distress may occur without associated sexual dysfunction. Moreover, sexual dysfunctions may differ in degree of associated distress. In a Swedish study of 1,056 women aged 18–65, vaginismus was found to be most strongly associated with sexual distress while orgasm problems had the weakest association with sexual distress (Öberg et al., 2004). One subsequent question is what other variables are associated with sexually related personal distress? Sexual distress has, for example, been shown to be closer related to lack of emotional well-being and negative feelings during sexual interactions than to the sexual response itself (Bancroft et al., 2003). Hayes et al. (2008) reported only two significant associations of sexually related personal distress in a multivariate regression analysis of multiple potential risk factors including any type of sexual function. These were a positive association with depression and a negative association with better communication of sexual needs to partner.

Consistent with findings of Hayes et al. (2008), sexual distress was significantly associated with every dysfunction when looked at in separate analyses. Not surprisingly, the association was strongest between sexual dissatisfaction and sexual distress most likely reflecting that they partly measure the same underlying construct. Pain was the dysfunction with the second strongest association thus supporting the findings reported by Öberg et al. (2004). But in contrast to Hayes et al. (2008) every dysfunction except lubrication remained significant in the multiple regression analysis performed in the present study. An additional difference was the role of relationship length which in the present study was found to be associated with sexual distress while Hayes et al. (2008) did not find such an association. This discrepancy is likely to be attributed to differences in length categories, with longer and broader age categories included in the Hayes study. There was no effect of age on sexual distress, but relationships shorter than a month were associated with less sexual distress and relationships lasting 2–6 months were associated with more distress compared to relationships lasting more than 10 years. Nonetheless, as could be expected based on earlier publications (Bancroft et al., 2003; Hayes et al., 2008; King et al., 2007; Öberg & Sjögren Fugl-Meyer, 2005) the compatibility items *poor communication* and *partner's erection problem* were more strongly associated with sexual distress than any of the sexual dysfunctions except sexual dissatisfaction. That partner is more interested in sexual activity reflects a discrepancy in

desired frequency of sexual activities and obviously can be expected to cause distress, since either the woman has to engage in sexual activity even if she does not desire it or she turns down the partner which might leave feelings of guilt in disappointing the partner. In light of these findings, it can be hypothesized that a relationship with a compatible partner without sexual dysfunctions might be one important protective factor against feeling sexual distress, with or without concomitant sexual dysfunction. However, it cannot be excluded that in cases where the distress is connected to sexual dysfunctions of the partner, these dysfunctions are reciprocal reactions to signs of distress in the woman. Clinical observations also suggest that the perception of and amount of distress experienced from sexual function problems are to some extent dependent on and mediated by how satisfied the woman is with the relationship in general and overall sex life (Aubin & Heiman, 2004).

6.5 Genetic and Environmental Influences on Female Sexual Dysfunctions (Study III)

Sexual dysfunctions are complex traits and can as such be expected to be influenced by multiple genes and environmental factors (Plomin et al., 2001). These might differ between populations and times and thus the heritability estimates are only valid for a particular population at a particular time. Finding genetic influence on a behavior does not imply genetic determinism, on the contrary a heritable behavior can still be altered through changes in the environment.

In Study III, the heritability of the sexual dysfunctions was explored. There was no significant decrease in model fit statistics when constraining either the additive genetic parameters or the shared environmental influences to be equal in the two age groups (18–33 and 34–49), suggesting that the etiology is similar across these age groups. There were significant genetic influences on each of the sexual dysfunctions but the individual differences on all six subdomains of the FSFI were primarily due to nonshared environmental influences. Nonshared environmental influences are factors and experiences that are unique for a specific individual, for example partner, illness, and sexual abuse. Shared environmental influences were not significant suggesting that the shared family environment during upbringing is negligible for adult women's sexual functions. The findings concerning orgasm were comparable with the studies of Dawood et al. (2005) and Dunn et al. (2005) in that nonshared environmental influences accounted for most of the individual differences despite slightly higher heritability estimates in the British and Australian studies. In addition, Dawood et al. (2005) found some indication of nonadditive genetic effects for orgasm during sexual activity

other than intercourse with partner. The strength of the present study was a larger sample as well as the use of a composite variable comprised of three questions for the orgasm function while the prior studies used single items. However, the other two studies explored heritability estimates for orgasm during different circumstances and as shown by Dawood et al. (2005), female orgasm may be dependent on the context and thereby affected by different genes.

