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Article

The Nigerian Twin and Sibling Registry: An Update

Yoon-Mi Hur[1], Hoe-Uk Jeong[1], Man Chull Kang[1], Frances Ajose[2], Jong Woo Kim[3], Jeffrey J. Beck[4], Jouke-Jan Hottenga[5], Hamdi Mbarek[5], Casey T. Finnicum[4], Erik A. Ehli[4], Nicholas G. Martin[6], Eco J. de Geus[5], Dorret I. Boomsma[4,5], Gareth E. Davies[4,5] and Timothy Bates[7]

[1]Department of Education, Education Research Institute, Mokpo National University, Jeonnam, South Korea, [2]Clinical Sciences, Lagos State University College of Medicine, Lagos, Nigeria, [3]Department of Neuropsychiatry, Kyung Hee University, Seoul, South Korea, [4]Avera Institute for Human Genetics, Avera McKennan Hospital & University Health Center, Sioux Falls, SD, USA, [5]Department of Biological Psychology, Behavioral and Movement Sciences, Vrije Universiteit, Amsterdam, The Netherlands, [6]QIMR Berghofer Medical Research Institute, Brisbane, Queensland, Australia and [7]Department of Psychology, University of Edinburgh, UK

Abstract

Here we provide an update of the 2013 report on the Nigerian Twin and Sibling Registry (NTSR). The major aim of the NTSR is to understand genetic and environmental influences and their interplay in psychological and mental health development in Nigerian children and adolescents. Africans have the highest twin birth rates among all human populations, and Nigeria is the most populous country in Africa. Due to its combination of large population and high twin birth rates, Nigeria has one of the largest twin populations in the world. In this article, we provide current updates on the NTSR samples recruited, recruitment procedures, zygosity assessment and findings emerging from the NTSR.

Keywords: extreme poverty; mental health; Nigeria; psychological characteristics; siblings; twin registry

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General Background and Aims

Africa was the likely origin of the global expansion of modern *Homo sapiens* (Templeton, 2002). African populations, as a result, have the highest levels of genetic and phenotypic variations among all human populations. Thus, twin and genetic studies that characterize genetic and environmental variations in African populations may provide critical information about human evolutionary origins of complex traits and the genetic basis of human adaptation to diverse environments (Campbell & Tishkoff, 2008). Africans are known to have the highest rate of spontaneous dizygotic (DZ) twin births among human races. As twin birth rates in most African countries tend to be derived from hospital statistics, they are likely biased due to the factors associated with selection. Unlike in most developed countries, however, DZ twin birth rates in most African countries remain stable because the use of artificial reproductive technique and contraception are relatively uncommon (Sunday-Adeoye et al., 2008). It has been reported that spontaneous DZ twin birth rates are as high as 45–50 pairs per thousand births in Nigerians in contrast to 1–2 pairs per thousand births in Japanese and South Koreans (Aduloju et al., 2015; Bulmer, 1970; Hur & Kwon, 2005; Imaizumi, 1992; MacGillivray, 1986; Nylander, 1970, 1971; Obiechina et al., 2011; Smits & Monden, 2011). In spite of these high twin birth rates, twin studies have been rarely conducted in African countries, perhaps due to limited resources and inadequate research infrastructure in Africa. In 2010, the Nigerian Twin and Sibling Registry (NTSR; Hur et al., 2013) was created with the aim of enabling the study of genetic and environmental influences and their interplay in psychological and mental health development in Nigerian children and adolescents.

The population of Nigeria is unique at least in two ways. First, Nigeria is the most populous country in Africa, encompassing about 18% of the total population in Africa. Due to its combination of large population and high twin birth rates, Nigeria has one of the largest twin populations in the world, making it one of the best regions in the world to study genetic and environmental origins of twinning. Second, the vast majority of Nigerians live in environmental conditions characterized by severe deprivation of food, safe drinking water, sanitation facilities and access to health, education and information services. It has been recently reported that the country with the greatest number of people living in extreme poverty is Nigeria (World Bank, 2017). The bioecological model of human development predicts that genetic influences are lower in adverse than in affluent environments (Bronfenbrenner & Ceci, 1994). However, because there has been very little genetically informative research using twins living below the low end of the socioeconomic continuum in many Western countries (Tucker-Drob & Bates, 2016), the impact of extreme poverty on gene × environmental transaction in psychological and health

Author for correspondence: Yoon-Mi Hur, Email: ymhur@mokpo.ac.kr

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development remains largely unknown. Thus, the NTSR can provide an unparalleled opportunity to address the issues of whether and how abject poverty influences gene–environment interplays in human development.

