The shared environment explains individual differences in children's exercise behavior: A twin study

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Aim

The main purpose of this study was to investigate causes of individual differences in children's exercise behavior. Twin studies offer the unique opportunity to disentangle the relative contribution of genes, shared environment and unique environment to a trait. Previous twin studies have looked at exercise behavior in both adolescents and adults (Stubbe & de Geus, 2009). The heritability of participation in exercise activities peaks in late adolescence (80%) and then decreases to values between 40% and 70% . The remaining variance is generally explained by unique environmental factors (Van der Aa et al., 2010, Stubbe et al., 2006). This is the first twin study on participation in leisure time exercise activities looking at children who are younger than 12 years old.

Methods

Data were collected as part of the longitudinal survey study of the Netherlands Twin Register which was established by the Department of Biological Psychology at the VU University Amsterdam in 1987 (Boomsma et al., 2006, Bartels et al., 2007). The twins were 7 (N=3,966 subjects), 10 (N=3,562) and 12 years old (N=8,687). For 27% of the children, there were data at more than one age. Both mothers and fathers were asked to report on their children's participation in exercise activities, including frequency and duration. If the surveys were filled out by both parents, their average rating was taken. Twin correlations were estimated for each sex by zygosity group. Genetic models comparing the resemblance between monozygotic (MZ) and dizygotic (DZ) twins were fitted with the software package openMx to estimate the relative influence of genetic and environmental factors on weekly MET hours spent on leisure time exercise activities.

LICHAMELIJKE ACTIVITEITEN EN VRIJETIJDSBESTEDING

1. **Omcirkel** hieronder het cijfer bij de sport(en) die de oudste en de jongste van de tweeling **op dit moment** beoefent. Geef aan hoeveel jaar, hoeveel maanden per jaar, hoeveel keer per week en hoe lang ze per keer deze sport(en) beoefenen.

	sport		aantal jaar		aantal maanden per jaar		aantal keren per week		gemiddelde tijd per keer in minuten	
	oudste	jongste	oudste	jongste	oudste	jongste	oudste	jongste	oudste	jongste
schoolgym	1	1	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
schoolzwemmen	2	2	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
atletiek	3	3	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
badminton	4	4	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
ballet/ dansen	5	5	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
basketbal	6	6	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
conditietraining/ fitness	7	7	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
gymnastiek/ turnen	8	8	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
handbal	9	9	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
hardlopen/ joggen	10	10	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
hockey	11	11	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
korfbal	12	12	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
paardrijden	13	13	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
schaatsen/ skaten	14	14	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
tennis	15	15	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
wechtsport	16	16	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
voetbal	17	17	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
zwemmen	18	18	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
volleybal	19	19	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min
anders, nl:	20	20	.....jaar	.....jaar	.....mnd	.....mnd	.....keer	.....keer	.....min	.....min

Results

Average weekly MET hours did increase over time in both sexes (p<.001), but were lower for girls across all ages (p<.001; Table 1). Around 13% of boys and girls across all age groups did not participate in any leisure time exercise activities. Tracking of exercise behavior from age 7 to age 12 was modest (.168 < r < .534). MET hours spent on physical education classes at school correlated weakly with leisure time exercise activities (r<.14).

