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NEWS, VIEWS & COMMENTS

Twins' Injuries: Genetic and Environmental Risks / Twin Research Reports / Human Interest Stories

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The relative contributions of genetic and environmental factors to unintentional injuries are of interest to families with young twins. A recent study found that childhood injuries are explained mostly by child-specific environmental factors. Next, twin research reviews of the association between periodontal disease and cancer, secular trends in gestational age and birthweight, and language development in hearing and deaf co-twins are also summarized. Interesting reports of newborn twins, twin-like relationships, twin interactions and missed twin relationships are presented.

Twins' Injuries: Genetic and Environmental Risks

Twin children may or may not be more likely than non-twins to be affected by unintentional injuries. However, the possibility of genetic influence on accident-proneness is reasonable, given the demonstrated genetic components underlying physical characteristics and personality traits.

An early twin study by Matheny (1986) reported a relationship between children's temperamental patterns, such as activity level and attentiveness, and injury liability. Subsequent work by the same author supported the finding that children's psychological characteristics are associated with accident proneness, but also showed that this association was affected by the sex of the child and features of the rearing parents and home environment (Matheny, 1987). For example, greater childhood adaptability, eating and sleeping regularity, attentiveness and positivity were associated with lower injury liability. Boys were also more likely than girls to receive medical attention. Mothers who described themselves as more emotionally stable, energetic, socially engaged or reflective had children who showed a lower risk for childhood injuries. The homes of these children were less noisy, showed less confusion and included more ample child development resources. The contribution of child characteristics to injury liability was higher in a cohort of children followed from age 6 to 9 years, relative to a cohort of children followed from 1 to 3 years. This result is a likely reflection of the somewhat greater freedom and mobility of older children.

A later study by Phillips and Matheny (1995) similarly examined the occurrence of accidents and injuries in a cohort of twins between birth and three years of age. Twin correlations in injury liability showed genetic dominance effects in the absence of additive variance. The investigators noted, however, that such results could only be explained with reference to epistatic or other interaction effects. As before, injuries were more frequent among males than females, although this result applied only to twins whose parents responded to detailed questioning about their children. Activity and impulsivity were the strongest childhood predictors of accidental injury.

In a more recent study, Ordonana et al. (2008) argued that genetic effects on accidental injury in childhood suggest the presence of 'intermediate phenotypes between

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genes and risk of injury (e.g., temperamental or behavioral characteristics under genetic influence).' They noted that a great deal about the interaction of these factors and how they may eventuate in accidents and other mishaps is unknown. As such, they conducted an extensive study of the problem, using 1,027 same-sex twin pairs assessed within two months of their fifth birthday. The twins were enrolled in the Environmental Risk (E-risk) Longitudinal Twin Study and comprised two cohorts of twins born in England and Wales in 1994 and 1995. Zygosity was assigned on the basis of a physical resemblance questionnaire, with unclear cases classified by DNA analysis.

The twins' mothers were interviewed twice such that data were gathered for each co-twin on separate occasions; thus, the information was obtained retrospectively. Specifically, parents were asked to indicate the occurrence of any accident or injury on the part of each twin child that required medical attention. The socioeconomic status of each family, assigned with reference to income, place of residence and other factors, was examined with reference to childhood injuries.

The final sample of MZ and DZ twins showed an equal distribution of injuries: *None:* 64.3% of MZ twins and 65.4% of DZ twins; *One:* 26.7% of MZ twins and 24.3% of DZ twins; and *Two or more:* 9.1% of MZ twins and 10.3% of DZ twins. The MZ twin correlation of .14 for one or more injuries was twice as large as the corresponding DZ twin correlation (.06). However, effects specific to the child played a greater role as shown by the difference between 1.0 (all sources of influence) and the MZ correlation of .14 (shared genes and shared environments) or .86. In other words, having an injury within the first 5 years of life was only modestly associated with genetic factors, whereas specific environmental effects played the biggest role. Surprisingly, a genetic effect on having two or more injuries did not show genetic influence. This is surprising because children who are hardest to control might be expected to show the greatest risk for injury. However, attentive parents might mitigate this effect by introducing more constant supervision or other safeguards.

As in the earlier twin studies, being male posed the greatest risk for accidental childhood injuries, regardless of frequency, and child-specific environmental risk factors made greater contributions to injury risk than genetic factors. Other important contributions came from the younger age of the mother and the presence of childhood externalizing difficulties. The authors asserted that children's behavioral styles should be considered in this area, in particular with respect to how they interact with features of the environment.

