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University of Washington Twin Registry: Construction and characteristics of a community-based twin registry

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Abstract

The University of Washington Twin Registry is a community-based registry of twins identified from the Washington State Department of Licensing. A fortuitous quirk in the Washington State drivers' license and identification number assignment, and collaborative Washington State laws, permitted us to build a statewide registry. Since obtaining approval from the Washington State Attorney General, the Washington State Department of Licensing has provided us with information on over 26,000 newly licensed twins, and we continue to receive computerized records on approximately 80 new twins per week. The University of Washington Twin Registry is assembled by mailing each twin a recruitment packet that includes an information sheet, brochure, brief survey, and nominal gift. Once both members of a twin pair have completed the packet, the pair is enrolled in the Registry. As of June 2006, 2,287 adult twin pairs have enrolled in the Registry; about one half of these are female-female pairs. Among all twins, the average age is 32 years. Based on self-report, 52% of twins are MZ, 42% are DZ, and zygosity on 6% cannot yet be determined. We also have established a clinical protocol for collecting additional data and DNA from all twins participating in research studies requiring an in-person visit. The Registry has established policies and procedures to protect the confidentiality of twin data and guidelines for the use of the Registry by investigators. Plans for the further growth of the University of Washington Twin Registry and its use are discussed.

Introduction

Many twin registries in the United States are built by linking birth records to state drivers' license records (Anderson et al., 2002). In Washington (WA) State, we identified a unique strategy to build a community-based registry of twins directly from drivers' license records. This is possible because of a fortuitous quirk in the WA Department of Licensing (DOL) identification system. The license/identification number in WA is an encrypted version the

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applicants' date of birth, and first and last name. However, because twins typically have the same last name, often highly similar first names and identical dates of birth, this method, when first implemented decades ago, resulted in the issuance of duplicate license numbers. To solve this problem, the WA DOL soon began asking all applicants “Are you a twin?”. This method of bypassing duplicate license numbers is unique to WA State.

In 1998, we began negotiating with DOL and the WA State Attorney General to obtain full access to all DOL records necessary to construct a twin registry. As a result, since 1999, we have been receiving the names, addresses, telephone numbers, date of birth, place of birth, height, weight, and eye color for all twins who obtain a WA drivers license or ID card. Adult twins identified in this manner are contacted to become members of the University of Washington Twin Registry (UWTR). This project has been fully approved by the University of Washington Human Subjects Division and the office of the WA State Attorney General. Informed consent is obtained from all participants.

Recruitment

In 2002, we developed an invitation packet, including an introductory letter, a letter from the DOL, a UWTR brochure, a brief survey and consent form, a nominal gift, and a postage paid envelope. Due to the large number of names we had received from the DOL in the previous years, we used Research Data Incorporated, a survey design, direct mail, and data processing company in Richmond, Virginia, to mail and process the surveys to twins and co-twins for several rounds of recruitment. Although working with this firm initially was useful in establishing a process and recruiting through the backlog of over 13,000 twins, it was rather costly (a total of about $100,000) and somewhat inefficient.

Thus, in July 2003, we began recruitment mailings internally from the University of Washington. Over several months, the Registry Manager and the Data Manager worked together to establish databases for tracking and data entry, methods for linking the numerous databases together, and systems for monitoring outgoing and incoming mailing. Currently, we have a team of research coordinators and research assistants, who under the direction of the Registry Manager, process outgoing and incoming mail, contact twins by telephone to collect various pieces of information, and enter survey and contact information data directly into an online database. The UWTR team mails a recruitment packet to each new twin who has been identified by the DOL in the previous few months. The completion of the brief survey by the index twin triggers the recruitment process for the co-twin. Non-respondents are mailed a second packet after 4 weeks. Lastly, research assistants telephone co-twins to encourage the return of surveys because the twin pair is added into the Registry only when both the index twin and the co-twin complete the survey.

As of September 2005, 21,375 twins and more than 2,800 co-twins have received packets inviting them to become UWTR members. It is difficult to establish a true response rate for the index twins because we cannot estimate the number of DOL-identified twins who actually receive the recruitment invitation (i.e., denominator). Nonetheless, after eliminating twins known to have bad addresses from postal records, we estimate our response rate for the index twin ranges from 21%-38%, across eleven independent mailings. As expected, the response rate for co-twins has been much higher at 56%-76%. We also have examined the age and gender of adult twins who enroll in the Registry in comparison with all adult twins who are identified through the DOL process (Table 1). Twins who participate in the UWTR are slightly younger and more likely to be female than the population of twins from which they are drawn.

