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Research report

Development and validation of prediction algorithms for major depressive episode in the general population

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ABSTRACT

Background: To develop and validate sex specific prediction algorithms for 4-year risk of major depressive episode (MDE) using data from a population-based longitudinal cohort.
Methods: Household residents from 10 provinces were randomly recruited and interviewed by Statistics Canada. 10,601 participants who were aged 18 years and older and who did not meet the criteria for MDE in the 12 months prior to a baseline interview in 2000/01 were included in algorithm development; data from 7902 participants who were aged 18 and older and who were free of MDE in 2004/05 were used for validation. Validation was also conducted in sub-populations that are of practice and policy importance. MDE was assessed using the World Health Organization's Composite International Diagnostic Interview (CIDI)—Short Form for Major Depression (CIDI-SFMD).
Results: In the training data, the C statistics for algorithms in men was 0.7953 and was 0.7667 for algorithm in women. The algorithms had good predictive power and calibrated well in the development and validation data.
Limitations: The data relied on self-report. MDE was assessed with CIDI-SFMD. It was not feasible to validate the algorithms in different populations from different countries.
Conclusions: More studies are needed to further validate and refine these algorithms. However, the ability of a small number of easily assessed variables to predict MDE risk indicates that algorithms are a promising strategy for identifying individuals in need of enhanced monitoring and preventive interventions. Ultimately, application of algorithms may lead to increased personalization of treatment, and better clinical outcomes.

1. Introduction

Major depression is prevalent and imposes considerable burden on society (Murray and Lopez, 1996). Major depressive episode (MDE) is the building block for mood disorders (American Psychiatric Association, 1994). In the past decades, research has identified risk factors for MDE. The most consistent demographic factors associated with the risk of MDE have been female sex, younger age and low socioeconomic status (Skapinakis et al., 2006; Weich and Lewis, 1998a, 1998b; Weich et al., 1998; Wang et al., 2010). Psychosocial risk factors include negative life events, experience of traumatic events, work stress, financial strain, poor marital or interpersonal relationships, lack of social support and low self-esteem and mastery (Blazer and Hybels, 2005; Goldberg, 2006; Hope et al., 1992; Janzing et al., 2009; Kendler et al., 2003; Kessing et al., 2003; Libby et al., 2005; Patel et al., 1999; Patten et al., 2005; Patton et al., 2003; Wang, 2005; Wang et al., 2012). Past occurrence of MDE and family history are strongly associated with the risk of MDE. These results have laid a strong foundation for early identification and intervention. However, the combined effects of a key set of risk factors that are the most predictive of future risk are unknown. To more accurately identify individuals who are at high risk of having MDE, prediction algorithms that include a key set of risk factors are needed.

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Prediction algorithms are tools that aid physicians, individuals and population health policy makers to make informed decisions when it comes to the health problems. In the clinical setting, predictive risk algorithms are embedded in clinicians' daily practice as the primary tool to estimate individual risk of future disease. Thousands of risk algorithms are used to guide clinical decisions about disease prevention and treatment. Prediction algorithms are not about identifying new risk factors. Rather the algorithms are clinical and public health decision aids that are developed using known risk factors. The practical application of risk prediction algorithms is that they can be used to assess the risk or probability of developing certain health conditions among those who are free of the health conditions at the time of assessment, based on the exposure to risk factors included in the model (Anderson et al., 1991; Chen et al., 2006; Decarli et al., 2006; Park et al., 2009). Well-known examples include the Framingham risk prediction algorithms for cardiovascular disease (Anderson et al., 1991) and prediction algorithms for cancer risk (Chen et al., 2006; Decarli et al., 2006; Park et al., 2009). Risk prediction models can also be used for individual and population applications including self-assessment, prediction of the number of new cases of disease in populations and estimating the potential benefit of preventive interventions implemented community wide (Manuel and Rosella, 2010).

There is a paucity of research in risk prediction for mental disorders. To our knowledge, only the PredictD Study that was conducted in European primary care settings attempted to develop a risk prediction algorithm for MDE (King et al., 2008; Bellon et al., 2011). General population studies employing more feasible measurement strategies are needed so that the developed algorithms cannot only be used in clinical practice, but also be feasibly incorporated in general population health surveys for health planning purpose. Like the Framingham Risk Function (Anderson et al., 1991) and the Gal Score (Decarli et al., 2006), we believe that prediction algorithms should be developed for men and women separately due to their biological and social role differences and sex difference in the prevalence and incidence of MDE. Therefore, the objective of the current study was to develop and validate sex specific prediction algorithms for MDE over 4 years in the Canadian general population.