The target sites for the NTSR are Abuja, Federal Capital Territory (FTC), Lagos State and Ibadan. In our previous introduction of the NTSR (Hur et al., 2013), we described the adolescent twin and sibling sample ($N = 1538$) collected from Abuja, FTC. In the present article, we report the samples collected from Lagos State in the years 2013 and 2014. Lagos State is located in the southwestern geopolitical zone of Nigeria and is one of the most populous urban areas in Nigeria. Although the residents of Lagos State are ethnically diverse, they are mainly members of the Yoruba ethnic group. The main religions in Nigeria are Christianity (approximately 40%), Islam (about 50%) and indigenous beliefs (about 10%), though Christianity is more common in Lagos State (Pew Research Center, 2012). Lagos State is currently the most prosperous region in sub-Saharan Africa. However, there is a huge variation in economic distribution among people living in Lagos State as well as in Nigeria (World Bank, 2017). As our primary interest was the impact of extreme poverty, we recruited twins from public schools in the poorest areas in Lagos State, as described below.

Samples and Zygosity Assignment

The NTSR includes three samples: the first consists of adolescent twins and siblings recruited from public schools in Abuja, FTC, from 2010 to 2012 ($N = 1538$), the second consists of adolescent twins collected from public schools in Lagos State in 2013 and 2014 ($N = 3685$) and the third consists of mothers of opposite-sex DZ (OSDZ) twins attending public schools in district I of Lagos State in 2017 ($N = 100$). The third sample was collected for the purpose of a pilot study to understand genetic underpinnings of DZ twinning. The mean (*SD*, range) age of mothers when their first child was born and when their first set of twins was born in the third sample were 24.0 (4.1, 13–35) and 28.7 (5.1, 15–40), respectively. For all same-sex twin samples, zygosity was determined by analysis of 18 microsatellite markers of DNA, including amelogenin. Opposite-sex twins were assigned as DZ. Table 1 presents zygosity composition, mean (*SD*) in years of age and sex ratio for each sample. Of note, Table 1 differs from our earlier report (Hur et al., 2013) in the numbers of monozygotic (MZ) and DZ twins in the Abuja sample. As indicated in the earlier report, some of the twins' zygosity in the Abuja sample was determined by the questionnaire method because the DNA analyses of all the same-sex twins were not complete at the time of writing this report. DNA-based zygosity assignment has now been completed for all same-sex twins in both the Abuja and Lagos State samples, as shown in Table 1. The much larger number of DZ compared to MZ twin pairs in Table 1 is in line with twin birth rates in Nigeria (Bulmer, 1970; MacGillivray, 1986; Nylander, 1970, 1971).

Recruitment Procedures

Twins and their families in the NTSR are identified through public schools because birth records in Nigeria are known to be incomplete and their validity is controversial. The Nigerian public education system consists of 6 years of primary school (age 5–11 years), 3 years of junior secondary school (JSS; age 12–14 years), 3 years of senior secondary school (SSS; 15–17 years) and 3 or more years of tertiary education.

To recruit participants in the first sample, we obtained approvals from the Universal and Secondary Education Boards in Abuja, FCT. Permission to recruit participants in the second and third samples was obtained from the Ministry of Education and the Health Research and Ethics Committee of the Lagos State University Teaching Hospital in Lagos State. Along with letters of permission, the authorities gave us a list of all public schools in Abuja, FCT, and Lagos State, including names and telephone numbers of the principals and addresses and the enrollment size of the schools.

