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Rural birth/upbringing and childhood adversities are associated with psychotic experiences in university students in China

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ABSTRACT

Background: Urbanicity has been reported to associate with an increased risk of psychotic experiences (PEs) in developed countries but less is known about the situation in developing countries. The present study aimed to investigate the effects of birth/upbringing place and other environmental factors on PEs in Chinese university students.

Methods: A computer-assisted cross-sectional survey was conducted on 4620 second-year undergraduates, using a stratified cluster sampling. Birth places and residential mobility before 16 years old were recorded. PEs were measured using the subscales of psychoticism and paranoid ideation in the Symptom Checklist-90-R (SCL-90-R). Six questions extracted from the childhood section of the World Mental Health Composite International Diagnostic Interview (WMH-CIDI) were used to assess childhood trauma.

Results: Generalized ordered logit model of multiple regression analysis revealed that participants with rural birth/upbringing (e.g. rural upbringing, on graded factor score of psychoticism and paranoid ideation [GFSPPI], 0 versus 1 & 2, odds ratio [OR] 1.409, 95% CI 1.219–1.628, $p < 0.00001$; 0 & 1 versus 2, OR 1.584, 95% CI 1.179–2.128, $p < 0.00001$) and those who reported childhood trauma (e.g. on GFSPPI, 0 versus 1 & 2, OR 1.737, 95% CI 1.498–2.014, $p < 0.00001$; 0 & 1 versus 2, OR 1.618, 95% CI 1.224–2.140, $p < 0.00001$) were apt to present more severe PEs. While upbringing places and childhood trauma affected both the presence and the severity of PEs, gender affected the presence or absence of PEs only (e.g. females, on GFSPPI, 0 versus 1 & 2, OR 1.887, 95% CI 1.631–2.183, $p < 0.00001$; 0 & 1 versus 2, OR 0.927, 95% CI 0.702–1.223, $p = 0.593$). Besides, the number of risk factors was associated with the severity of PEs in the cumulative odds logistic regression analysis (e.g. 3 risk factors versus 0 risk factor, on GFSPPI, OR 4.126, 95% CI 3.075–5.537, $p < 0.00001$).

Conclusions: Female, rural birth/upbringing and childhood trauma are risk factors of PEs in university students in China. The discrepancy in the findings between developed countries and China has important implications for urbanicity as a risk factor for PEs.

1. Introduction

In recent years, there has been an increasing interest in the association between social environment including geographical variables and the increased risk of psychotic experiences (PEs) (Croft et al., 2018; DeVylder et al., 2018; Leaune et al., 2018; Linscott and van Os, 2013; McGrath et al., 2015; van Os and Reininghaus, 2016; Wigman et al., 2011) as well as mental disorders (Breslau et al., 2014; Castillejos et al., 2018; Jansen et al., 2016; Li et al., 2016a, b; Misiak et al., 2017; Selten et al., 2013; Toulopoulou et al., 2017; van Os et al., 2010). PEs are defined as experiences that resemble the symptoms of psychosis found in clinical patients; however, they do not reach the degree of clinically significant distress, disability, or loss of function (Sun et al., 2015). PEs are relatively common in general population (Rossler et al., 2015) with a prevalence of approximately 7%–13% (DeVylder et al., 2018; Linscott and van Os, 2013) and can potentially represent the behavioral manifestation of distributed multifactorial (genetic and non-genetic) risk for psychosis (van Os and Reininghaus, 2016), which are thought to be both phenomenologically and temporally continuous with the

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clinical psychotic disorder as an "extended psychosis phenotype" (van Os and Linscott, 2012). Most individuals with PEs have a certain diagnosis of non-psychotic mental disorder, such as mood or anxiety disorder, in which PEs predict greater illness severity and poorer treatment response (Jeppesen et al., 2015; Varghese et al., 2011; Wigman et al., 2012). In around 80% of the individuals, PEs are transitory, while about 20% develop persistent PEs and 7% develop psychotic disorders (Kaymaz et al., 2012; Linscott and van Os, 2013; Zammit et al., 2013). Preliminary evidence suggested that PEs before early adulthood may be the precursor for a wide range of psychotic and non-psychotic mental disorders in later life with poor psychosocial outcomes (Healy et al., 2018; Kaymaz et al., 2012; Kirli et al., 2018; Rossler et al., 2011).