Ordonana and colleagues noted some important limitations of their work, namely that the data were gathered retrospectively and that twins from opposite-sex twin pairs were not included. Several ideas come to mind in this regard. First, following twins longitudinally might capture the nature and source of their accidents more effectively than parental recall. Second, it may be that twins are more likely to suffer accidental injury than nontwins. This is because rearing two children is often more difficult than raising one child since caregiver attention becomes divided. Furthermore, parents and others may leave twins on their own to a greater degree, assuming they are safe and happy in each other's company. This may allow twin children (especially MZ twins) to collaborate in unsafe ways. Alternatively, in the event that one twin is harmed, the other child may be available to alert their parents or to seek other assistance. Research shows that twin children are more likely to be abused than nontwin children (see Segal, 2000), but no one has, to my knowledge, conducted a comparable analysis of accidental injuries.

An interesting and important finding provided by all the studies reviewed is that being male poses a greater injury risk than being female. It would be of interest to know if females from opposite-sex twin pairs have a mitigating influence on their twin brothers in this regard, or if twin males are more likely to succeed in engaging their sisters in risk-taking behaviors.

Twin Research Reports

Periodontal Disease and Cancer Risk

Research evidence has suggested a link between the risks of periodontal disease and cancer. A recent study by Manish Arora, who researches factors associated with the oral health of populations, and colleagues used a co-twin analysis to further explore these relationships (Arora et al., 2010). MZ co-twins, in particular, control for both shared familial and genetic factors. Participants were drawn from the well-known Swedish Twin Registry. In order to assess the occurrence of periodontal disease, twins responded to the question, 'Have you noticed that some of your own teeth have come loose or fallen out on their own?' Periodontal disease was indicated if twins reported that half or more of their teeth were loose, while cancer diagnoses were determined by linking the cohort participants to the Swedish National Cancer Register. Smoking histories and other risk factors, such as height, weight and alcohol intake, were also considered.

Significant associations were observed between periodontal symptoms and total cancer risk. This relationship was reduced, but remained significant, after controlling for individual risk factors. For example, periodontal disease was significantly associated with an increased risk

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of prostate cancer in men and an increased risk of cancer of the corpus uteri in women. Some types of cancers could not be analyzed in this way because of their relatively rare occurrence. However, co-twin analyses did not replicate the relationship between periodontal disease and cancer risk, nor did adjusting for individual factors affect the outcome as in the previous analysis. Restricting analyses to the MZ co-twins showed an absence of a relationship between periodontal disease and cancer risk, but such relationships did emerge for the DZ co-twins, for both total cancer risk and digestive tract cancers. The investigators concluded that shared genetic factors may underlie the association between these conditions, but noted that confirmation of this association is required.

Twin's Gestational Age and Birthweight

Prematurity is of great concern with respect to newborn infants, especially twins who are often born early. Researchers from the East Flanders Prospective Twin Study in Belgium underlined the importance of further investigation in this area, given that premature births have been increasing (Gielen et al., 2010). A cross-sectional study was undertaken of 6,310 twin pairs born between 1964 and 2007.

Gestational age decreased over the 43-year time period, with a decrease of .25 days per year observed in both MZ and DZ twin pairs. Birthweight decreased for twins born prior to 32 weeks gestation, but increased for twins born later. Birthweight was unaffected by factors such as fertility treatment, Cesarean delivery, maternal age and primiparity, even though these factors increased over the years. The authors pointed out that low birthweight remains a concern for preterm infants and twins, and that reducing the incidence of multiple births may be one solution to this problem.

Case Study of Hearing and Deaf Co-Twins

Case studies are a valuable addition to the research process because they may suggest new ideas that can be tested in larger samples. That is why a recent study of the language development in a pair of twins discordant for profound bilateral sensorineural hearing loss (Ruggirello & Mayer, 2010) is somewhat disappointing; I will explain my response below after describing the study. The deaf twin was fitted with simultaneous bilateral cochlear implants at age one year; evidence suggests that the earlier this intervention occurs the more favorable the outcome. In fact, the deaf child in this case did show less language delay than most children with hearing loss. More specifically, she showed progress across four measures of language skill, namely expressive vocabulary, social interaction, reading readiness and expressive language, although her twin sister did show more advanced ability. The twins' family was described as supportive of and contributing to the twins' cognitive development. It is also likely that the hearing twin provided support and experience for her deaf co-twin.

