Psychiatry Research 219 (2014) 204–213

Contents lists available at ScienceDirect

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

The heritability of mental health and wellbeing defined using COMPAS-W, a new composite measure of wellbeing

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ARTICLE INFO

Article history:
Received 4 November 2013
Received in revised form
20 March 2014
Accepted 13 April 2014
Available online 10 May 2014

Keywords:
TWIN-E
Happiness
Resilience
NEO-FFI
WHOQOL
SWLS
ERQ

ABSTRACT

Mental health is not simply the absence of mental illness; rather it is a distinct entity representing wellness. Models of wellbeing have been proposed that emphasize components of subjective wellbeing, psychological wellbeing, or a combination of both. A new 26-item scale of wellbeing (COMPAS-W) was developed in a cohort of 1669 healthy adult twins (18–61 years). The scale was derived using factor analysis of multiple scales of complementary constructs and confirmed using tests of reliability and convergent validity. Bivariate genetic modeling confirmed its heritability. From an original 89 items we identified six independent subcomponents that contributed to wellbeing. The COMPAS-W scale and its subcomponents showed construct validity against psychological and physical health behaviors, high internal consistency (average $r=0.71$, Wellbeing $r=0.84$), and 12-month test–retest reliability (average $r=0.62$, Wellbeing $r=0.82$). There was a moderate contribution of genetics to total Wellbeing (heritability $h^2=48\%$) and its subcomponents: Composure ($h^2=24\%$), Own-worth ($h^2=42\%$), Mastery ($h^2=40\%$), Positivity ($h^2=42\%$), Achievement ($h^2=32\%$) and Satisfaction ($h^2=43\%$). Multivariate genetic modeling indicated genetic variance was correlated across the scales, suggesting common genetic factors contributed to Wellbeing and its subcomponents. The COMPAS-W scale provides a validated indicator of wellbeing and offers a new tool to quantify mental health.

1. Introduction

Psychiatric research has been driven by an illness ideology; a focus on identifying risk markers for mental illness, their underlying mechanisms and appropriate treatment strategies. In comparison, much less focus has been given to mental health and wellbeing and ways to promote it. This is because of the common misconception that the absence of mental illness is the equivalent to mental health (Keyes, 2005; Slade, 2010). However, only one quarter of the factors that define mental health and mental illness are shared in common (Kendler et al., 2011; Keyes, 2005; Slade, 2010). This suggests that the genetic, environmental and biological markers that underlie mental illness differ substantially from those that underlie mental health. Accordingly we are witnessing a paradigm shift towards mental health or wellbeing (Maddux, 2008), in which the focus is on defining optimal wellbeing and on the emerging science of resilience (Russo et al., 2012; Southwick and Charney, 2012).

Existing definitions of wellbeing have tended to emphasize concepts of subjective wellbeing, psychological wellbeing, or their combination. "Subjective wellbeing" reflects hedonia (Andrews and Withey, 1976; Bradburn and Caplovitz, 1965; Diener et al., 1995, 1999; Wilson, 1967) and has been quantified by measures of positive and negative affect (Diener et al., 2010) and satisfaction with life (Diener et al., 1985). "Psychological wellbeing" is tied to the concept of eudaimonia, which is focused on the development of human potential (Broadie and Rowe, 2002; Ryff, 1989). For instance, Ryff (1989) defined psychological wellbeing as a composition of autonomy, positive relations with others, purpose in life, self-acceptance, environmental mastery and personal growth, which was later quantified by the Ryff Scales of Psychological Well-Being (Ryff and Keyes, 1995). Only recently has a distinction been drawn between subjective and psychological wellbeing (Ryff and Singer, 1998) whereas early theorists never made such a distinction (Argyle, 1987; Brickman and Campbell, 1971; Wilson, 1967). There is much to be gained in the empirical study of both the