Urban birth and upbringing were associated with an increased risk of schizophrenia and non-affective psychosis (Heinz et al., 2013), but the link between urbanicity and PEs is somewhat ambiguous (Linscott and van Os, 2013; Newbury et al., 2016). A recent study reporting that living in urban settings, a longstanding risk factor for psychosis or PEs, may not be associated with elevated odds for PEs in developing countries (DeVylder et al., 2018). To date, most studies focusing on the role of urbanicity in PEs have been carried out amongst population of developed countries (Castillejos et al., 2018; Linscott and van Os, 2013).While only a few studies are based on population of middle-income countries like China (Coid et al., 2017) or low-income countries (Lundberg et al., 2009). Over the past 40 years, China has undergone the most rapid urbanization. The imbalanced development between urban and rural areas polarized the population significantly (Li et al., 2016a, b). The rural areas are marked by lower family income and inferior health care conditions as compared to the urban areas (Ma, 2016; Sicular et al., 2007). As a developing country, the 'urban' and 'rural' environment in China may have different components as compared to that of developed countries. Another notable fact is that accompanied by the rapid urbanization in China, large number of adults migrates from rural villages to urban areas, with their children left behind. Those left-behind children are at higher risk for PEs (Sun et al., 2017a) and depressive symptoms (Wang et al., 2015), and show significantly less favorable emotional, social and school functioning (Wang and Mesman, 2015) than their non-left-behind counterparts. On the other hand, previous studies show Chinese rural-urban migrant children are impaired in all domains of functioning compared to local urban children (Wang and Mesman, 2015). All these findings suggest that it is important to obtain detailed geographical information on birth and upbringing place while exploring role of environmental factors in PEs.

Substantial evidence showed that childhood adversities increase the risk of PEs (Kraan et al., 2015; Linscott and van Os, 2013; Trotta et al., 2015) and mental disorders (Kessler et al., 2010; Patten et al., 2015; Varese et al., 2012; Walsh et al., 2017). Childhood adversity is defined as the exposure to a range of difficulties or unpleasant situations or experiences, usually before the age of 16 (Morgan and Gayer-Anderson, 2016). The adversities considered in previous studies usually consist of household poverty, separation from one of or both parents, death of a parent, abuse, neglect and peer bullying (Morgan and Gayer-Anderson, 2016). Few studies investigated the effects of both upbringing environment and childhood adversities on PEs in low- and middle-income countries. So far, most of the geographical variables employed in studies exploring social factors on PEs amongst Chinese population (Coid et al., 2017; Sun et al., 2017b) and low- and middle-income countries (Lundberg et al., 2009) included only birth place or current resident place, while critical changes of growth environment in personal history have been detected to contribute to the timing effect and cumulative effect of environmental exposure on PEs (Pedersen and Mortensen, 2001).

Our cross-cultural study aimed to investigate the association between environmental risks, such as urbanicity and childhood adversities, and the severities of PEs in China. Inspired by findings from previous studies (Guloksuz et al., 2015; Pries et al., 2018), we also explored the cumulative effect of these environmental risks on the severities of PEs.

2. Methods

2.1. Participants

This survey was conducted in October 2013 at a comprehensive university located in Chengdu, Sichuan Province, China, where the undergraduate students have come from across the country. There were 41,228 undergraduates and 10,054 second-year undergraduates at the time of our survey at the university. In order to recruit a representative sample and reduce confounding factors such as the effect of adaptation to university life as a freshman, we conducted the survey in the second-year undergraduates. 182 classes from the 26 colleges of the university were randomly selected using a stratified cluster sampling method. The numbers of classes sampled from each college depended on its proportion of the student number at the university. All undergraduates in each randomly-sampled class were invited to participate in this study using computer-assisted self-report questionnaire. The participants who had or have psychotic disorder were excluded. 4862 second-year undergraduates were invited and 4620 provided valid data after quality control. This resulted in an overall effective response rate of 95.02%. Informed consent was obtained from all participants. The Medical Ethics Committee of West China Hospital, Sichuan University approved this study.