Lagos State had over 600 public JSS and SSS in addition to many private schools spread over six school districts. Twins in the second sample were recruited from 272 (42.6% of the total) public JSS and SSS in the five poorest districts of Lagos State. As the number of twins in each school tended to vary depending on the enrollment size of the school, we contacted schools with an enrollment size of at least 500 students. After reaching the school principal by phone, we explained our research, obtained information about the number of twins enrolled in the school and scheduled the assessment of twins. Public schools in Lagos State were generally cooperative. In each of the 272 schools, we administered questionnaires to twins in small groups in library or special classrooms. Research assistants and schoolteachers were present in the testing room to monitor twins and give instructions to twins. For DNA analysis, a saliva sample was taken from each same-sex twin during the testing session.

To recruit mothers of OSDZ twins in the third sample, we asked the office of district 1 to solicit volunteers from all public schools in the district. More than 100 mothers of OSDZ twins volunteered. However, due to shortage of funds, we selected only 100 mothers on a first-come, first-served basis. We gave a questionnaire to the mothers and collected saliva samples in large classrooms.

Measures

The measures used for the NTSR can be divided into three broad categories: cognitive abilities, problem behaviors and mental health and home environment. To facilitate collaboration with other twin studies in the world, we chose widely used instruments with demonstrated high levels of reliability and validity. As the official language in Nigeria is English, English versions of the measures were given to twins. However, because many indigenous languages are still widely spoken by children at home and school (Federal Research Division, United States Library of Congress, 2008), some items of the instrument should be reworded to make them culturally appropriate. Thus, it is our protocol to discuss items in the instruments with university or graduate-level students or faculties in Nigeria before we choose the measures.

Major Findings

Major findings based on the NTSR samples to date are briefly summarized in Table 2. As indicated, singletons outperformed twins on Standard Progressive Matrices plus (Raven, 2008) and the Mill-Hill Vocabulary test (Raven, 2008). The average difference between twins and singletons was equivalent to 4.2 IQ points ($d = 0.28$; Hur & Lynn, 2013). These findings were similar to the twin-singleton gap found in earlier Western cohorts, but in contrast to the results from recent studies using contemporary twins in developed countries where no or a very small twin penalty is found (e.g., Christensen et al., 2006; Posthuma et al., 2000). However, many outcomes reveal similar results in the NTSR and Western or East Asian twin samples. For example, coefficients

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Table 1. Zygosity composition, age and sex ratio of the three samples in the Nigerian Twin and Sibling Registry

Sample		MZ	DZ[a]	Others[b]	Mothers of OSDZ	Total *N*
First sample (Abuja, FCT)	*N*[c]	150	534	854	–	1538
	Mean (*SD*) age in years	15.29 (3.50)	15.16 (2.71)	15.65 (2.38)		15.31 (2.56)
	M:F (%)	49:51	46:54	41:59		44:56
Second sample (Lagos state)	*N*[c]	842	2660	189		3685
	Mean (*SD*) age in years	14.44 (2.00)	14.58 (2.01)	14.58 (1.93)		14.55 (2.00)
	M:F (%)	43:57	48:52	57:43		47:53
Third sample (Lagos state)	*N*[c]		–	–	100	100
	Mean (*SD*) age in years				43.41 (5.52)	43.41 (5.52)
	M:F (%)				0:100	

Note: MZ = monozygotic twins; DZ = dizygotic twins; OSDZ = opposite-sex dizygotic twin.
[a]Includes opposite- and same-sex dizygotic twins.
[b]Includes full- and half-siblings, co-twin missing, zygosity unknown or sex unknown cases.
[c]Individuals.