Incentives

As we have worked to refine the mailing process, we have specifically focused on determining the best incentive strategy to maximize response rate and minimize cost. In March 2005, we conducted a pilot study with a multifactorial design to determine the impact of types of incentive, method of mail delivery, and use of heads up letters. We assessed the response rates to varying incentives ($5.00 versus $2.00 bills), methods of mail delivery (United States Postal Service delivery versus Federal Express delivery), and preceding the mailing of the invitation packet with a preliminary letter (heads up letter versus no heads up letter).

A total of 756 twins were randomized into the 8 study cells, then underwent the standard recruitment procedures including 2 rounds of mailings followed up by telephone calls. Table 2 presents response rates by type of incentive, mailing method, and heads up letter. Once all recruitment attempts had been made, response rates did not differ statistically based on type of incentive ($p = 0.26$) or the inclusion of a heads up letter ($p = 0.48$). There was a modest but significant difference between United States Postal Service delivery and Federal Express delivery methods ($p = 0.03$). Although Federal Express delivery yielded a higher response rate, it was also a more costly recruitment strategy. For example, sending the packet containing a $2.00 incentive through the United States Postal Service without a heads up notification cost $9.00 for each completed twin survey compared to $16.00 using Federal Express. Based on the response rates and costs per completed twin survey, we estimated for each $10,000.00 spent, using United States Postal Service would yield up to 70% more twin surveys than using Federal Express.

We also have focused efforts on determining the minimum amount of incentive that could be used without reducing our baseline response rate. In this pilot study, 1,851 twins were randomized to receive the $2.00 incentive, no incentive ($0), or a multicolor magnet with the UWTR logo and contact information. All twins underwent the standard recruitment procedures, which included 2 rounds of mailings without the heads up letter as it was ineffective in the first pilot study. Follow-up telephone calls are now in progress. We found that the response rate to no incentive did not differ significantly from the response to $2.00 (15% versus 17%, $p = 0.40$). Surprisingly, however, significantly fewer twins who received the magnet responded to our recruitment efforts than twins who received $2.00 (11% versus 17%, $p = 0.001$) or no incentive (11% versus 15%, $p = 0.035$). These findings suggest neither a small monetary incentive nor a nominal gift improves response rates over offering no incentive.

Initial Survey Data

Twins receive a 2-page survey as part of their initial invitation to become members of the UWTR (available for viewing at www.uwccer.org). Aside from index and co-twin contact information, the survey contains items on demographics (age, gender, race, education, marital status), self-reported health symptoms, health-related behaviors (sleep, exercise, smoking, drinking), physician-diagnosed health conditions, and several standardized measures of health. The standardized measures include modified versions of the London Fibromyalgia Epidemiology Study Screening Questionnaire (White et al., 1999) to assess for chronic widespread pain and the Impact of Events Scale (Horowitz et al., 1979) to identify symptoms related to post-traumatic stress disorder. Additionally, the survey includes questions about childhood similarity that are used to determine zygosity. These questions, such as “As children were you and your twin as alike as 2 peas in a pod or of ordinary family resemblance?”, can be used to classify zygosity with an accuracy of 95-98% compared to biological markers (Eisen et al., 1989; Torgersen, 1979). Based on these questions, a zygosity algorithm is applied to the entire population of the Registry.

As of June 2006, 2,287 twin pairs have enrolled in the Registry. Based on the zygosity algorithm, 1,193 pairs (52%) are monozygotic (MZ), 959 pairs (42%) are dizygotic (DZ), and zygosity on 135 pairs (6%) cannot yet be determined; 49% are female-female pairs. Table 3 presents the demographic characteristics of the twins for the entire Registry and by gender and zygosity. As a whole, twins average 32 years of age, have about 14 years of education, 52% are single, and 86% are White. Aside from their marital status, these demographic characteristics are consistent with the characteristics of the WA State population from the 2000 census (see www.census.gov).

