Attention deficit hyperactivity disorder (ADHD) is a common childhood-onset neurodevelopmental disorder. Comorbidity with other neurodevelopmental conditions, learning problems and psychiatric disorders is high and ADHD symptoms themselves, particularly inactivity, can also persist into adulthood. ADHD is indexed by high levels of functional impairment and adversely affects social relationships, academic achievements and employment record. Rates of substance misuse and smoking behaviours are elevated, contributing to the physical and mental health disadvantage of those with ADHD.

Although highly heritable, ADHD is aetiological complex whereby the coaction and interaction of inherited and non-inherited factors likely play a role in its development, maintenance and adverse consequences. Indeed, no single causal risk factor, genetic or otherwise, has been identified to date as is the case for all common, complex disorders. The evidence suggests there is contribution from both common genetic variants of small effect size and rare variants (copy number variants) of larger effect size. Such variants have been found to impact on similar biological pathways, interestingly including one related to nicotinic acetylcholine receptor signalling.

Another dimension to the strategy of Thakur et al is an interesting finding that the authors highlight: that ADHD has consistently been found to be associated with exposure to maternal smoking during pregnancy. This has been thought to be due to the causal risk effects of cigarette smoke on the developing foetus as there are biologically plausible mechanisms. The constituents of cigarette smoke can alter physiological processes which might in turn contribute to aberrant neurodevelopment in ADHD. However, research suggests that the association with maternal smoking during pregnancy may be due to the confounding effects of shared genetic liability between maternal smoking behaviour and offspring ADHD.

The study by Thakur et al benefits from a strong theoretical premise and hypothesis-driven approach and detailed neurocognitive profiling and rigorous phenotypic description with a dimensional and categorical approach. In summary, the research finds that of the five single nucleotide polymorphisms (SNPs) that were selected and considered to be significantly associated with smoking behaviour in the genome-wide meta-analysis, one, the C* allele of rs1329650 on 10q25 (which is associated with number of cigarettes smoked per day), is overtransmitted to the offspring with ADHD and is associated with several indices of phenotypic severity and neurocognitive dysfunction.

However, although the findings are potentially exciting, the authors are right to be tentative about their conclusions at this stage as there are certain cautions to be exercised when considering the implications. At a conceptual level, the SNPs found to reach genome-wide significance in the smoking meta-analysis have not been found to be associated with ADHD in either ADHD candidate gene meta-analyses or a meta-analysis of ADHD genome-wide association studies (GWAS). With small sample sizes (a limitation of all ADHD genetic studies to date) and the small effect sizes of individual gene variants, results can reflect Type 1 or Type 2 errors. Replication, as the authors state, is always necessary—especially as multiple outcomes were tested.

On the other hand, it is worth bearing in mind that studies investigating ADHD genetics to date have not had sample sizes comparable with those that have had success for other complex disorders, including psychiatric disorders. The meta-analysis of ADHD GWAS, which involves hypothesis-free testing of thousands of genetic variants, is almost certainly underpowered to detect effects. It may be that the common gene variants examined in the study by Thakur et al are found, in time, to be significant in subsequent GWAS or meta-analyses of larger ADHD samples. Such replications would lend greater weight to the results of this current investigation.

This interesting and novel study should be interpreted as preliminary evidence that the theoretical plausibility of shared inherited risks underlying ADHD and smoking behaviours could extend to detecting shared gene variants at a molecular level (see figure 1). Future research could perhaps consider replicating findings using case control designs as well as considering different ways of capturing smoking-associated genetic variation. It would also be interesting to investigate longitudinally the effects of smoking associated gene variants including the SNPs in this study, and to test whether they contribute to the known elevated risk of smoking behaviour in those with ADHD.

In summary, although the results of this exploratory study can only be considered as preliminary findings at present, this is an intriguing starting point from which to conduct further related...
analyses. Acknowledging that the same genetic risk variants can have different phenotypic effects could help inform discovery of risk variants for childhood developmental/psychiatric disorders for which it can be difficult to assemble very large sample sizes. Such efforts could help uncover novel biological risk pathways and contribute to explaining neurodevelopmental comorbidities.

**Funding** MRC and Wellcome Trust.

**Competing interests** None.

**Provenance and peer review** Commissioned; externally peer reviewed.

Accepted 6 August 2012

Arch Dis Child 2012;0:1–2
doi:10.1136/archdischild-2012-302461

**REFERENCES**


---

**Figure 1** Illustration of shared genetic risks between attention deficit hyperactivity disorder (ADHD) and smoking.
Shared biological risks that influence brain and behaviour

Miriam Cooper and Anita Thapar

Arch Dis Child  published online October 29, 2012

Updated information and services can be found at:
http://adc.bmj.com/content/early/2012/10/24/archdischild-2012-302461

These include:

References
This article cites 5 articles, 1 of which you can access for free at:
http://adc.bmj.com/content/early/2012/10/24/archdischild-2012-302461#BIBL

Open Access
This is an open-access article distributed under the terms of the Creative Commons Attribution Non-commercial License, which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non commercial and is otherwise in compliance with the license. See: http://creativecommons.org/licenses/by-nc/3.0/ and http://creativecommons.org/licenses/by-nc/3.0/legalcode

Email alerting service
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Topic Collections
Articles on similar topics can be found in the following collections

Open access (206)
Press releases (64)
Attention-deficit hyperactivity disorder (93)
Child and adolescent psychiatry (paediatrics) (683)
Health education (555)
Health promotion (611)
Smoking (150)
Smoking and tobacco (150)
Child health (3922)
Autism (133)
Pervasive developmental disorder (138)
Drugs: CNS (not psychiatric) (497)
Adolescent health (329)
Drugs misuse (including addiction) (75)
Molecular genetics (111)
Pregnancy (528)
Reproductive medicine (945)

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/