Table 2. Major findings as of 2019

Research question	Major findings	Source
Twin–singleton difference in cognitive abilities	Singleton > twin; SPM+ ($d = 0.32$, 4.8 IQ points); MHV ($d = 0.24$, 3.6 IQ points)	Hur & Lynn (2013)
Assortative mating for education	$r = .57$ (95% CI [0.55, 0.59])	Hur (2016)
Changes in sex differences in cognitive abilities during development	From age 8 to 19 years, sex differences in the total score of the SPM+ increased from −0.06*d* (favoring females) to 0.46*d* (favoring males), with an average of 0.23*d*.	Hur, te Nijenhuis et al. (2017)
Heritability of prosocial behavior	$A = 38\%$ (95% CI [31%, 46%]; $E = 62\%$ (95% CI [54%, 69%])	Hur, Taylor et al., (2017)
Heritability of religious attendance	$C = 74\%$ (95% CI [69%, 78%]; $E = 26\%$ (95% CI [22%, 31%])	Hur et al. (2019)
Heritability of family cohesion	$A = 33\%$ (95% CI [24%, 40%]); $E = 67\%$ (95% CI [60%, 76%])	Hur, Taylor et al., (2017)
Moderation effects of family cohesion on prosocial behavior	FC significantly moderated E unique to PB (E × E interaction). A for PB was stable across all levels of FC. E for PB was highest when FC was lowest and decreased as the levels of FC increased, suggesting that FC reduces individual differences in PB by changing environmental experiences rather than genetic factors in PB.	Hur, Taylor et al., (2017)
Moderation effects of religious attendance on prosocial behavior	Religious attendance significantly moderated E unique to PB (E × E interaction). A for PB was stable but E declined with increasing levels of religious attendance.	Hur et al. (2019)
Genetic similarity and distance among Australian, Midwestern American and the Netherlands populations and Nigerians	According to the analysis of genotyping arrays, estimations of fixation indices (F_{ST} values) between the Australian, Midwestern American and the Netherlands populations suggest minimal genetic differentiation compared to the estimates between each population and Nigerians.	Beck et al. (2019)

Note: SPM+ = Standard Progressive Matrices plus; MHV = Mill-Hill Vocabulary test; A = additive genetic factors; C = shared environmental factors; E = nonshared environmental factors plus measurement error; PB = prosocial behavior; FC = family cohesion.

of assortative mating for educational achievement (Hur, 2016) are comparable, as are developmental changes in sex differences in cognitive abilities (Hur, te Nijenhuis et al., 2017), heritability of prosocial behavior (Hur & Rushton, 2007; Hur, Taylor et al., 2017) and measures of family environment (Hur, Taylor et al., 2017; Kendler & Baker, 2007). Furthermore, the finding of Hur et al. (2019) that religious attendance shows a large shared environmental influence with negligible amount of genetic effects was also consistent with reports from many western twin studies (e.g., Kirk et al., 1999). To detect genetic and environmental moderators of prosocial behavior, religious attendance and family cohesion were examined. Both religious attendance and family cohesion significantly influenced prosocial behavior by moderating the effects of environmental experiences rather than genetic influences on prosocial behavior (Hur et al., 2019; Hur, Taylor et al., 2017). These findings await replications from other twin studies. Genetic similarity and distance were assessed among Australian, Midwestern American and Dutch samples and a subsample of the NTSR. As expected, consistent genetic differences were demonstrated between the subsample of the NTSR and the three samples of European ancestry (Beck et al., 2019).

Future Directions

The development of the NTSR is ongoing. The NTSR maintains telephone numbers of the parents of twins in the hope to perform follow-up assessments in the future. We also hope that the NTSR can be expanded to include children and adolescents in private schools in Nigeria in the near future to better assess the effects of socioeconomic status on human psychological development.

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Yoruba of western Nigeria is considered 'land of twins'. Taiwo, meaning 'taste the world' is a name reserved for the first of a set of twins in Nigeria, while Kehinde, meaning 'last to arrive' is for the second of a set of twins. However, twins account for a substantial and growing share of childhood mortality in Nigeria. It has been estimated that childhood mortality among multiple birth children in Nigeria is about two times as high as that in singletons (Uthman et al., 2008). Coordinated action is required to improve the situation of this extremely vulnerable group.

We welcome collaborations with other twin researchers for development of large consortia. Through such collaborations, we hope to further increase the knowledge of genetic and environmental etiologies of psychological and mental health traits across human populations and ultimately contribute to the development of best intervention strategies to improve human health conditions.

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