In general, twins enrolled in the UWTR are healthy; 73% rated their general health as very good to excellent on the General Health item of the Medical Outcome Study Short Form-12 (Ware et al., 1996). Table 4 presents the number of MZ and DZ twin pairs who are concordant and discordant for selected self-reported health conditions. In the majority of MZ and DZ twin pairs, both members of the pair are free of any self-reported health conditions. As expected, conditions common in the general population, such as asthma, low back pain, allergies, headaches, depression, and anxiety, are also common in this sample. Data from the initial survey have been used to identify discordant twin pairs for co-twin control studies and to generate preliminary univariate and multivariate heritability analyses for various conditions.

In-Person Module

The brief survey completed by twins at enrollment into the UWTR focuses on self-reported information regarding demographics, contact information, zygosity, and a selected number of symptoms and health conditions. The information from this survey, however, does not truly characterize the health status and health-related behaviors of the twins. More detailed objective and self-reported data and biological samples are necessary to more fully describe our population of twins, as well as provide a more substantial body of preliminary data for future studies. This optimal information should be broad and relevant to all twins and useful to investigators as new tests or markers for diseases are discovered, novel links are described, and innovative collaborations are undertaken.

Thus, we have instituted a protocol to obtain additional data, DNA, and other biological samples from all twins who agree to participate in UWTR studies that require an in-person visit. This additional data collection effort is called the in-person “module”. Table 5 outlines the procedures for the module that include collecting blood, urine, saliva, and buccal cell samples, vital signs, data on fitness, strength, and lung function tests, and measures of pain. Twins also complete a battery of questionnaires to assess various domains such as health-related quality of life (Ware et al., 1996), stress (Cohen et al.,1983), psychological distress (Kessler et al., 2002), and degree of closeness and environmental similarity between twins (LaBuda et al., 1997). Each twin is paid $60.00 to complete the module.

The collection of the module data takes places following a study visit, is discrete from any required study procedures, and is stored separately. To facilitate their eventual broader use, the investigators at the UWTR, and not individual investigators, are the guardians of these data. As of June 2006, the module data and specimens have been collected from 167 twin pairs (334 individual twins) who have participated in various in-person studies.

Follow-Up Contact

Several strategies are in place to maintain contact with the twins in the Registry, update their contact information, and generate interest in the UWTR and its studies. First, we send each twin a personalized birthday card, thereby receiving updated addresses from the United States Postal Service on twins who have moved since our last contact. With the birthday cards, we request that twins provide us with their current contact information and the best method of

reaching them. Second, twins receive letters and newsletters informing them about studies that are recruiting participants, other information about the UWTR, and information twins might find useful or entertaining. These mailings also generate contact information updates through returned mail and telephone calls. Lastly, we engage twins through occasional surveys that focus on topics of possible interest to this population. For example, this year's follow-up survey collects information on eating and sleeping habits, domains that are of particular relevance to a relatively young and healthy population.

Research

The UWTR is a resource for all investigators in genetics and other fields who wish to use twin methodologies in their research. As the gatekeepers to this resource, we have worked extensively with the University of Washington Human Subjects Division to establish procedures to protect the privacy of research participants and safeguard the confidentiality of the UWTR data, as well as procedures that facilitate the use of the Registry by investigators. Over the last year, we have refined the processes involved in making the UWTR available to researchers, including developing the UWTR Policies and Procedures, establishing the application process and Registry access fees, and formalizing the membership of the scientific advisory committee that oversees all approved Registry projects.

Additionally, we have made a concentrated effort to obtain funding for research projects that use the UWTR. Although these projects do not directly support the building and maintenance of the Registry, they do provide funding for some personnel and collect Registry access fees that help to defray the costs of maintaining the UWTR. To date, the National Institutes of Health has funded 3 studies on the variability of the innate inflammatory response, and 2 projects on chronic widespread pain; both support the clinical examination of twins. Two National Institutes of Health Career Development Awards are supporting an interdisciplinary study of eating behaviors and an investigation of sleep duration and metabolism. A University of Washington Diabetes Endocrinology Research Center pilot award supports a project on inflammation and obesity. Publications from the vast UWTR database addressing a diverse range of topics are beginning to emerge (Arguelles et al., 2006; Hallstrand et al., 2005; Watson et al., 2006).

