The South Korean Twin Registry: An Update

Yoon-Mi Hur,1 Hoe-Uk Jeong,2 Kee Wha Chung,3 Joong Sik Shin,4 and Tae-Bok Song5

1Industry-Academics Cooperation Foundation, Mokpo National University, Jeonnam, South Korea
2Department of Education, Mokpo National University, Jeonnam, South Korea
3Department of Biology, Kongju National University, Kongju, South Korea
4Department of Obstetrics & Gynecology, CHA University School of Medicine, Seoul, South Korea
5Department of Obstetrics & Gynecology, Jeonnam National University Hospital, Kwangju, South Korea

The South Korean Twin Registry (SKTR) is an ongoing nation-wide volunteer registry of South Korean twins and their families, which was established in the year 2001 to understand genetic and environmental etiologies of psychological and physical traits among South Koreans. Recently, the SKTR sampling has been extended in two important ways. First, we began to recruit twins from lower socio-economic families to study interaction effects of gene by environmental context. Second, as a parallel study of the SKTR, the Nigerian Twin and Sibling Registry was developed to understand the origin of the population group differences/similarities in psychological traits between South Koreans and Nigerians. This article summarizes the main findings (based on the SKTR sample to date), recruitment procedures, zygosity assessment, measures, and future plans for the SKTR.

Keywords: twin, genetics, South Korea, psychological traits, physical traits, mental health

A Review of the Past Findings and Current Major Research Issues

The South Korean Twin Registry (SKTR) is an ongoing nation-wide volunteer registry of South Korean twins and their families. The general goal of the SKTR is to understand genetic and environmental etiologies of psychological and physical traits among South Koreans. Since its inception (Hur, 2002; Hur et al., 2006), twin studies based on the SKTR samples have demonstrated that genetics play a significant role in individual differences in many physical and psychological traits among South Koreans, especially from childhood to young adulthood (Table 1). For physical traits, body mass index (BMI), and cold hands symptoms in adolescence and young adulthood showed very high heritability (about 60–90%) with little shared environmental influences (Hur, 2007a; Hur et al., 2008, 2012) although during childhood these traits were significantly influenced by shared environmental factors (Hur & Shin, 2008). Substantial intrauterine environmental influence was also observed in birth weight (Hur et al., 2005). Genetic influences on childhood temperament and adolescent personality traits fell between 30% and 60%, of which non-additive genetic effects were important (Hur, 2006, 2007b, 2009a; Hur & Rushton, 2007; Hur et al., 2011). The estimates of genetic influences on many psychiatric symptoms were similar to those found in personality traits (Hur, 2008, 2009b; Hur & Jeong, 2008; Hur et al., 2012). However, shared environmental influences were notable in conduct problems (Ha et al., 2010), depressive symptoms in males (Hur, 2008), and obsessive-compulsive symptoms in females (Hur & Jeong, 2008). As with personality traits, many psychiatric symptoms demonstrated that individual-specific environmental influences were important sources of variation. Overall, these findings based on the SKTR samples were consistent with the results from Western twin samples, suggesting that the proportions of genetic and environmental influences on psychological and physical traits found in Western countries may be generalized to South Koreans.

Our current major research focus of the SKTR samples includes detection of G × E interactions for the mean level as well as for the variations of psychological and physical phenotypes. To examine the process of G × E interactions, we...
make efforts to identify specific genetic, and environmental protective and risk factors for psychological and physical traits. We also investigate developmental differences in genetic and environmental influences on phenotypes and endophenotypes, using age as a continuous moderator. The large age span of twin participants in the SKTR enables us to pursue this research question. In line with these research interests, we recently extended the SKTR sampling in two important ways. First, as explained below, we began to recruit twins from lower socio-economic families, which will facilitate studies of interactions between genetics and social classes. Second, as a parallel twin study of the SKTR, we started to develop an age-matched sample of Nigerian twins and siblings (Hur et al., 2013 in this issue). The combined data sets of Nigerian and South Korean twins will provide a unique opportunity to investigate population group differences/similarities in psychological traits between South Korean and Nigerian children and adolescents.

