

# 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 × 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

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

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 <sup>b</sup>	13–23 years	42	—	58	Hur (2007b)
EAS <sup>c</sup>	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.

<sup>a</sup>Main effects of age were adjusted; main effects of sex were also adjusted when males and females were not separated.

<sup>b</sup>Average across seven scales (Extraversion, Neuroticism, Psychoticism, Impulsivity, Venturesomeness, Empathy, and Lie).

<sup>c</sup>Average 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<sup>a</sup> 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: <sup>a</sup>Individual 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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## References

- Brunner, T. M., & Spielberger, C. D. (2009). *State-trait anger expression inventory-2 child and adolescent*. Professional manual. Lutz: Psychological Assessment Resources.
- Buss, A. H., & Plomin, R. (1984). *Temperament: Early developing personality traits*. Hillsdale, NJ: Erlbaum.
- Cho, M. J., & Kim, K. H. (1998). Use of the center for epidemiologic studies-depression scale in Korea. *Journal of Nervous and Mental Disease*, 186, 304–310.
- Eysenck, H. J., & Eysenck, S. B. G. (1991). *Manual of the Eysenck personality scales*. London: Hodder & Stoughton.
- Goodman, R. (1997). The strengths and difficulties questionnaire: A research note. *Journal of Child Psychology and Psychiatry*, 38, 581–586.
- Ha, N., Jin, M. J., Koo, S., Jo, O., Kim, B., Kim, K., . . . Hur, Y.-M. (2010). Genetic and environmental covariations between emotional problems and conduct problems in South Korean twin children. Abstracts for the 13th International Congress on Twin Studies. *Twin Research and Human Genetics*, 13, 261.
- Hodgson, R. J., & Rachman, S. (1977). Obsessional-compulsive complaints. *Behavior Research and Therapy*, 15, 389–395.
- Hur, Y.-M. (2002). Seoul Twin Family Study: Design, sampling, assessments, and future directions. *Twin Research*, 5, 389–393.
- Hur, Y.-M. (2006). Nonadditive genetic effects on hostility in South Korean adolescent and young adult twins. *Twin Research and Human Genetics*, 9, 637–654.

- Hur, Y.-M. (2007a). Sex difference in heritability of BMI in South Korean adolescent twins. *Obesity*, 15, 2908–2911.
- Hur, Y.-M. (2007b). Evidence for nonadditive genetic effects on Eysenck Personality Scales in South Korean twins. *Twin Research and Human Genetics*, 10, 373–378.
- Hur, Y.-M. (2007c). Stability of genetic influence on morningness-eveningness: A cross-sectional examination of South Korean twins from preadolescence to young adulthood. *Journal of Sleep Research*, 16, 17–23.
- Hur, Y.-M. (2008). Sex difference in genetic and environmental contributions to depression symptoms in South Korean adolescent and young adult twins. *Twin Research and Human Genetics*, 11, 306–313.
- Hur, Y.-M. (2009a). Genetic and environmental contributions to childhood temperament in South Korean twins. *Twin Research and Human Genetics*, 12, 549–554.
- Hur, Y.-M. (2009b). Genetic and environmental contributions to the covariations between obsessive-compulsive symptoms, neuroticism, and extraversion. *Twin Research and Human Genetics*, 12, 142–149.
- Hur, Y.-M., Chae, J.-H., Chung, K. W., Kim, J.-J., Jeong, H.-U., Kim, J. W., . . . Kim, K. S. (2012). Feeling of cold hands and feet is a highly heritable phenotype. *Twin Research and Human Genetics*, 15, 166–169.
- Hur, Y.-M., Cherney, S. S., & Sham, P. C. (2012). Heritability of hallucinations in adolescent twins. *Psychiatry Research*. Retrieved from <http://dx.doi.org/10.1016/j.psychres.2012.04.024>
- Hur, Y.-M., & Jeong, H.-U. (2008). Sex differences in genetic and environmental influences on obsessive-compulsive symptoms in South Korean adolescent and young adult twins. *Twin Research and Human Genetics*, 11, 314–320.
- Hur, Y.-M., Jeong, H.-U., Schermer, J., & Rushton, J. P. (2011). Miserliness is heritable. *Personality and Individual Differences*, 51, 1052–1055.
- Hur, Y.-M., Kaprio, J., Iacono, W. G., Boomsma, D. I., McGue, M., Silventoinen, K., . . . Mitchell, K. (2008). Genetic influences on the difference in variability of height, weight and body mass index between Caucasian and East Asian adolescent twins. *International Journal of Obesity*, 32, 1455–1467.
- Hur, Y.-M., Kim, J. W., Chung, K. W., Shin, J. S., Jeong, H.-U., & Auta, E. (2013). The Nigerian Twin and Sibling Registry. *Twin Research and Human Genetics*, 16, 1.
- Hur, Y.-M., Luciano, M., Martin, N. G., Boomsma, D. I., Iacono, W. G., McGue, M., . . . Han, J. Y. (2005). A comparison of twin birth weight data from Australia, the Netherlands, the United States, Japan, and South Korea: Are genetic and environmental variations in birth weight similar in Caucasians and East Asians? *Twin Research and Human Genetics*, 8, 638–648.
- Hur, Y.-M., & Rushton, J. P. (2007). Genetic and environmental contributions to prosocial behavior in 2- to 9- year-old South Korean twins. *Biology Letters*, 22, 664–666.
- Hur, Y.-M., & Shin, J. (2008). Effects of chorion type on genetic and environmental influences on height, weight, and body mass index in South Korean young twins. *Twin Research and Human Genetics*, 11, 63–69.
- Hur, Y.-M., Shin, J., Jeong, H.-U., & Han, J. Y. (2006). The South Korean Twin Registry. *Twin Research and Human Genetics*, 9, 838–843.
- Koskenvuo, M., Kaprio, J., Rose, R. I., Kesaniemi, A., Sara, S., & Heikkilä, K. (1988). Hostility as a risk factor for mortality and ischemic heart disease in men. *Psychosomatic Medicine*, 50, 330–340.
- Launay, G., & Slade, P. D. (1981). The measurement of hallucinatory predisposition in male and female prisoners. *Personality and Individual Differences*, 2, 221–234.
- Morey, L. C. (1991). *Personality Assessment Inventory, professional manual*. Lutz, FL: Personality Assessment Resources.
- Olson, D. H., Portner, J., & Lavee, Y. (1985). *FACES III*. St. Paul, MN: Family Social Science, University of Minnesota.
- Raven, J. (2008). *Standard progressive matrices-plus version and Mill Hill Vocabulary Scale. Manual*. London: Pearson.
- Smith, C. S., Reilly, C., & Midkiff, K. (1989). Evaluation of three circadian rhythm questionnaires with suggestions for an improved measure of morningness. *Journal of Applied Psychology*, 74, 728–738.
- Spielberger, C. D. (1983). *State-Trait Anxiety Inventory (Form Y)*. Menlo Park: Mind Garden.