Soc Psychiatry Psychiatr Epidemiol (2004) 39 : 364–368 DOI 10.1007/s00127-004-0771-3

ORIGINAL PAPER

N. C. Stefanis · Ph. Delespaul · N. Smyrnis · A. Lembesi · D. A. Avramopoulos · I. K. Evdokimidis · C. N. Stefanis · J. van Os

Is the excess risk of psychosis-like experiences in urban areas attributable to altered cognitive development?

Accepted: 17 December 2003

Abstract *Background* Rates of psychotic disorder and related attenuated psychotic experiences are higher in urban areas. We examined to what degree differences between urban and rural areas could be attributed to differences in cognitive development. *Method* Scores on the nine subscales of the schizotypal personality questionnaire (SPQ) as well as IQ and specific neuropsychological functions of memory and attention were assessed in a representative sample of 943 young army conscripts from the 49 counties of Greece. *Results* Young men from urban areas had higher scores on the SPQ subscale *Odd beliefs/magical thinking* (OR = 1.99, 95 % CI: 1.42, 2.78), but lower scores on *Excessive social anxiety* (OR = 0.63, 95 % CI: 0.49, 0.81) and *No close friends* (OR = 0.42, 95 % CI: 0.29, 0.62). Adjustment for demographic factors, IQ and specific neuropsychological functions did not change the results. When the lower scores on *Excessive social anxiety* and *No close friends* were taken into account, the differences on the *Odd beliefs/magical thinking* subscale became even more pronounced (OR = 2.33, 95 % CI: 1.56, 3.49). *Conclusions* Young men from urban areas are socially more competent, but display higher levels of positive psychotic experiences, which are not mediated by lower IQ or higher levels of neuropsychological impairment.

N. C. Stefanis · N. Smyrnis · A. Lembesi · D. A. Avramopoulos · I. K. Evdokimidis · C. N. Stefanis
University Mental Health Research Institute (UMHRI)
Athens, Greece

P. Delespaul · Prof. J. van Os (✉)
Dept. of Psychiatry and Neuropsychology
Maastricht University
P.O. BOX 616 (DRT 10)
6200 MD Maastricht, The Netherlands
Tel.: +31-43/387-5443
Fax: +31-43/387-5444
E-Mail: j.vanos@sp.unimaas.nl

J. van Os
Division of Psychological Medicine
Institute of Psychiatry
London, UK

SPPE 771

Key words schizotypy – psychosis – risk – urban environment – cognition

Introduction

Previous work has shown dose-response relationships between the level of clinical and non-clinical psychotic experiences on the one hand, and growing up in an urban environment on the other, suggesting that environmental factors in urban areas impact on development in such a way that the expression of mental states that increase the risk for psychotic disorder is facilitated (Pedersen and Mortensen 2001; Van Os et al. 2001). Environmental factors that are more prevalent in urban environments such as poverty and malnutrition, pre- or post-natal infectious diseases, exposure to lead and exposure to psychological stress (Dalgard and Tambs 1997; Freeman 1994; Mueser et al. 2001; Thornicroft et al. 1993; Torrey and Bowler 1990) may all impact on the developing organism and facilitate expression of psychosis. Previous work has suggested that differences between urban and rural areas in psychosis rates are not related to differences in childhood SES and obstetric complications (Harrison et al. 2003).

Instead of the search for particular factors possibly mediating the association between urbanicity and psychosis, an alternative strategy is to examine possible mediation by an underlying indicator of neurodevelopmental impairment. As the expression of psychosis is preceded by developmental changes in cognition (Jones et al. 1994; Marcus et al. 1993), and adult schizophrenia is characterised by neuropsychological impairment, in particular in the areas of memory and attention (Krabbendam et al. 2001), it is attractive to speculate that the impact of the urban environment on the expression of psychosis is mediated by changes in cognitive development.

The aim of the current study was twofold: i) to replicate our previous finding of an association between exposure to an urban environment and expression of psy-

chosis-like experiences, and ii) to examine whether the difference in distribution of psychotic experiences between urbanised and non-urbanised areas could be attributed to differences in the underlying distribution of the neuropsychological factors that have been associated most with schizophrenia.

