

The South Korean Twin Registry: An Update

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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). For personality traits, shared environmental influences were generally negligible during childhood and adolescence as well as in young adulthood. Environmental factors important for personal-

ity and temperament were primarily those resulted from individual-specific experiences (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 $G \times E$ interactions for the mean level as well as for the variations of psychological and physical phenotypes. To examine the process of $G \times E$ interactions, we

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TABLE 1
Genetic and Environmental Influences (%) on Various Traits Estimated From Sub-Samples of the South Korean Twin Registry^a

Measure	Age	A + D	C	E	Reference
Birth weight (males)		15	48	36	Hur et al. (2005)
Birth weight (females)		16	52	31	
BMI (males)	13–19 years	82 (72–95)	—	18 (15–21)	Hur (2007a)
BMI (females)	13–19 years	87 (77–99)	—	13 (11–15)	
BMI	1.9–8.7 years	55 (43–68)	35 (22–47)	10 (8–13)	Hur & Shin (2008)
Cold hands symptoms	12–24 years	64 (55–72)	—	36 (28–45)	Hur et al. (2012)
Hostility	13–23 years	34 (30–36)	—	66 (64–70)	Hur (2006)
Eysenckian scales ^b	13–23 years	42	—	58	Hur (2007b)
EAS ^c	2–9 years	39	—	61	Hur (2009)
Miserliness	12–25 years	28 (21–34)	—	72 (66–79)	Hur et al. (2011)
Morningness-eveningness	9–23 years	45 (39–50)	—	55 (50–61)	Hur (2007c)
Pro-social behavior	2–9 years	55 (45–64)	—	45 (36–55)	Hur & Rushton (2007)
Depression symptoms (males)	13–23 years	12 (0–54)	32(0–53)	56 (44–70)	Hur (2008)
Depression symptoms (females)	13–23 years	41(0–52)	0(0–36)	59 (48–72)	Hur (2008)
Obsessive-compulsive symptoms (males)	13–23 years	53 (45–59)	—	47 (41–55)	Hur & Jeong (2008)
Obsessive-compulsive symptoms (females)	13–23 years	41 (33–48)	—	59 (52–67)	Hur & Jeong (2008)
Conduct problems	4–13 years	—	39	61	Ha et al. (2010)
Hallucination symptoms	12–19 years	33 (23–42)	—	67 (60–77)	Hur et al. (in press)

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 parenthesis.

^aMain effects of age were adjusted; main effects of sex were also adjusted when males and females were not separated.

^bAverage across seven scales (Extraversion, Neuroticism, Psychoticism, Impulsivity, Venturesomeness, Empathy, and Lie).

^cAverage across Emotionality, Activity, and Sociability scales.

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

TABLE 2

Number^a of Twins Who Have Been Registered With the SKTR By Age Group and the Sex-Ratio of Each Age Group

Age group	N	Sex ratio (M:F)
Children (age < 8 years)	5,210	45:55
Adolescents (7 years < age < 19 years)	13,230	48:52
Young adults (age > 18 years)	3,048	47:53
Total	21,488	

Note: ^aIndividual twins.

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 3
Description of Selected Measures Used in the South Korean Twin Registry

Domain	Description	Source
Cognitive abilities	Non-verbal general ability	Standard Progressive Matrices-Plus version (Raven, 2008)
Personality	Verbal general ability	Mill Hill Vocabulary Scale (Raven, 2008)
	Adolescent personality	Eysenck Personality Scale (Eysenck & Eysenck, 1991)
	Childhood temperament	EAS (Buss & Plomin, 1984)
Mental health	Behavioral problems	Economic Behaviors
		Strengths and Difficulties Questionnaire (Goodman, 1997)
	Anger	State-Trait Anger Scale (Brunner & Spielberger, 2009)
	Anxiety	State-Trait Anxiety Scale (Spielberger, 1983)
	Hostility	Koskenvuo et al. (1988).
	Morningness-eveningness	Composite Scale (Smith et al., 1989).
	Hallucination	Launey-Slade Hallucination Scale –Revised (Launay & Slade, 1981).
	Clinical symptoms	Personality Assessment Inventory (Morey, 1991)
	Depression	CES-D (Cho & Kim 1998)
	Obsessive-compulsive symptoms	Maudsley Obsessive-Compulsive Inventory (Hodgson & Rachman, 1977).
Family environment	Substance use	
	Perception of social support	
	Physical environment	Family Asset questionnaire
Physical development	Psychological environment	FACES III (Olson et al., 1985)
	Puberty (self-report)	
Demographic information	Birth weight (parental report)	
	Height, weight (self-report; parental report)	
	Chorionicity (lab examination)	
	Cold hands symptom (self-report)	
	General health (self-report, parental report)	
	Parents' education, occupation, religion (self-report, parental report)	

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.

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