Future Directions

One of our primary aims for the next several years is to increase the size of the Registry at a substantial pace. In this regard, we have learned that the WA State DOL is expecting many federally mandated changes in the next 2-3 years. As a fortuitous outcome of these changes, all drivers' license applicants, not just new applicants as is the current practice, will be asked the twin question. Once these changes are implemented, we expect to receive the contact information of about 40,000 twins within 5 years. We are beginning to strategize about resources and efforts needed to optimally recruit these twins into the UWTR. We also are exploring the possibility of linking birth and drivers' license records to find twins who are not identified by the current DOL processes.

Additionally, we hope to have the financial means to collect most elements of the module by mail from all UWTR participants. Our primary aim here is to collect DNA samples from all UWTR participants. One of this year's follow-up survey questions is designed to assess twins' willingness to provide a DNA sample by mail. We currently are working with laboratory personnel and University of Washington Human Subjects Division to arrange for the logistics of this undertaking.

Other primary goals are to collaborate with multidisciplinary investigators to generate manuscripts from the vast UWTR database and to design and implement studies that would

use this resource to its fullest capacity. Investigators who are interested in learning more about the Registry or would like to collaborate can obtain further information from the UWTR web pages at www.uwccer.org. We encourage investigators to review this information prior to contacting the senior author directly.

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Table 1

Demographic comparison of twins identified through the Department of Licensing database and those twins who enrolled in the University of Washington Twin Registry.

	Twins identified through DOL, 1999-2006 (N = 26,129)				**Twins in the UWTR, 1999-2006 (N = 2,465)[3]**			
	Females		***Males***		***Females***		***Males***	
Age in years[1]	N	(%)	N	(%)	N	(%)	N	(%)
< 18[2]	4,372	(34)	4,197	(32)	533	(36)	390	(40)
18 – 20	1,713	(13)	1,766	(13)	166	(11)	98	(10)
21 – 30	2,828	(22)	3,062	(23)	315	(21)	162	(17)
31 – 40	1,740	(13)	1,916	(15)	196	(13)	122	(12)
41 – 50	1,051	(8)	1,229	(9)	134	(9)	105	(11)
51 – 60	627	(5)	604	(5)	87	(6)	65	(7)
61 – 70	262	(2)	244	(2)	32	(2)	24	(2)
71+	340	(3)	178	(1)	20	(1)	16	(2)

[1] Age at the time of data receipt from the DOL, missing N = 57;

[2] Twins enrolled in UWTR were < 18 years when identified by DOL but were ≥ 18 years when enrolled in the registry;

[3] Although there are 4,574 twin in the UWTR, 2,465 were index twins and cotwins who were identified through the DOL. The remainder of the Registry are cotwins who were identified by their index twin; DOL = Department of Licensing; UWTR = University of Washington Twin Registry.

Table 2

First pilot study response rate by mail type, incentive, and letter.

	Before calls began			Overall		
	N	***Response rate, %***	**(*95% CI*)**	***N***	***Response rate, %***	**(*95% CI*)**
Mail type						
USPS	74	17	(13 – 20)	124	28	(24 – 32)
FedEx	71	23	(18 – 28)	111	36	(30 – 41)
P value		*0.04*			*0.03*	
Incentive						
$2	78	18	(14 – 21)	131	30	(25 – 34)
$5	67	21	(17 – 26)	104	33	(28 – 39)
P value		*0.18*			*0.26*	
Letter						
None	69	18	(15 – 22)	122	32	(28 – 37)
Letter	76	20	(16 – 24)	113	30	(25 – 35)
P value		*0.52*			*0.48*	

USPS = US Postal Service; FedEx = Federal Express; CI = Confidence Interval.

Table 3

Demographic characteristics of the UWTR twins (not pairs) as a group and by gender and zygosity.