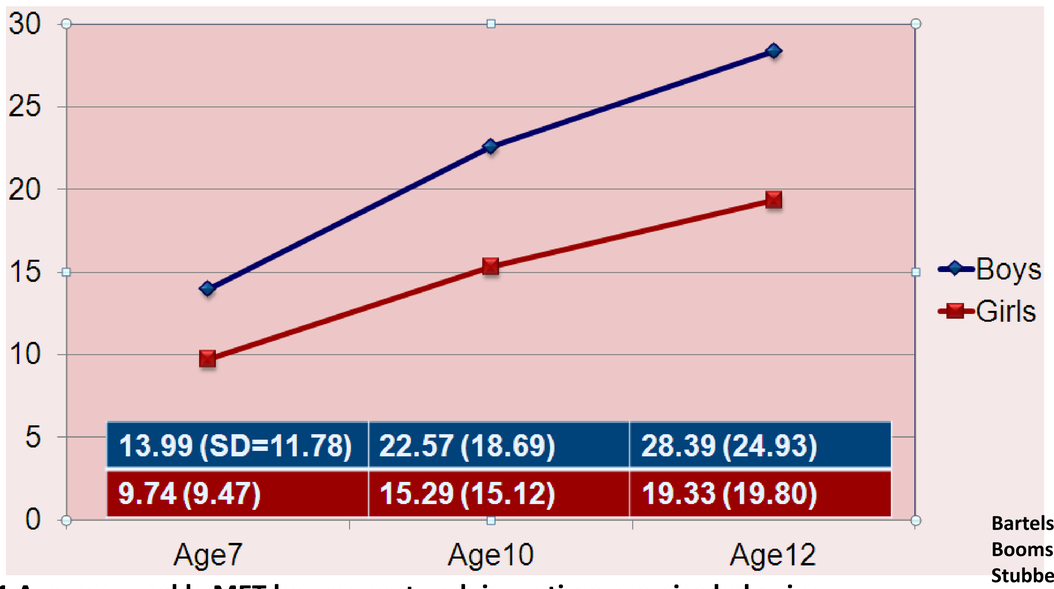


Table 1 Average weekly MET hours spent on leisure time exercise behavior.

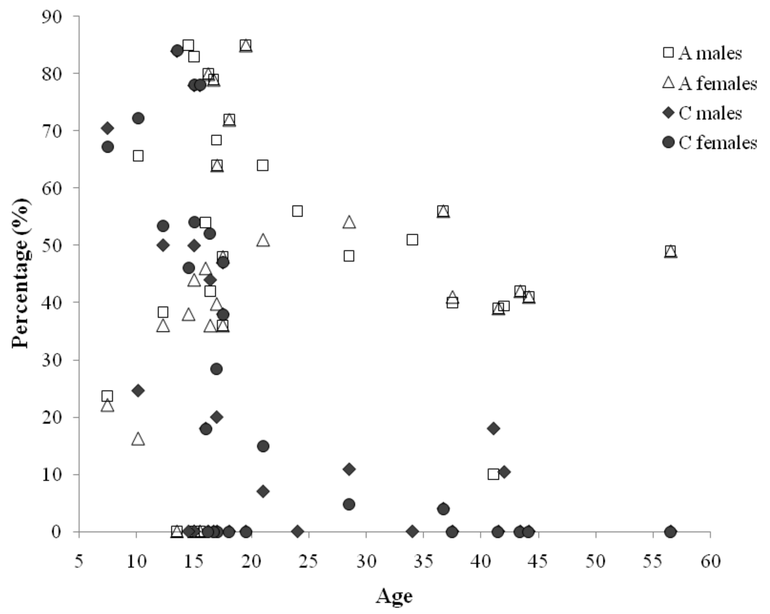
		A	C	E
Age7	**Boys**	24% (18-30%)	71% (64-76%)	6% (5-7%)
	Girls	22% (15-30%)	67% (60-74%)	11% (9-12%)
Age10	**Boys**	66% (53-81%)	25% (9-38%)	10% (8-12%)
	Girls	16% (9-24%)	72% (64-79%)	11% (10-14%)
Age12	**Boys**	38% (32-46%)	50% (43-57%)	12% (10-13%)
	Girls	36% (30-43%)	53% (47-59%)	11% (10-12%)

Table 2 Heritability (A) estimates and the relative contribution of shared (C) and unique (E) environmental factors to individual differences in leisure time exercise behavior (95% CIs).

Results

The MZ twin correlations were higher than the DZ twin correlations in all three age groups, suggesting genetic influence on the variance in leisure time exercise behavior. More importantly, as the DZ twin correlations were larger than half the MZ twin correlations across all ages , the *shared environment* was likely to play a role in children's exercise behavior. Finally, the DZ opposite sex correlations tended to be lower than the same-sex correlations which implied *qualitative sex differences*. Genetic model fitting revealed that partly different aspects of the shared environment affected exercise behavior in boys and girls. Standardized estimates of genetic, shared, and unique environmental influences can be found in Table 2.

Figure 1 Estimates provided by previous twin studies (see Stubbe & de Geus, 2009) and our results.



Discussion

Our analyses confirmed the important role of shared environmental factors for children's exercise behavior that gradually give way to genetic influences when they reach adolescence (Figure 1). The shared environment is made up of all environmental factors that make members of a family more similar to each other. Parenting behavior is a classic example of such a factor and may be the most likely suspect to explain the strong shared environmental impact in the present study as parents often act as gatekeepers to children's leisure time activities. Around 2/3 of the twin pairs had at least one type of exercise activity in common, which is much more than could be expected based on the frequency of each of the types of exercise activities. It is likely more convenient for parents to organize transportation to and cheer their children at a single exercise location as opposed to handling two locations.

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