By applying multivariate models to the obtained data the comorbidity and heterogeneity of the dysfunctions were further addressed. The fact that a correlated factors model provided the best fit to the obtained data indicates that the dysfunctions should be considered as separate entities and not due to some common underlying factor (Jang, 2005). Yet, statistical models do not have one-to-one correspondence with reality and the results need replication. However, the multivariate analyses also showed that there is a substantial overlap in genetic and nonshared environmental influences between the dysfunctions. In addition, there is also heterogeneity which suggests that the six subdomains are distinct.

These findings have important implications for research and classification of sexual dysfunctions. Our results strongly imply that female sexual dysfunctions should be seen as multidimensional, including them all as separate diagnoses, even in the case of subjective arousal and lubrication in line with recommendations by the International Consensus Conference (Basson et al., 2003). In the present study, there was no objective measure of lubrication, but the results show that subjective arousal and lubrication as reported by the women themselves differed in etiology to some extent. Regarding pain, there was some shared genetic etiology with desire, arousal, orgasm, and satisfaction which further support the view that pain may well be included under the sexual dysfunctions.

6.6 Factors Associated with Female Sexual Dysfunctions (Studies I, II, and IV)

The relations between sexual dysfunctions and a selection of potentially important presumably environmental variables were explored. The associations between sexual functions and alcohol consumption, psychological problems, pregnancy, number of children, and relationship satisfaction were assessed among women aged 33–43 (Study I and II). Relationship length and compatibility with partner and their associations with sexual dysfunctions were assessed in women aged 18–49 (Study IV). Explanations of the associations can only be tentative in the light of the present findings. Longitudinal studies are needed to investigate

which causal relationships are most likely. It is, furthermore, important to recognize that these findings are on the group level and that individual differences might be considerable.

6.6.1 The Effect of Age (Studies I, III, and IV)

The literature concerning age effects on sexual function in premenopausal women is contradictory and sparse (Dunn et al., 2002; Hayes & Dennerstein, 2006). Changes in sexual function due to hormonal changes are limited in healthy premenopausal women, except for periods of pregnancy and lactation. Hayes et al. (2008) reported a linear decrease in desire with increasing age from 20 to 70, while genital arousal and orgasm problems tended to have U-shaped distributions with least problems in the 30s and 40s. The results from the present research might reflect similar effects with the only significant effect of age in the age group 33–43 being a decrease of pain problems (Study I). The decrease in orgasm and pain problems in the broader age group 18–49 might be due to younger women in their 20s having more problems. Some other studies have not found an association between orgasm and age in women in similar age groups as in the present study (Abdo et al., 2004; Laumann et al., 1999; Ponholzer et al., 2005). The most consistent effect in the broader age group 18–49 seems to be a general negative effect of age on desire and a positive effect on pain, findings which have also been supported in earlier studies (Abdo et al., 2004; Dunn et al., 1998; Ponholzer et al., 2005). Additionally, Laumann et al. (1999) reported a decrease in pain problems with age but found no association between age and interest in sex. Notable is the confounding association between relationship length and age, an issue that should be addressed in future studies when assessing the effect of age on sexual function in women being in a relationship.

6.6.2 Relationship with Partner (Study II and IV)

Even though sexual activities are not exclusively reliant on a partner, sexuality and sexual needs are an essential and integrated part of intimate relationships and thus interrelated and sensitive to the quality of the relationship and the partner's sexuality.

Consistent with the literature (Blumstein & Schwartz, 1983; Byers, 2005; Dunn et al., 1999; Hurlbert et al., 2000; McCabe & Cobain, 1998; Meana et al., 1997; Sprecher, 2002), higher relationship satisfaction was associated with better sexual function, in particular with sexual satisfaction (Study II). Rosen et al. (2000) have suggested that there is a partial conceptual overlap between sexual satisfaction and relationship satisfaction.

In the present study, as well as in the study by Rosen et al. (2000), the shared variance between desire and relationship satisfaction was rather small, suggesting that desire is least influenced by relationship satisfaction. Then again, when considering that relationship length predicted desire dysfunction and explained as much as 13% of the variance in desire, the complexity of desire deepens (Study IV). The reason for why relationship satisfaction is least associated with sexual desire while relationship length shows the strongest association with desire dysfunction is unclear. Age and relationship taken together also explained 13% of the variance in desire and age alone 4%. Presumably, age can not be the explaining variable. There are, however, many foundations of a relationship and once the first "honeymoon" has passed and the everyday life continues, many other aspects, such as shared values, interests, and respect, might be equally or more important than desire. It has also been suggested (Sprecher, 2002) that it is likely that women, less than men, use the quality of their sexual relationship as an indicator for the overall relationship quality.