	Entire Registry (n = 4,574)	**MZ/MM (n = 908)**	**DZ/MM (n = 340)**	**MZ/FF (n = 1,478)**	**DZ/FF (n = 594)**	**DZ/FM (n = 984)**
Age at survey, mean years (SD)	31.7 (14.7)	30.2 (13.8)	34.1 (13.8)	30.4 (13.6)	35.6 (13.9)	32.1 (13.5)
Marital Status, %						
Single	52	60	51	49	39	55
Married	32	29	36	33	38	28
Widowed	1	<1	0	2	4	1
Divorced	6	4	5	5	11	6
Separated	1	1	2	2	1	2
Living with partner	8	5	6	9	7	8
Race/Ethnicity, %						
White	86	85	90	83	92	86
African-American	3	4	4	3	3	3
Asian/Pacific	4	5	1	5	2	2
Islander						
Hispanic/Latino	4	3	3	5	2	4
Native American	1	1	1	2	1	1
Other	2	2	2	2	1	3
Education, mean years (SD)	13.6 (2.4)	13.5 (2.5)	13.8 (2.5)	13.6 (2.3)	13.9 (2.4)	13.5 (2.3)

UWTR = University of Washington Twin Registry; MZ = monozygotic; DZ = dizygotic; FF = female-female; MM = male-male; FM = female-male; SD = standard deviation.

Table 4

Number of concordant and discordant twin pairs for selected self-reported conditions by zygosity.

	MZ pairs (n = 1,193)			DZ pairs (n = 959)		
	Concordant yes	***Concordant no***	***Discordant***	***Concordant yes***	***Concordant no***	***Discordant***
High blood pressure	48	991	136	48	725	171
Diabetes	7	1127	39	5	886	51
Asthma	59	920	196	42	712	190
Low back pain	139	711	321	105	496	343
Gastroesophageal reflux	20	1054	101	10	828	106
Irritable bowel syndrome	21	1050	100	6	846	88
Chronic sinus problems	33	1001	136	17	786	141
Allergies	201	612	342	126	438	368
Migraine headaches	67	873	233	28	674	243
Chronic tension headaches	23	1011	140	12	810	124
Chronic fatigue syndrome	6	1125	42	3	901	37
Fibromyalgia	4	1130	34	4	910	25
Temporomandibular Joint Disorder	11	1064	93	5	855	79
Depression	100	840	231	71	605	270
Panic/anxiety attacks	44	955	170	25	721	196
Attention deficit hyperactivity disorder	20	1094	54	9	841	88
Post traumatic stress disorder	9	1091	71	3	874	63
Hearing loss	34	1019	101	18	770	139
Speech problems	29	1011	112	12	824	94

Table 5

University of Washington Twin Registry in-person module assessment domains.

Domains	What they measure	Time required
Biological Samples		
Blood	5 ml for DNA for zygosity and storage	10 minutes
	10 ml for sera	
	10 ml for plasma and buffy coat	
Saliva	Storage for future analysis of viral shedding (e.g. human herpesviruses)	1 minute
Urine	Storage for future analysis of kidney function, hormones, and metabolites	5 minutes
Buccal cells	DNA for zygosity	1 minute
Physical Examination		
Vital signs	Height, weight, blood pressure, heart rate, temperature, respiratory rate	5 minutes
Waist circumference, body mass index	Obesity	1 minute
Spirometry	Lung function	15 minutes
Pulse oximetry	Oxygen saturation	1 minute
6-minute walk and Borg	Fitness, subjective exertion	10 minutes
Dolorimetry	Pain threshold and tolerance	5 minutes
Hand Dynometer	Grip strength	2 minutes
Self-Report Measures		
Demographics	Marital status, education, socioeconomic status, race/ethnicity, religious affiliation, number/type of immediate family members	2 minutes
Items from SF-12	Health-related quality of life	1 minute
Kessler-10	Psychological distress	5 minutes
Cohen Perceived Stress Scale	Stress	1 minute
Food Frequency Questionnaire	Food consumption, nutrient intake	15 minutes
Lifestyle Questionnaire	Sleep habits and quality (insomnia and diurnal-nocturnal patterns), alcohol use (frequency and quantity), tobacco use (quantity and duration), exercise	5 minutes
Medical History	Self-reported medical conditions, medications	5 minutes
Visual analog scales	Fatigue frequency and intensity, pain frequency and intensity, memory difficulties	1 minute
Exposure Questionnaire	Exposure to toxins, chemicals, infectious agents, and other substances	1 minute
Occupation Questionnaire	Professions and jobs	1 minute
Environmental Similarity Questionnaire	Equal Environment Assumption	1 minute