2. Methods

2.1. Study setting

This analysis is based on longitudinal data from the biennial National Population Health Survey (NPHS) (from cycle 1 to cycle 8). The household component of the survey covers the population living in private dwellings in the 10 provinces in 1994/1995. It excludes people on Indian reserves, in the territories, on Canadian Forces bases, and in some remote areas. Of 20,095 individuals selected for the longitudinal panel in 1994/1995, 17,276 agreed to participate. More detailed descriptions of the NPHS can be found in published reports (Catlin and Will, 1992; Tambay and Catlin, 1995).

2.2. Study participants

For this study, we chose Cycle 4 in the year of 2000/01 as baseline because comprehensive information about risk factors is available in this cycle. Participants who were aged 18 years and older and who were free of MDE in Cycle 4 were eligible to be included in model development ($n=10,601$). Prediction algorithms for 4-year risk of MDE were developed for men ($n=4737$) and women ($n=5864$), separately. Data from Cycle 5 (2002/03) and Cycle 6 (2004/05) were used to identify MDE occurring over the 4-year follow-up period (from 2002/03 to 2004/05).

2.3. MDE and risk factors

In the NPHS, MDE in the past 12 months was assessed by the Composite International Diagnostic Interview Short Form for Major Depression (CIDI-SFMD) (Kessler et al., 1998). The CIDI-SFMD was designed to provide an operationalization of the DSM-III-R diagnostic criteria (which have remained essentially unchanged in DSM-IV) for MDE. The instrument detects symptoms indicative of MDE, and identification of five such symptoms out of nine indicates a high probability that the subject fulfilled DSM-IV criteria for MDE in the past 12-months. The sensitivity and specificity of the CIDI-SFMD were 89.6% and 93.9% in relation to the full version of CIDI (Kessler et al., 1998). The CIDI-SFMD was used in all cycles of the NPHS.

We initially selected and examined the associations between the following potential risk factors and the 4-year risk of MDE: demographic and socioeconomic characteristics, self-rated general health and self-rated stress, activity restrictions, chronic medical conditions diagnosed by physicians, difficulty in mobility, cognitive function, levels of pain, monthly frequency of physical activity last 15 minutes or longer, ongoing chronic stress (18 items), recent negative life events (10 items), childhood traumatic events (7 items), work stress based on the brief version of Job Content Questionnaire(Karasek et al., 1998) (13 items), self esteem (Pearlin and Schooler, 1981) (6 items), mastery (Pearlin and Schooler, 1981) (7 items), anti-depressants and sleeping pill use in the past month, smoking, problematic alcohol consumption, K-6 psychological distress in the past month (Kessler et al., 2002) (6 items), having had depressed mood or loss of interests in activity in the past year, having talked or seen a health professionals for emotional or mental health issues in the past year, past MDE, and family history of depression. We used MDE occurring from Cycle 1 to Cycle 3 as an indicator for past MDE. It was decided to include this variable as it is likely to be one of the strongest predictors of MDE, and it was the goal of the study to predict new-onset episodes as opposed to new-onset disorders. The coding of the predictors included in the algorithms can be found in Appendix I.

2.4. Statistical analysis

All analyses were conducted using STATA 11 (StataCorp, 2010) We first examined the bi-variate relations between selected variables and the risk of MDE. Variables that were strongly associated with the outcome at the level of $p=0.002$, were kept as candidates for model development. Missing data in candidate risk factors were imputed using STATA's "ice" program with the outcome variable included in the imputation equation (Royston, 2005). We created 5 imputed data sets and obtained combined estimates using Rubin's rules (Rubin, 1987).

2.5. Development of prediction algorithms

Prediction algorithms for 4-year risk of MDE were developed using logistic regression modelling for men and women separately. We first included age (continuous variable), past MDE and family history of MDE in the model. We then examined whether adding an additional variable improved the model's discriminative power and fit with data. Once all the predictors from a specific domain were assessed, we re-evaluated the model to determine whether specific factors could be excluded without affecting the performance of the model. The observed effect (such as odds ratio) of specific predictor assumes that the effect is constant regardless of the levels of other predictors in the model. This is not always