Over and above the effect of age, relationship length also positively predicted arousal, lubrication, and sexual satisfaction dysfunctions while orgasm dysfunction was negatively predicted. The reason for the decrease in orgasm dysfunction with increasing relationship length might depend on an increasing comfort with the partner that allows the woman to be more expressive of her sexual needs and preferences.

The results regarding partner compatibility supports previous studies (Hurlbert et al., 2000; Kelly et al., 2006; MacNeil & Byers, 1997; Offman & Matheson, 2005; Purnine & Carey, 1997) in that poor partner compatibility was associated with sexual dysfunctions. More than 40% of the women complained that there is too little foreplay, making it the most common complaint. On the other hand, only 2% complained about excessive foreplay and this item was also not associated with any dysfunction. As could be expected, sexual satisfaction was significantly associated with every partner compatibility item except excessive foreplay. Byers (2005) showed intimate communication to be associated with changes in both relationship and sexual satisfaction over a time period of 18 months. Those reporting poor communication also reported a decrease in both relationship and sexual satisfaction during this time period while those reporting good communication reported an increase. In the present study 39% of the women feeling sexually dissatisfied also reported poor communication compared to only 12% of the women being sexually satisfied. That the items that expressed unwillingness or incapacity for sexual activity *(partner cannot do, you cannot do, you do not want to, partner does not want to)* were associated with every dysfunction suggests that differences in sexual preferences and sexual scripts and roles are major influences on sexual interactions in couples.

6.6.3 Pregnancy and Number of Children (Study II)

Overall, there were few associations between pregnancy and sexual dysfunctions. Women pregnant with their first child reported less pain problems compared to matched nonpregnant nulliparous women and women who already had one or more children had more orgasm problems compared to matched nonpregnant parous women. Earlier research has shown considerable variations in sexual functions during pregnancy, both between individuals as well as between trimesters (Elliott & Watson, 1985; von Sydow, 1999). The measure in the present study was not suitable for exploring the different phases of a pregnancy. In addition, the number of women being pregnant was small $(n = 76)$. It is of course important to explore the effects as a function of the phase of the pregnancy in detail but it can also be of importance to look at pregnancies as a transient period of nine months that taken together do not in general seem to have a major impact on female sexual functions.

After pregnancies follows birth and child rearing. Both of these are major transitions in life, physiologically more so for the one giving birth but psychosocially for the dyad of the couple as well as for the individuals in becoming parents. In the present study, parity was not associated with arousal, lubrication, or relationship satisfaction. Women without children had more desire than women with 1–3 children while women with 4 or more children had the same level of desire as nulliparous women. Overall, women with children had less pain problems and were sexually more satisfied than women without children. In a recent Italian study an increasing number of children was associated with decreased sexual function as measured by the total score of the FSFI (Nappi et al., 2008). It could be argued that having smaller children would be more time consuming and exhausting leaving less room, time, and energy for enjoyment of sexual activities. The reasons for the discrepancies between the present study and the one by Nappi et al. (2008) are far from obvious. One possibility is that women with better sexual functions are those who more easily become pregnant. It has been hypothesized that the adaptive function of female orgasm is to increase sperm retention and thereby increase the chance of conception (Baker & Bellis, 1993).

6.6.4 Psychological Problems (Study I)

Earlier reported associations between psychological problems and arousal, lubrication, orgasm, sexual dissatisfaction, and pain problems (see literature overview) were replicated in the present study. Overall and as expected, the more psychological problems the more sexual dysfunctions the women had. In contrast to the findings of Bonierbale et al. (2003) but congruent with findings by Abdo et al. (2004) as well as by Frohlich and Meston (2002) there was no association between depres-