Subjects and methods

Sample and measures

In eight separate waves, between January 1999 and March 2000, 2243 randomly selected young male conscripts aged 18–24 years were recruited from the Greek Air Force, during their first 2 weeks of admission in the National basic Airforce training centre. A full description of sample and methods was given in earlier work (Stefanis et al. 2002). Conscripts are selected into a particular section of the army on the basis of a weighted (depending on how many recruits are needed) random selection procedure. Conscripts underwent an extensive interview of computerised neurocognitive abilities and a self-rated schizotypy scale, the SPQ (Raine 1991). The SPQ is a 74 "dichotomous" item (yes/no) questionnaire that assesses all nine aspects of DSM-III-R SPD (Schizotypal Personality Disorder), thus yielding nine subscale scores (ideas of reference, excessive social anxiety, odd beliefs/magical thinking, unusual perceptual experiences, odd or eccentric behaviour, no close friends, odd speech, constricted affect, suspiciousness). In order to verify the degree of collaboration with the self-report scales, we used the four validity items of the Temperament and Character Inventory (Cloninger et al. 1993). Only individuals found to respond reliably to these items were included in the analysis (n = 1411). Conscripts were excluded if they had failed to respond to at least two items of any specific SPQ subscale or to more than seven items in the total SPQ questionnaire, or because they had missing data on county of residence. Thus, the SPQ subscale scores of 1337 conscripts were eventually available for analyses. Subscale scores were expressed as proportions of the sum of positive responses divided by the number of items of each subscale minus missing values.

Cognitive assessments

IQ was assessed with Raven's Colored Progressive Matrices Test (Raven 1982) (hereafter: IQ). Verbal and spatial memory were assessed with the verbal and spatial N-BACK test respectively (Gevins et al. 1996), and attention was assessed with the Continuous Performance Test (CPT) (Cornblatt et al. 1989; Cornblatt et al. 1988). Other variables assessed were number of years of full-time primary and secondary education and age in years.

Urbanicity

The conscripts were drawn from 49 different counties in Greece. We used a measure of population density, i. e. the number of inhabitants per square kilometre of current county of residence according to the 2001 census, as the urbanicity exposure. As the distribution of population density in the sample was binary, with 46 % from the two counties with the highest population density of 4880 and 5069 persons per square kilometre, and the remainder from counties with population densities in the range of 733 to 2366, we used a dichotomous measure of urbanicity contrasting the two counties with the highest densities with the others (hereafter: urban vs. rural).

Analyses

Mean scores on the nine SPQ subscales were compared between urban and rural areas. As the expression of psychosis is associated with younger age (Verdoux et al. 1998), and the mean age of the rural group of our sample was slightly younger than the rural group (mean rural group 20.7 years, mean urban group 21.1 years, $P < 0.001$), adjusted comparisons were conducted by assessing the association, expressed as the odds ratio, between urbanicity and the nine SPQ subscales, using logistic regression in STATA (StataCorp 2001) with the dichotomous urbanicity measure as the dependent variable. Similarly, we adjusted for number of years in full-time education. In order to assess independence of possible associations between urbanicity and multiple SPQ subscales, analyses were also conducted with multiple subscales entered together in the equation, effectively controlling the effect of one subscale for all others. In order to assess whether any differences in schizotypy between the rural and urban groups were mediated by IQ, memory or attention, these variables were added to the equation with assessment of the subsequent degree of change in the association between schizotypy and urbanicity.

As conscripts from the same county are more similar to each other than conscripts from different counties, compromising statistical independence of the data, the CLUSTER and ROBUST options were used in the STATA logistic regression analyses. The CLUSTER option combined with the ROBUST option allows for the use of observations which are not independent within clusters (in this case, within counties) and obtains the Huber/White/Sandwich estimator of variance instead of the traditional variance estimator. These procedures result in standard errors that are adjusted for clustering within counties.

As we conducted nine tests with correlated outcomes, we applied the Simes method for multiple hypothesis testing with positively dependent test statistics, which represents the correct alternative for the Bonferroni procedure in the case of related outcomes (Simes 1986).