Registry Membership

Twins in the SKTR have been recruited from a variety of sources, including large maternity hospitals, twin mothers’ clubs, media advertisement, and kindergartens and schools throughout South Korea (Hur et al., 2006). More recently, to reach twins from lower socio-economic families who are typically under-represented in volunteer research projects, we began to call and send letters to the community child centers and youth counseling centers supported by the government in all provinces in South Korea. As these centers support children and adolescents from poor families and those with problem behaviors, a successful recruitment of these children and adolescents is likely to make the participants of the SKTR well representative of a large number of low-income as well as middle- to upper-class families in South Korea.

Due to a high mobility rate among residents in large cities in South Korea, however, we have lost the contact information of twins for the past years. To replenish the registry membership, we continue to recruit new volunteers as well as to trace contact information of the twins who moved. Table 2 presents the number of individual twins who have been at least once registered with the SKTR.

Zygosity Assignment

Opposite-sex twins in the SKTR are automatically assigned to dizygotic twins. Zygosity assignment for the same-sex twins is initially based on the questionnaire method and in some cases by chorionicity determined by the examination of placentas in the pathology lab after delivery. However, the questionnaire method is currently supplemented with analysis of 16 micro-satellite DNA markers.

### Table 1

<table>
<thead>
<tr>
<th>Measure</th>
<th>Age</th>
<th>A + D</th>
<th>C</th>
<th>E</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight (males)</td>
<td>15</td>
<td>48</td>
<td>36</td>
<td></td>
<td>Hur et al. (2005)</td>
</tr>
<tr>
<td>Birth weight (females)</td>
<td>16</td>
<td>52</td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (males)</td>
<td>13–19 years</td>
<td>82 (72–95)</td>
<td>—</td>
<td>18 (15–21)</td>
<td>Hur (2007a)</td>
</tr>
<tr>
<td>BMI (females)</td>
<td>13–19 years</td>
<td>87 (77–99)</td>
<td>—</td>
<td>13 (11–15)</td>
<td></td>
</tr>
<tr>
<td>BM1</td>
<td>1.9–8.7 years</td>
<td>55 (43–68)</td>
<td>35 (22–47)</td>
<td>10 (8–13)</td>
<td>Hur &amp; Shin (2008)</td>
</tr>
<tr>
<td>Cold hands symptoms</td>
<td>12–24 years</td>
<td>64 (55–72)</td>
<td>—</td>
<td>36 (28–45)</td>
<td>Hur et al. (2012)</td>
</tr>
<tr>
<td>Eysenckian scalesb</td>
<td>13–23 years</td>
<td>42</td>
<td>—</td>
<td>58</td>
<td>Hur (2007b)</td>
</tr>
<tr>
<td>EAS</td>
<td>2–9 years</td>
<td>39</td>
<td>—</td>
<td>61</td>
<td>Hur (2009)</td>
</tr>
<tr>
<td>Pro-social behavior</td>
<td>2–9 years</td>
<td>55 (45–64)</td>
<td>—</td>
<td>45 (35–55)</td>
<td>Hur &amp; Rushton (2007)</td>
</tr>
<tr>
<td>Depression symptoms (males)</td>
<td>13–23 years</td>
<td>12 (0–54)</td>
<td>32 (0–53)</td>
<td>56 (44–70)</td>
<td>Hur (2008)</td>
</tr>
<tr>
<td>Depression symptoms (females)</td>
<td>13–23 years</td>
<td>41 (0–52)</td>
<td>0 (0–36)</td>
<td>59 (48–72)</td>
<td>Hur (2008)</td>
</tr>
<tr>
<td>Conduct problems</td>
<td>4–13 years</td>
<td>39</td>
<td>—</td>
<td>61</td>
<td>Ha et al. (2010)</td>
</tr>
<tr>
<td>Hallucination symptoms</td>
<td>12–19 years</td>
<td>33 (23–42)</td>
<td>—</td>
<td>67 (60–77)</td>
<td>Hur et al. (in press)</td>
</tr>
</tbody>
</table>

Note: A = additive genetic effects; C = shared environmental effects; D = non-additive genetic effects; E = individual environmental effects including measurement error. 95% CI are in parentheses.