sion and reduced desire. Neither was desire associated with anxiety, panic, or somatization. The reasons for these results are unclear. One difference might be that patients in the study by Bonierbale et al. (2003) were more severely depressed. In the present study the psychological problems were measured as symptoms. In addition, no information about antidepressant medication was available, although any significant influence of medication is unlikely as at least SSRI medication has been reported to cause reduced sexual desire (Bonierbale et al., 2003). Sexual desire is, as defined by the FSFI, not dependent on sexual activity but based on feelings, thoughts and dreams, an important difference compared to the other dysfunctions. Desire is further a complex concept, reflected by women themselves reporting difficulties in differentiating desire from arousal (Graham, et al., 2004). Some women in this focus group study (Graham et al., 2004) also reported that when feeling anxious they were less interested in sex with partner but possibly more interested in masturbation as a way of distraction and relaxation. In addition, some of them were longing for physical affection but not sex when feeling depressed. A woman suffering from psychological problems may think or dream about sex without having the energy to actually engage in sexual activities with a partner. Women having psychological problems may thus have a desire for physical intimacy without sexual activity and for sex alone, a possible explanation for the lack of association between psychological problems and desire. It could also be that a retained or in some cases even an enhanced sexual desire (Figueira et al., 2001) is in fact a biologically based psychological strategy to meet depression with resistance.

Most likely, the physiological changes associated with psychological problems have different effects on different dysfunctions, both quantitatively as well as qualitatively. The association between psychological problems and pain could be due to increased bodily tensions and problems relaxing caused by depression, anxiety, and panic which is emphasized in pain showing the strongest association with somatization. Psychological problems contributing to insufficient arousal and lubrication is another possible path.

6.6.5 Alcohol (Study I)

Alcohol consumption was measured both as drinking in general and in connection to intercourse. Interestingly, alcohol use in general was associated with fewer sexual problems while frequent alcohol use in connection to intercourse was associated with more arousal, lubrication, and orgasm problems as well as lower sexual satisfaction. In contrast, the women who used alcohol sometimes reported more desire compared to women who never or rarely drank alcohol prior to intercourse. Alcohol is known to reduce genital response (Covington & Kohen, 1984; George & Stoner, 2000) which might be a reason for the increase in sexual problems when drinking prior to intercourse. On the other hand, it is also possible that women who drink in connection with sexual activities initially have sexual function problems and, therefore, consume alcohol in order to reduce anxiety. Alcohol consumption may, in fact, lead to more disinhibited sexual behavior (Abbey, Zawacki, & McAuslan, 2000) especially through expectations and beliefs (Beckman & Ackerman, 1995; George and Stoner, 2000), a possible explanation for the increase in desire. Most likely, alcohol use in connection with sexual activities may increase sexual problems, as well as sexual function problems may increase anxiety about sexual performance and thus lead to greater alcohol consumption in order to reduce anxiety. It could also be that we are dealing with two independent categories of women, those with a generally high consumption of alcohol representing individuals less dependent on outside social control and consequently generally less inhibited with a greater ability to enjoy both drinking and sexual activities. Women who encourage themselves with alcohol before sexual activities instead could probably have the same level of problems even without the alcohol. It can further be hypothesized that these women feel sexual distress in addition to sexual function problems. In light of the overall adverse consequences of excessive alcohol consumption on a person's health and life, eventual self-medication with alcohol needs to be addressed in clinical contexts even though the variance in sexual dysfunctions explained by alcohol consumption was minor.

6.7 Limitations

The findings of the present research should be considered in light of the limitations of this study. First, there are possible limitations concerning the sample. The total response rate of 53% may appear rather low at first glance. When taking into account the extensiveness of the questionnaire, which covered a large range of instruments on sensitive topics, the response rate must, nevertheless, be considered as surprisingly good. Further, it is comparable with prior sexuality related mail survey studies both nationally (Haavio-Mannila & Kontula, 2003; Ojanlatva et al., 2004) and internationally (Bailey, Dunne, & Martin, 2000; Hayes, Bennett, Dennerstein, Gurrin, & Fairley, 2007; Långström & Zucker, 2005). In addition, the present sample is comparable with other representative samples of the Finnish population with respect to important sexuality related characteristics, such as mean age at first sexual intercourse (Mustanski, Viken, Kaprio, Winter, & Rose, 2007) and rates of sexual abuse (Sariola & Uutela, 1994). When generalization of the results to other ethnic and cultural groups are made, reported discrepancies between nations and ethnic groups (Cain et al., 2003; Graziottin, 2007; Lutfey et al., 2008) should be taken into consideration.

