INTRODUCTION

It is pain rather than clear pathology that defines the low back problems and associated disability that are endemic to most developed countries of the world. Although the specific pathology underlying common back-related symptoms remains unknown, intervertebral disc degeneration and associated sequelae lead the list of suspects.

Evidence over the past decade suggests that familial influences and genetic factors, in particular, may be largely responsible for the interindividual variation seen in disc degeneration and pathology among adults. Furthermore, several gene polymorphisms and mutations have been identified in association with disc degeneration and sciatica, implying a direct genetic link.

If disc degeneration and failure are influenced by genes, it follows that back symptoms also may be genetically determined, in part. Yet, little is known about the role of genes in common low back pain problems or the pathways or mechanisms through which they may influence these problems. Using various definitions of back pain, several classic twin studies have been conducted suggesting a genetic component. However, these studies do not paint a consistent picture of the magnitude of genetic influences on back pain problems, which may be explained in part by variations in back pain definitions used, as well as sample characteristics and true population differences.

The aim of the present study was to estimate the magnitude of genetic versus environmental influences on various definitions of common back pain problems among Finnish men. Our hope was to further clarify the presence and magnitude of genetic influences on low back pain problems, given the conflicting reports to date. Furthermore, we sought to identify the effects of specific degenerative changes in the disc and environmental exposures on back symptoms to better understand the pathways through which genes and environment influence common back pain problems in men. In particular, we were interested in examining the hypothesis that disc degeneration may be one pathway through which genes influence back pain.

METHODS

We conducted a classic twin study with consideration of covariates. Such a design allows the estimation of the relative importance of genetic and environmental influences on the phenotype of interest, in this case history of low back pain. The inclusion of covariates in analyses allows for the exploration of pathways through which these factors may be influencing back pain. Routine occupational and leisure time physical demands and lumbar disc degeneration were of particular interest.

Male twin pairs were selected from the population-based Finnish Twin Cohort either at random or based on discordance between co-twins for a specific common behavioral or environmental factor (exercise or occupational sitting, lifting or driving). The sample of monozygotic (MZ) twins was compared to the larger twin cohort on a multitude of factors, including history of low back pain, and was found to be representative. The only exceptions were a slightly greater likelihood of being employed and having higher physical job demands. Dizygotic (DZ) twins were selected in an analogous way to the MZ twins using the same criteria, for a total of 147 MZ and 153 DZ male twin pairs (aged 35-70 years).

All study subjects were transported to a central location in Finland where an extensive, structured interview was conducted to obtain data on recent and lifetime experiences of low back symptoms, as well as exposure to suspected environmental and behavioral risk factors. Low back pain history was determined from several questions reflecting subjects’ experience with low back pain problems over the past year and over their lifetimes. Clinical examinations of each subject also were conducted, including MRI of the lumbar spine, among other measures.

We used the ordered probit estimation method for twin data to estimate heritability for back pain variables, adjusting for covariates. Bivariate and trivariate Cholesky decomposition genetic factor models were used to estimate to what degree the genetic (and environmental) effects on one trait are correlated with the genetic effects on another trait.

RESULTS

Intra-class correlation coefficients demonstrated clearly greater degrees of similarities within MZ twin pairs than in DZ pairs for back pain intensity, frequency and interference with daily activities over the past 12 months, as well for the duration of the worst low back pain episode. These led to heritability estimates ranging from 30% to 39% for various definitions of back pain problems over the prior year. The greatest discordance between MZ and DZ pairs was found for prior hospitalization due to back problems, with a heritability estimate of 46% (95% CI 14-78). The heritability estimates remained the same or only minimally changed (less than 4% of variance) after adjusting for measured covariates. A genetic influence on selection of occupational physical loading conditions was also apparent.

The genetic correlations of the various back pain variables with disc height narrowing were greatest for duration of the worst lifetime episode and associated hospitalization ($r=0.46-0.49$), as opposed to back problems experienced over the prior year. Yet, less than one-quarter of the variance in the lifetime back pain variables was explained by genetic influences common to both back pain variables and disc height narrowing. The unique environmental component explaining the variance in most of the back pain variables was correlated insignificantly or modestly to the environmental component explaining disc height. Consequently, only 5% or less of the variance in back pain explained by environmental factors was accounted for by those same environmental factors influencing disc height.

**DISCUSSION**

We found moderate heritability estimates for most definitions of back pain problems. However, the estimates are surrounded by wide confidence intervals given the limited sample size of 300 twin pairs, which is a study limitation.

A particular strength of the current study was the availability of lumbar MRI and exposure data allowing for control of covariates in heritability estimates and multivariate genetic analyses. Genetic correlations indicated the presence of underlying genetic factors common to both disc degeneration and back pain. Up to one-quarter of genetic influences on back pain history appears due to the same genetic influences affecting disc narrowing. This supports the hypothesis that disc degeneration is one pathway through which genes influence back pain problems.

The complexity of genetic influences on back pain was also apparent through the influence of genes on the occupational loading conditions selected by subjects. The genetic factors influencing selection of occupational conditions, in part, were also associated with back pain disability and disc height narrowing, as seen through the bivariate and trivariate models (Figure). Thus, some genetic effects on low back pain problems may act through influences on behavior, as well as structure.

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