### Table 2

<table>
<thead>
<tr>
<th>Age group*</th>
<th>N</th>
<th>Sex ratio (M:F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children (age &lt; 8 years)</td>
<td>5,210</td>
<td>45:55</td>
</tr>
<tr>
<td>Adolescents (7 years &lt; age &lt; 19 years)</td>
<td>13,230</td>
<td>48:52</td>
</tr>
<tr>
<td>Young adults (age &gt; 18 years)</td>
<td>3,048</td>
<td>47:53</td>
</tr>
<tr>
<td>Total</td>
<td>21,488</td>
<td></td>
</tr>
</tbody>
</table>

Note: *Individual twins.
TABLE 3
Description of Selected Measures Used in the South Korean Twin Registry

<table>
<thead>
<tr>
<th>Domain</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive abilities</td>
<td>Non-verbal general ability</td>
<td>Standard Progressive Matrices-Plus version (Raven, 2008)</td>
</tr>
<tr>
<td></td>
<td>Verbal general ability</td>
<td>Mill Hill Vocabulary Scale (Raven, 2008)</td>
</tr>
<tr>
<td>Personality</td>
<td>Adolescent personality</td>
<td>Eysenck Personality Scale (Eysenck &amp; Eysenck, 1991)</td>
</tr>
<tr>
<td></td>
<td>Childhood temperament</td>
<td>EAS (Buss &amp; Plomin, 1984)</td>
</tr>
<tr>
<td>Mental health</td>
<td>Behavioral problems</td>
<td>Strengths and Difficulties Questionnaire (Goodman, 1997)</td>
</tr>
<tr>
<td></td>
<td>Anger</td>
<td>State-Trait Anger Scale (Brunner &amp; Spielberger, 2009)</td>
</tr>
<tr>
<td></td>
<td>Anxiety</td>
<td>State-Trait Anxiety Scale (Spielberger, 1983)</td>
</tr>
<tr>
<td></td>
<td>Hostility</td>
<td>Koskenvuo et al. (1988)</td>
</tr>
<tr>
<td></td>
<td>Morningness-eveningness</td>
<td>Composite Scale (Smith et al., 1989)</td>
</tr>
<tr>
<td></td>
<td>Hallucination</td>
<td>Launey-Slade Hallucination Scale –Revised (Launay &amp; Slade, 1991)</td>
</tr>
<tr>
<td></td>
<td>Clinical symptoms</td>
<td>Personality Assessment Inventory (Morey, 1991)</td>
</tr>
<tr>
<td></td>
<td>Depression</td>
<td>CES-D (Cho &amp; Kim 1998)</td>
</tr>
<tr>
<td></td>
<td>Obsessive-compulsive symptoms</td>
<td>Maudsley Obsessive-Compulsive Inventory (Hodgson &amp; Rachman, 1977).</td>
</tr>
<tr>
<td>Substance use</td>
<td>Perceptions of social support</td>
<td></td>
</tr>
<tr>
<td>Family environment</td>
<td>Physical environment</td>
<td>Family Asset questionnaire</td>
</tr>
<tr>
<td></td>
<td>Psychological environment</td>
<td>FACES III (Olson et al., 1985)</td>
</tr>
<tr>
<td>Physical development</td>
<td>Puberty (self-report)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Birth weight (parental report)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Height, weight (self-report; parental report)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chorionicity (lab examination)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cold hands symptom (self-report)</td>
<td></td>
</tr>
<tr>
<td>Demographic information</td>
<td>General health (self-report, parental report)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Parents’ education, occupation, religion</td>
<td></td>
</tr>
</tbody>
</table>

**Measures**

Studies using the SKTR samples encompass a broad range of psychological and physical domains. The measures for the SKTR samples have been chosen for their high psychometric properties and for their broad acceptance in the field. These practices allow cross-national comparison studies. Table 3 provides an overview of selected measures used in the SKTR.

**Conclusions and Future Plans**

This article is not an exhaustive description of all the studies of the SKTR. Development of the SKTR is an ongoing process. Plans are still underway to conduct extensive genotyping in order to examine polymorphisms associated with psychological and physical traits among South Koreans. Efforts are also being made for epigenetic analyses and co-twin-control studies using a subset of the SKTR sample.

**Acknowledgments**

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**References**