Comparisons with other studies (Helweg-Larsen & Bøving Larsen, 2002; Sariola & Uutela, 1994) indicate that the generalizability of the results should not be limited to twins only. Several studies have shown that twins do not differ from singletons either on socio-demographic and lifestyle characteristics or on behavioral characteristics or in psychiatric morbidity such as depression, somatization, and insomnia (Andrew et al., 2001; Johnson, Krueger, Bouchard, & McGue, 2002; Kendler, Martin, Heath, & Eaves, 1995; Pulkkinen, Vaalamo, Hietala, Kaprio, & Rose, 2003).

Second, there are limitations concerning information about the women, for example the women's menopause status. However, considering their age, it is reasonable to assume that the majority were premenopausal. Age was found to have a negative effect on desire and positive effects on orgasm and pain. In the literature, findings concerning age effects are inconsistent, but there is some general agreement that desire problems increase while pain problems remain constant or decline with increasing age (Hayes & Dennerstein, 2005). It is reasonable to assume that the age effect would have been larger if postmenopausal women had also been included. Age and relationship are also confounded and these effects were analyzed in Study IV. This confounding needs to be taken into account in future studies. Since sexual function is dynamic and changes throughout a person's lifespan the generalization of the present results to other age groups could be limited. In addition, the age

of the partner was not known and this fact could also be influential on sexual functions through partnership variables.

Third, the classification of the women as sexual dysfunctional may not have been optimal. This classification was based on cut-off points without concomitant clinical evaluations. A future study would be to compare the classification based on the cut-off with the assessment of well-trained clinical experts on sexual dysfunctions on a subsample of women. On the other hand, clinician-defined and individual-defined sexual dysfunction have been found to be poorly correlated (King et al., 2007), preferably then the women's own perception should also be considered. The time period during which the women reported their sexual functioning may also influence the results. For those being singles, a time period of 4 weeks may affect the results negatively. However, since only females who reported sexual activity during that time period were included in the analysis, the effect of being single was minimized. In addition, FSFI has been shown to be an instrument with good reliability and validity (Masheb et al., 2004; Meston, 2003; Rosen et al., 2000; Wiegel et al., 2005).

Finally, we did not test for either gene-environment interactions or correlations. Both of these might, however, be at work. Some women may be more vulnerable for stressful life events that may affect sexual functioning negatively. Further, the type of experience might affect which sexual dysfunction becomes manifest.

SUMMARY AND CONCLUSIONS

Female sexual functions are complex behaviors associated with various biopsychosocial factors. In the present study, the prevalence, comorbidity, heredity, and a number of other biopsychosocial factors potentially affecting female sexual functions and dysfunctions were studied in a population based sample of female twins and their female siblings. It is the first study to have used a validated instrument to explore female sexual dysfunctions across a relative large age range in a population based sample from Finland. In addition, it is the first study to measure the genetic and environmental influences across all main domains of sexual functions; desire, arousal, lubrication, orgasm, satisfaction, and pain. The key findings of the present study were:

1. The factor structure of the Finnish version of the Female Sexual Function Index was satisfactory and comparable to the original validation of this instrument. The results suggested that the FSFI is applicable to population based samples in both younger 18–33 and older women 34–49. No validation against clinical judgments of DSM-IV diagnosis was made and this is an important issue to address in a follow-up study. Some concerns were raised about the possible bias in prevalence of sexual functions problems due to zero responses being included when calculating the composite scores. Lower scores are interpreted as more sexual function problems. Zero responses indicate that the woman had not had sexual activity or vaginal intercourse during the past four weeks but the reasons for this are unclear and may be due to other reasons than sexual function problems. In this study the women who checked the zero response for all items for which this was possible were excluded from the study in order to reduce the bias.

2. The prevalence rates of female sexual dysfunctions according to the FSFI for women aged 18–49 were high, 55% of the women were classified having desire dysfunction, 31% orgasm dysfunction, 25% sexual satisfaction dysfunction, 21% pain dysfunction, 18% arousal dysfunction, and finally 11% lubrication dysfunction. According to DSM-IV sexual dysfunctions need to be associated with distress in order to be classified as sexual disorders. The prevalence rates for sexual disorders were notably smaller, 23% of the women were classified as having desire disorder, 16% orgasm disorder, 15% sexual satisfaction disorder, 12% arousal disorder, 11% pain disorder, and 7% lubrication disorder. Sexual dysfunctions are hence not always associated with distress. The relative risk of reporting a dysfunction when another

was present (odds ratio) was significant between every dysfunction. Thus, the woman suffering from one sexual dysfunction is likely to suffer from another. The association was strongest between arousal dysfunction and lubrication dysfunction followed by pain dysfunction and sexual satisfaction dysfunction.