2.2. Survey measures

The Chinese version of psychoticism and paranoid ideation subscales in the Symptom Checklist-90-R (SCL-90-R) (Kramer et al., 2012) were used to assess PEs. These two subscales were often used to measure PEs in previous studies (Kramer et al., 2012; Sharifi et al., 2012), and has shown good validity and reliability in its original version and Chinese version, in both general population (Chen and Li, 2003) and university students (Shi et al., 2013) in China. There are 10 items in the psychoticism subscale including psychotic symptoms such as thought control, auditory hallucination, experience of thought being revealed and thought insertion. The paranoid ideation subscale consists of 6 items to identify paranoia primarily involving suspicion and delusion of reference. The participants were asked if they were bothered or distressed by the above problems during the past 12 months. Subsequently, each was assessed by the rating score according to the severity, 1 for "not at all", 2 for "a little bit", 3 for "moderately", 4 for "quite a bit", and 5 for "extremely". The separate scores of the above-mentioned subscales and the sum of the both were used in subsequent analyses. Moreover, to examine whether effects of the exposure and other survey variables differed across severities of PEs, the separate factor scores of the two subscales and the merged factor score of the both were calculated and grouped into ordinal data for subsequent analyses. A priori based on the rating criteria of the scale, scores 1.0 ("not at all", i.e., "no symptoms"), 1.1–1.9 (on average between "not at all" and "a little bit", i.e., ranging between "no symptoms" and "definite symptoms"), and 2.0–5.0 (on average between "a little bit" or "extremely", i.e., "definite symptoms") was defined as 0, 1, and 2, respectively.

2.3. Exposure variables

2.3.1. Birth/upbringing place and household income

All participants were inquired about their birthplaces. Inspired by Mortensen (Mortensen et al., 1999), a six-level rating method was used, ranking from 6 to 1 corresponding to the residence place recorded as countryside, township, county-level city, prefecture-level city, provincial capital city, and municipality, respectively. The numbers representing the urbanicity level of the birth place also represent the population size of that place inversely. As per the condition of China

and for obtaining sufficient statistical power after comparing different combinations, we added a two-level assessment for the urbanicity level of the birthplaces, i.e. score 2 for being borne at the countryside and township (rural areas), and score 1 for being borne at county-level city, prefecture-level city, provincial capital city, and municipality (urban areas).

The changes in residences before 16 years old were recorded, since evidences suggested a crucial role of the upbringing environment during the first 15 years of life (Lederbogen et al., 2011; Pedersen and Mortensen, 2001). The participants were inquired about the change of residences and their age when it happened. Residence was also rated in a six-level method the same as that of birth place. The upbringing place was scored in two categories: 1 for "without the experience of living in the rural area before 16 years old", and 2 for "with the experience of living in the rural area before 16 years old". In order to assess the cumulative exposure to rural areas, we calculated the "rurality score" by multiplying the years spent in each area until the age of 16 with the category score of that area in both six-level and two-level models.

The household income was assessed by self-report, in the form of ordinal data according to per capita annual income, i.e. 1 to 6 corresponded to <¥3000, ¥3000–4999, ¥5000–9999, ¥10,000–19,999, ¥20,000–29,999, and ≥¥30,000, respectively.

2.3.2. Childhood neglect and physical abuse

Childhood neglect and physical abuse before 16 years old were measured using six questions extracted from the Childhood Section of Chinese World Mental Health (WMH) initiative version of the World Health Organization (WHO) Composite International Diagnostic Interview Version 3.1 (WMHCIDI-3.1) (Kessler and Ustun, 2004; Lee et al., 2011). Childhood neglect was assessed with 5 questions about the frequency of not having adequate food, clothing, school supplies or medical care, having inadequate supervision, and performing age-inappropriate chores. Childhood physical abuse was assessed with 1 question about the frequency of "being beaten, slapped, hit, pushed, grabbed, shoved, or thrown something at the child" by the caregivers. A four-level rating from 0 to 3 as per the frequency was recorded, standing for "never", "rarely", "sometimes", and "often", respectively. The original scores of childhood neglect and physical abuse were structured into binary variables, 0 for original score = 0, and 1 for original score ≥ 1. We then merged the neglect and physical abuse into one item, i.e. childhood trauma, in order to increase the statistical power in the model by adding up the original scores of childhood neglect and physical abuse. Similarly, the cumulative scores were structured into binary variables as well, 0 for cumulative score = 0, and 1 for cumulative score ≥ 1.