Results

The mean age of the conscripts was 20.9 years (SD = 1.9). As noted above, rural subjects were slightly younger than their urban counterparts. The mean number of years of education was 13.1 (SD = 2.2), slightly lower in rural subjects (12.9, SD = 2.2) than in urban subjects (13.3, SD = 2.1; F = 15.1, df = 1328, $P < 0.001$). A similar difference was apparent for Raven's IQ (rural: 45.1, SD = 9.0; urban: 47.5, SD = 7.3; F = 28.4, df = 1333, $P < 0.001$), and the CPT (urban: 1.95, SD = 0.91; rural: 1.73, SD = 0.87; F = 20.54, df = 1297, $P < 0.001$). No large or significant differences were apparent for spatial and verbal memory. There were significant differences between the groups in three of the nine SPQ subscales, all with *P*-values smaller than the *P* after correction with the Simes procedure, indicating statistically significant differences (Table 1). The differences indicated that urban subjects had higher scores on the *Odd beliefs/magical thinking* subscale, and lower scores on the *Excessive social anxiety* and the *No close friends* subscale. The odds ratios of these differences from the logistic regression procedure were 1.99 (95 % CI: 1.42, 2.78) for the positive association with *Odd beliefs/magical thinking*, and 0.63 (95 % CI: 0.49, 0.81) and 0.42 (95 % CI: 0.29, 0.62) for the negative associations with the *Excessive social anxiety* and *No close friends* subscales, respectively. Adjustment for age and years in full-time education did not essentially change the results. Similarly, neither adjustment of the effect of one subscale for that of the others, nor adjustment for IQ, memory and attention changed the associations. The association between urbanicity and *Odd beliefs/magical thinking* increased rather than decreased when the effect of the other two factors was taken into account (Table 2).

Table 1 Mean scores on SPQ subscales in urban and rural groups

SPQ subscale	Mean rural (SD)	Mean urban (SD)	F (df = 1,1335)	*P*	P Simes*
Ideas of reference	0.56 (0.23)	0.55 (0.24)	0.13	0.72	–
Excessive social anxiety	0.42 (0.28)	0.38 (0.30)	6.0	0.014	0.017
Odd beliefs/magical thinking	0.27 (0.23)	0.30 (0.23)	8.41	0.0038	0.011
Unusual perceptual experiences	0.29 (0.24)	0.29 (0.24)	0.10	0.75	–
Odd or eccentric behaviour	0.40 (0.32)	0.39 (0.33)	0.16	0.69	–
No close friends	0.27 (0.20)	0.24 (0.20)	10.0	0.0016	0.0056
Odd speech	0.43 (0.27)	0.43 (0.27)	0.07	0.79	–
Constricted affect	0.27 (0.23)	0.26 (0.23)	1.84	0.18	–
Suspiciousness	0.48 (0.25)	0.46 (0.27)	0.88	0.35	–

* If the actual P-value is smaller than the Simes P-value, the result is statistically significant. All three results are, therefore, statistically significant

Table 2 Adjusted associations between urbanicity and three SPQ subscales

SPQ subscale	OR* (95% CI) Unadjusted	P	OR (95% CI) Adjusted-I	P	OR (95% CI) Adjusted-II	P	OR (95% CI) Adjusted-III	P	OR (95% CI) Adjusted-IV	P	OR (95% CI) Adjusted-V	P
Excessive social anxiety	0.63 (0.49, 0.81)	< 0.001	0.62 (0.48, 0.81)	< 0.001	0.67 (0.51, 0.88)	0.004	0.67 (0.51, 0.88)	0.004	0.62 (0.47, 0.82)	0.001	0.64 (0.48, 0.85)	0.002
Odd beliefs/ magical thinking	1.99 (1.42, 2.78)	< 0.001	1.98 (1.39, 2.80)	< 0.001	2.33 (1.56, 3.49)	< 0.001	2.37 (1.56, 3.62)	< 0.001	2.66 (1.72, 4.11)	< 0.001	2.31 (1.53, 3.50)	< 0.001
No close friends	0.42 (0.29, 0.62)	< 0.001	0.45 (0.31, 0.65)	< 0.001	0.50 (0.33, 0.76)	0.001	0.57 (0.37, 0.87)	0.010	0.48 (0.31, 0.74)	0.001	0.60 (0.40, 0.90)	0.014