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http://dx.doi.org/10.1016/j.psychres.2014.04.033
0165-1781/

subjective and psychological aspects of wellbeing as demonstrated by accumulating evidence from composite indices of wellbeing (e.g., the Mental Health Continuum, MHC-LF; Keyes, 2007); both constructs are strongly associated with each other with factor analytic studies showing shared variance of 49–74% (Keyes et al., 2002; Waterman, 1993). Other studies suggest that psychological wellbeing directly influences subjective wellbeing (Kasser and Ryan, 1996; Ryan and Deci, 2001; Sheldon, 2002). The direction of causation of these effects however is unclear, as many of these studies were correlational (Kashdan et al., 2008). In any case, each construct of wellbeing – whether correlated or causal – accounts for notable variance in wellbeing that would otherwise be unaccounted for if focusing only on one aspect (Kashdan et al., 2008). Recently, the PERMA theory of wellbeing, has attempted to encompasses aspects of both subjective wellbeing (positive emotion, meaning) and psychological wellbeing (engagement, relationships, accomplishment) (Seligman, 2011). This theory is a central component of The Positive Health Initiative (http://www.authentichappiness.sas.upenn.edu/) which aims to understand what defines wellbeing, how to determine its underlying neural circuitry and ways to promote it in the general population.

A composite measure of wellbeing may assist in assessing functional status in clinical and population cohorts. Functional correlates of wellbeing include enhanced cognitive functioning, increased marital satisfaction, and higher income and economic flourishing (Diener and Chan, 2011; Seligman, 2008). Wellbeing is also associated with physiological correlates of neuroendocrine level, cardiovascular and inflammatory activity (effect sizes of .38) (Brummett et al., 2009; Fredrickson and Levenson, 1998; Lyubomirsky et al., 2005; Steptoe et al., 2005). In addition, the measurement of wellbeing may be useful as a prognostic indicator of long-term health, disease outcomes and health behaviors. For instance, evidence from longitudinal studies shows that wellbeing is significantly predictive of longevity and ill-health (with effect sizes of .14–.18) (Diener and Chan, 2011; Howell et al., 2007; Lyubomirsky et al., 2005), as well as lower mortality in both healthy and diseased populations (Chida and Steptoe, 2008). In other studies, measures of wellbeing have been related to improved health behaviors such as non-smoking, physical exercise, healthy diets and use of sun protection (Grant et al., 2009).

In this study, we combine this theoretical background with a focus on heritability in order to address the questions of whether we have an innate disposition towards wellbeing or whether it is something we can modulate and elevate through personal life experience. Twin studies comparing monozygotic (MZ) to dizygotic (DZ) twins allow the contributions of genetics versus environment to wellbeing to be determined. In terms of hedonic (subjective) wellbeing, twin studies suggest additive genetics contributes 0% (Baker et al., 1992; Gatz et al., 1992) to 33% (Silberg et al., 1990) variance in positive affect, up to 46% in hedonia (Bogdan and Pizzagalli, 2009) and 48% for optimism (Schulman et al., 1993). In comparison, larger heritability estimates have been reported for eudaimonic (psychological) aspects of wellbeing. In young adult twins (23–24 years), additive genetics is reported to contribute from 37% variance in personal growth up to 64% in positive relations (Gigantesco et al., 2011), with estimates of 41% (autonomy), 47% (purpose in life), 58% (self-acceptance) and 62% (mastery) also reported (Gigantesco et al., 2011) for Ryff's psychological wellbeing scale. In contrast, in older twins (51–60 years), additive genetics contributes smaller estimates of 30% for locus of control (an element of mastery) and 41% for flow proneness (an element of engagement) (Mosing et al., 2012). Together, these findings suggest that some aspects of wellbeing may be more heritable than others; however they could also simply reflect differences between the twin cohorts. Each of these twin studies varied considerably in age of the cohort: all of the twin studies focusing on hedonia were based in twins across multiple decades, whereas the eudaimonic studies were within very specific age groups.