2.3.3. Parent-child separations

Parental death, parental divorce, and any other form of parent-child separations (adoption, foster placement, living with other relatives instead of parents, and parents migrating to urban from rural areas for job) were inquired using a self-designed questionnaire. The participants were asked about the accumulating months of parental separations before the age of 16. According to the previous studies, any separation from either one of or both parents for a minimum of 6 consecutive months counted (Friesen et al., 2017; Shen et al., 2015).

2.4. Confounding factors

The following variables were considered as potential confounding factors: gender, age, birth season (Cordova-Palomera et al., 2015), family history of psychotic disorder, ethnicity (Adriaanse et al., 2015; Morgan et al., 2009), cannabis and other psychoactive substance use (Bourque et al., 2017). According to previous study, the data with respect to the date of birth were categorized into winter (December 22–March 21) and the rest of the year (Cordova-Palomera et al., 2015). Participants with positive family history were defined as having one or more of their first-degree relatives with schizophrenia or any other psychotic disorder (including delusional disorder, brief psychotic disorder, schizophreniform disorder, schizoaffective disorder) (Hanssen et al., 2006). The ethnicity data were classified as the Han and minorities. Moreover, we inquired whether the participants used cannabis or any other psychoactive substance according to the Substance Use Section of WMHCIDI-3.1 (Kessler and Ustun, 2004).

2.5. Statistical analysis

Multivariate regression of generalized linear model (GLM) with Gamma family was used to examine the associations between the childhood adversities factors and the scores of psychoticism, paranoid ideation and the both subscales. Firstly, all independent variables including birth place, upbringing place, rurality score, childhood neglect, childhood physical abuse, parent-child separations, and demographic factors (gender, age, birth season, family history of psychotic disorders, household per capita annual income, and ethnicity) were put into the regression equation for variable selection. As birth place, upbringing place, and rurality score were highly correlated, they were separately put into the regression equation one by one to avoid multicollinearity. Similarly, the two divided indicators, childhood neglect and childhood physical abuse, and the integrated indicator of childhood trauma, were also separately put into the model. Secondly, we selected the independent variables based on the statistical significance of partial regression coefficient and Akaike information criterion. Thirdly, we also explored the interactions amongst the eventual independent variables by using GLM.

Fourthly, a generalized ordered logit model of multiple regression analysis was used to test whether effects of birth and upbringing place, childhood trauma, and other risk factors differed across severities of PEs (i.e., to test the pattern of associations between the above significant risk factors and the graded factor scores of psychoticism and paranoid ideation and the merged factor score of the both). Finally, we explored the effect of cumulated risk factors (i.e. the number of risk factors) on the graded factor scores of psychoticism and paranoid ideation and the merged factor score of the both using cumulative odds logistic regression analysis. All statistical analyses were carried out in Stata 14. Since the dependent variables were highly correlated with each other and owing to the inherent similarities between the models used in each analysis (i.e., measuring the association between PEs and exposures), statistical significances were set at two-tailed $p < 0.05$ without multiple corrections. All plots were generated using Stata 14.

3. Results

3.1. The demographic characteristics, childhood adversities and PEs

A total of 4862 students agreed to participate in this survey. 242 participants with missing data on birthplace, upbringing place, and scores of psychoticism and/or paranoid ideation of SCL-90-R were excluded. Consequently, 4620 participants with valid data were included in the subsequent analyses. The participants were aged between 16 and 22 years old, and the mean age was 19.58 (standard deviation [SD] = 0.85) years old. 2260 (48.9%) were males and 2360 (51.1%) were females. 1104 (23.90%) participants were winter births, and 420 (9.09%) were ethnic minorities rather than Han Chinese. 41 (0.89%) participants reported a positive family history of schizophrenia or any other psychotic disorder in their first-degree relatives. However, no one reported a diagnosis of schizophrenia or any other psychotic disorder at the time of or before recruitment. No history of cannabis or any other psychoactive substance use was reported either.

The demographic characteristics, childhood adversity events, and PEs in the recent 12 months of the participants grouped by the urbanicity level of birth place (6-level and 2-level, respectively) were presented in Table 1. Of the total 4620 participants, 2863 (62.0%) reported experiencing 1 or more psychoticism items, 2705 (58.5%) reported experiencing 1 or more paranoid ideation items, and 3172

Table 1
The demographic characteristics, childhood adversities and PEs of the participants grouped by different urbanicity levels of birth place.