It is unfortunate that the method for zygosity diagnosis was not explained in the published paper; the authors simply indicated that the twins in question were fraternal. We are told that both parents carried the genetic trait for deafness, so they presumably transmitted the relevant genes to one of the twins. The twin's discordance for deafness is consistent with dizygosity, but cannot be regarded as scientific proof. This unique study would have made a more significant contribution to the medical literature in general, and to professionals in auditory functioning who work with such cases, in particular if we could be confident that the twins were DZ.

Human Interest Stories

Royal Twins

A pair of male–female twins was recently born to Princess Mary and Prince Fredrik of Denmark. The male co-twin weighed 5.9 pounds and was 18.5 inches long, and the female co-twin weighed 5.5 pounds and was 18 inches long (*Huffington Post*, 2011). I suspect that the birth of twins to a royal family will help focus national attention on the specific behavioral and medical issues affecting multiple birth children. I am grateful to Danish journalist and mother of twins, Abelone Glahn, for bringing this news to my attention.

'Twiblings'

The new reproductive technologies have unintentionally yielded an interesting array of unique twin-like sibships, many of which can be scientifically informative. The most recent variation on this theme has been termed 'twiblings' (Belkin, 2010). Twiblings are infants conceived by combining a husband's sperm with eggs provided by an egg donor and implanting the resulting embryos in the wombs of different surrogate mothers. The babies, in this case, Violet and Kiernan, were born five days apart, making them near-in-age genetic opposite-sex full siblings. Their birth attracted considerable media attention, both in the press and on national television in the United States. Their model may offer useful guidelines for other infertile couples seeking reproductive assistance.

I was pleased to learn that the new parents did not refer to their children as dizygotic twins, even though they are genetically equivalent to such twins and were born within an interval that has been reported for some sets. The children

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are not DZ twins because they did not share their intrauterine environment, a defining feature of multiple birth pregnancies. Some ordinary DZ twins exhibit chimerism and some studies suggest twins' exposure to cross-sex hormones, events to which 'twiblings' would not be subject.

'Twiblings' could be used to investigate possible developmental effects associated with different prenatal environments, although confounding factors would be posed by the different genes of the two children and the different hormonal backgrounds of the two surrogates. However, the children's mitochondrial DNA would be the same, given that they were conceived with eggs provided by the same donor (Renneberg & Demain, 2007).

New Football Legends

The close relationship between MZ co-twins has been widely documented in scientific reports, biographical works and personal statements. Affectionate displays are expected between twins, but if the twins in question are football stars people take notice. In April 2010, when identical twin Maurkice Pouncey was invited to join the Pittsburgh Steelers, he kissed his twin brother Michael on the lips, a gesture that was captured by a television crew (Carpenter, 2010).

News of the kiss spread rapidly, but it was also an occasion to take a closer look at the lives of these close twins. The twins, raised in Florida, played together as children, dressed alike, shared their friends and eventually joined the University of Florida's football team — Maurkice as center and his twin brother Michael as guard. According to Maurkice, 'We were always each other's best friends. Why make new friends when I have this one?' Maurkice's invitation to join the Pittsburgh Steelers was the event that eventually separated the twins. Michael, whose draft status was less clear, remained in Florida. The twins continue to stay in close contact, but acknowledge the 'emptiness they feel.' They are hopeful that Michael will be drafted by the Steelers, but are aware that this may not happen.

A Fraternal Twin Missed

In a moving tribute to a twin sister he knew only briefly as a child, composer and Bennington College faculty member Allen Shawn has chronicled his recollections and reflections of his twin sister Mary. The twins were born 6 weeks prematurely in August 1948 to a mother and father who had an older son, but who had lost two babies in subsequent pregnancies. The twins were considered very special and they spent the first few years of their lives in close proximity to one another. However, as they approached the age of 5 or 6 years, Mary began showing disturbing behaviors that included excessive screaming, unusual monologues and uncharacteristic preoccupations. When the twins turned 8 or 9, Mary entered a summer camp for children with retardation, a situation that was to become permanent. The family visited her from time to time, but perhaps this increased Shawn's sense of what was missing from his life — when he became an adult he realized that Mary had always been a central part of his life. His book, *Twin* (Viking Press, 2011), was recently excerpted in the New York Times, and I look forward to reading my copy in full (Shawn, 2010).

Having observed and listened to many twins whose co-twins have passed away, I believe each one feels a sense of promise unfulfilled. This is true even of twins whose twins passed away at, or shortly after birth. Allen Shawn's twin sister is still alive, but she is unavailable to him. This is a type of twin loss that is deserving of further study.

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