In this study, we first aim to derive a valid self-report measure of wellbeing that includes both hedonic and eudaimonic aspects of wellbeing and quantifies these individual differences in an overarching construct of wellbeing, along with sub-constructs that contribute to it, using a multifactorial approach. Our second aim is to evaluate the contributions of genes and environment to wellbeing (both hedonic and eudaimonic aspects), and how this may be shared or unique to specific subcomponents. In this study, we report the development and heritability of the COMPAS-W index of wellbeing in 1669 healthy adult twins ranging in age from 18–61 years from the TWIN-E study (Gatt et al., 2012).

2. Methods

2.1. Participants

Healthy same-sex monozygotic (MZ) and dizygotic (DZ) twins from the TWIN-E study (the Twin study in Wellbeing using Integrative Neuroscience of Emotion) conducted at the University of Sydney, Australia (see Gatt et al., 2012 for the complete study protocol) participated in this study. The study received approval from the Human Research Ethics Committees of the University of Sydney (03-2009/11430) and Flinders University (FCREC#08/09). All participants provided written informed consent prior to participation and after receiving a complete written description of the study.

Twins were recruited from the Australian Twin Registry. Eligible participants were same-sex, healthy, adult twin pairs, with English as primary language, and of pure European ancestry. From initial screens conducted by the Australian Twin Registry, participants were excluded from the study if they reported current or lifetime psychiatric illness, history of stroke or neurological disorder, genetic disorder, brain injury (causing loss of consciousness for more than 10 min), chronic and serious medical conditions (e.g., cancer or heart disease), blood-borne illnesses (e.g., HIV, hepatitis), drug/alcohol substance abuse, and sensory impairments to hearing, hand movement or vision not corrected by glasses/lenses. However, of those participants who passed the screening criteria and participated in the study, 3.6% ($n=60$) later reported a current or past psychiatric, neurological or chronic illness ($n=18$ for psychiatric illness in particular) on online questionnaires. These participants were not excluded from analysis. Zygosity in 51 twin pairs (6.8% of sample) was determined using results from previous DNA tests conducted by the Australian Twin Registry. For remaining participants, zygosity was confirmed using the twin's responses to a 12-item questionnaire we developed (Gatt et al., 2012) using validated items from previously established questionnaires (Eisen et al., 1989; Magnus et al., 1983), shown to have 95% convergence with DNA results (Jackson et al., 2001).

The study recruited 2262 twins eligible to participate in the study. One thousand six hundred and sixty nine twins successfully completed Phase I baseline testing of web-based questionnaires. Total mean age of the sample was 39.64 ± 12.73 (18–62 years, with 686 males and 983 females, and mean education of $14.34 \text{ years} \pm 3.00$). This included 966 MZ twins (445 males, 521 females; mean age $=40.04 \pm 12.44$) and 677 DZ twins (227 males, 450 females, mean age $=39.17 \pm 13.05$), and birth order distributions of 846 twin 1 (345 males, 501 females, mean age $=39.54 \pm 12.74$) and 823 twin 2 (341 males, 482 females, mean age $=39.75 \pm 12.73$).

2.2. Measures and procedures

The methodology used in the current study is standardized across testing sites and has been previously validated in healthy and clinical populations (Paul et al., 2007; Paul et al., 2005; Silverstein et al., 2007; Williams et al., 2005). In this study, we report on the heritability of a new composite measure of wellbeing, the COMPAS-W index of wellbeing, derived from the following measures:

2.2.1. Self-report measures

The self-report measures were assessed using the WebQ online test battery (Gatt et al., 2012). These measures included: (1) the World Health Organization Quality of Life scale (WHOQOL-BREF) (World Health Organization (WHO), 1998) which measures overall perceptions of quality of life and health and the sub-domains of Physical Health, Psychological Health, Social Relationships and Environment; (2) the Satisfaction With Life Scale (SWLS) (Diener et al., 1985) which measures overall perceptions of life satisfaction relative to one's own circumstances and standards; (3) the Internal Control Index (ICI) (Duttweiler, 1984) which measures the degree to which one believes they can control events that affect them, and provides scores for overall Internal Control and sub-domains of Self-Confidence and Autonomy; (4) the Emotion Regulation Questionnaire (ERQ) (Gross and John, 2003) which measures both reappraisal and suppression strategies used to deal with