* OR > 1 indicates higher value in urban area
Adjusted I: adjusted for age and number of years of education
Adjusted II: as in I and in addition for each other (all subscales entered together in the equation)
Adjusted III: as in II and in addition for IQ
Adjusted IV: as in II and in addition for spatial and verbal memory
Adjusted V: as in II and in addition for attention

Discussion

Young men from the two counties in Greece with by far the highest population density displayed higher levels of positive psychosis-like experiences, as indicated by higher scores on the SPQ subscale *Odd beliefs/magical thinking*, and higher levels of the schizotypy measures tapping into social competence, as indicated by lower scores on the *Excessive social anxiety* and *No close friends* subscales, independent of each other and of demographic characteristics.

The finding of higher levels of psychosis-like experiences is in line with a previous report, in which the expression of psychosis-like experiences outside DSM-III-R psychotic disorder was found to increase linearly with population density (Van Os et al. 2001). The finding of higher levels of social competence has, to our knowledge, not been reported before. The fact that differences were found between the SPQ subscale *Odd beliefs/magical thinking,* and not between *Ideas of reference*, *Suspiciousness* and *Unusual perceptual experiences* requires an explanation. It may be that this particular scale is more sensitive in picking up differences because individuals are less inhibited in admitting to these than, for example, perceptual abnormalities. It may also be that experiences like magical ideation are more "core" to the psychosis phenotype that is more prevalent in urban areas. Further work is needed to replicate and extend these first findings.

One interpretation of this latter finding is that differences in scores on the subscales *Excessive social anxiety* and *No close friends* are related to the effect of growing up in different socio-demographic environments. It is possible that young men growing up in the city have denser social networks and because of higher levels of exposure to peer interaction in the developmental phase become less likely to experience social anxiety. Young men growing up in the city may, therefore, develop higher levels of social competence that may even protect against the onset of psychosis-like ideation. The fact that the association between urbanicity and *Odd beliefs/magical thinking* increased rather than decreased after adjustment for *Excessive social anxiety* and *No close friends* appears to be indicative of such a protective effect.

Despite the possible protective effect of higher levels of social competence in the urban environment, higher

rates of psychosis-like experiences were still present. Given the fact that this type of self-reported experiences are risk factors for the later onset of psychotic disorder (Chapman et al. 1994; Kwapil et al. 1997; Poulton et al. 2000), and also display strong cross-sectional associations with psychotic disorders (Hanssen et al. 2003; Van Os et al. 2001), it seems likely that the mechanism underlying the excess risk of psychosis-like experiences in urban areas is related to the mechanism causing higher rates of psychotic disorders in these areas. The main aim of the current paper, however, was to examine whether increased rates of psychosis-like experiences were accompanied by changes in cognitive development as indicated by IQ and specific neuropsychological functions associated with schizophrenia. The higher rate of psychosis-like experiences, however, was independent of IQ and neuropsychological measures. This does not exclude, but makes it less likely, that the higher rates of psychosis in urban areas are caused by higher rates of neurodevelopmental impairment. Similarly, this report does not suggest that higher rates of social isolation play a role in the excess risk of psychotic expressions in urban areas. If anything, results suggest that individuals living in more urbanised areas derive some protection from denser social networks and more peer interaction. Other pathways, such as those involving affective change and social cognition (Garety et al. 2001) rather than neurocognition, may, therefore, be more likely candidates that should be the subject of future investigations.

Some methodological issues need consideration. First, only 1337 conscripts were included in the analysis out of a possible 2243. Selection bias may have occurred with regard to schizotypy, but this would not explain the association between urbanicity and odd beliefs/magical thinking, nor would it explain the association between urbanicity and one SPQ scale and not others. Secondly, results were not adjusted for illicit drug use such as cannabis use. However, cannabis use in Greece, at a prevalence of around 9% in high-school students, is much less frequent than it is in Northern Europe (Plagianakou et al. 2001). The measure of urbanicity was cross-sectional reflecting current residence, so that some misclassification may have occurred, for example, for individuals who had grown up in urban areas and moved to a rural environment. However, urban-rural mobility before adulthood in Greece is very low, and in order for this type of misclassification to explain the findings, unlikely scenarios would have to be invoked.

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