3. The variation in female sexual functions was explained by additive genetic, nonadditive genetic, and nonshared environmental influences. The same model fitted both younger (18–33) and older women (34–49). A correlated factors model proved to be the best fitting multivariate model suggesting that the subdomains of female sexual functions are separate entities and not due to a common underlying factor and they should thus be classified as different types of dysfunctions. Nonshared environmental factors explained most of the variation while genetic influences were modest with additive genetic effects accounting for 3–11% and nonadditive genetic effects accounting for 5–18%, depending on the type of sexual function. The majority of the correlations between the genetic factors and every correlation between the nonshared environmental factors were significant indicating that there is some shared etiology between all subdomains. Finding genetic influence is the starting point for proceeding with molecular genetics in order to find genes associated with female sexual functions. These genes are to be seen as risk factors and not as determinants of female sexual functions.

4. All women classified as feeling sexually distressed were not classified as sexually dysfunctional. Sexual distress was shown to be associated with every dysfunction as well as every compatibility item and relationship length when performing univariate analysis. In a multivariate analysis with sexual dysfunctions, compatibility with partner and relationship length as predictors, the associations with lubrication dysfunction, partners erection problems, and partner having sexual needs which the woman does not want to satisfy were no longer significant. In short, the more sexual distress the greater the likelihood of concomitant sexual dysfunctions, partner incompatibility, having a partner with erection problems, and being in a relationship for 2–6 months.

5. Many of the biopsychosocial factors included in this study were significantly associated with sexual dysfunctions. The results of the behavioral genetic analyses showed the significance to explore each dysfunction separately. This was additionally emphasized by the observation that the direction and the power of the associations

were different between the dysfunctions. The findings of the associations per dysfunction were summarized in Table 4 and 5 in the Result section. In summing up, it can be claimed that psychological problems, poor satisfaction with the relationship, sexual distress, and poor compatibility with partner are generally associated with more dysfunction independent of type. For the remaining factors, it is not possible to generalize across the dysfunctions.

6. In light of the results presented in the present study, pain can be included under sexual dysfunctions. In addition, subjective and genital arousal would be best treated as separate entities. Pain showed co-occurrence with every other sexual dysfunction. Futhermore, there was shared etiology with the other sexual dysfunctions as shown by the correlation between the genetic and environmental factors influencing each sexual function. Even if pain is subdued under sexual dysfunctions, the reason for the pain still needs to be thoroughly investigated as it in some instances might be due to somatic factors not casually related to other sexual functions. The phenotypical correlation between subjective arousal and lubrication was high. However, heterogeneity was implied by the correlation between them not being unity. In addition, the genetic and environmental factors affecting each of them were correlated but again not unity. The clinical implications of treating subjective arousal and lubrication as separate dysfunctions was further shown by subjective arousal being closer related to desire and orgasm while lubrication was more associated with pain.

Applying the biopsychosocial model for viewing and understanding female sexual functions is in light of this study appropriate. The model can be applied both in treatment and research. Different biological, psychological, and social factors were contributing to both good and impaired sexual functions. In this study it was not possible to analyze the direction of the causality between the factors but it is quite reasonable to assume reciprocal causality between most of the factors. Interindividual factors like relationship with partner were important both for sexual dysfunction and sexual distress, all three likely to be closely intertwined. The genetic makeup is highly individual but genes and environment interact in an intrinsic way and both affect one another. Even when specific genetic risk factors can be identified in the future, these can be counteracted by preventive biopsychosocial factors. In light of the findings presented in this study, psychosocial interventions are important and should always be addressed in evaluation and treatment of female sexual dysfunctions. Since causality could not be established

it is impossible to know whether the dysfunctions cause interpersonal problems with partner or vice versa but given the repeatedly reported association and the strong impact of relationship variables, caution in pharmaceutical interventions is needed until the direction of the association is established. In addition, female sexual function problems are not well in agreement with the women's own perception of their satisfaction with their sexual life or with the distress. The usefulness and meaning of diagnostics without the distress criterion is thus questionable.

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