	Birth place (six-level)						Birth place (two-level)		Total
	Countryside	Township	County	Prefecture	Provincial	Municipality	Rural	Urban	
Number of participants	1888 (40.87%)	484 (10.48%)	795 (17.21%)	803 (17.38%)	457 (9.89%)	193 (4.18%)	2372 (51.34%)	2248 (48.66%)	4620
Demographic data									
Age, years	19.74 (0.93)	19.53 (0.80)	19.48 (0.82)	19.45 (0.75)	19.48 (0.68)	19.40 (0.64)	19.70 (0.91)[a]	19.46 (0.75)[b]	19.58 (0.85)
Female	834 (44.17%)	261 (53.93%)	459 (55.74%)	439 (54.67%)	266 (58.21%)	101 (52.33%)	1095 (46.16%)[a]	1265 (56.27%)[b]	2360 (51.08%)
Winter birth	455 (24.10%)	113 (23.35%)	180 (22.64%)	210 (26.15%)	103 (22.54%)	43 (22.27%)	568 (23.95%)[a]	536 (23.84%)[a]	1104 (23.90%)
Minority nationality	188 (9.96%)	45 (9.30%)	91 (11.45%)	51 (6.35%)	34 (7.44%)	11 (5.70%)	233 (9.82%)[a]	187 (8.32%)[a]	420 (9.09%)
Per capita annual income	2.12 (1.32)/2	2.90 (1.60)/3	3.25 (1.62)/3	3.69 (1.70)/4	3.75 (1.77)/4	4.01 (1.68)/4	2.28 (1.42)/2[a]	3.58 (1.70)/4[b]	2.91 (1.69)/3
Positive family history	16 (0.85%)	3 (0.62%)	7 (0.88%)	7 (0.87%)	8 (1.75%)	0	19 (0.80%)[a]	22 (0.98%)[a]	41 (0.89%)
Childhood adversities									
Childhood neglect	583 (30.88%)	126 (26.03%)	221 (27.80%)	180 (22.42%)	102 (22.32%)	46 (23.83%)	711 (29.97%)[a]	549 (24.42%)[b]	1260 (27.27%)
Childhood physical abuse	422 (22.35%)	90 (18.60%)	127 (15.97%)	107 (13.33%)	79 (17.29%)	20 (10.36%)	512 (21.59%)[a]	333 (14.81%)[b]	845 (18.29%)
Childhood neglect and physical abuse	771 (40.84%)	173 (35.74%)	279 (35.09%)	239 (29.76%)	139 (30.42%)	55 (28.5%)	944 (39.80%)[a]	712 (31.67%)[b]	1656 (35.84%)
Parent-child separation	865 (45.82%)	189 (39.05%)	253 (31.82%)	200 (24.91%)	133 (29.10%)	45 (23.32%)	1054 (44.44%)[a]	631 (28.07%)[b]	1685 (36.47%)
PEs in late 12 months									
Positive item number of psychoticism	2.44 (2.74)/2	2.27 (2.69)/1	1.99 (2.46)/1	1.88 (2.27)/1	1.75 (2.43)/1	1.90 (2.38)/1	2.40 (2.73)/1[a]	1.89 (2.38)/1[b]	2.15 (2.58)/1
Positive item number of paranoid ideation	1.70 (1.88)/1	1.66 (1.88)/1	1.48 (1.75)/1	1.50 (1.72)/1	1.46 (1.84)/1	1.69 (1.84)/1	1.70 (1.88)/1[a]	1.50 (1.77)/1[b]	1.60 (1.83)/1
Positive item number of psychoticism and paranoid ideation	4.14 (4.42)/3	3.93 (4.36)/3	3.47 (4.01)/2	3.37 (3.78)/2	3.21 (4.08)/2	3.59 (3.96)/3	4.10 (4.41)/3[a]	3.39 (3.94)/2[b]	3.75 (4.20)/2
Score of psychoticism	12.91 (3.68)/12	12.74 (3.57)/11	12.45 (3.45)/11	12.25 (3.04)/11	12.04 (2.99)/11	12.63 (3.95)/11	12.88 (3.66)/12[a]	12.31 (3.27)/11[b]	12.60 (3.48)/11
Score of paranoid ideation	8.05 (2.58)/7	7.99 (2.52)/7	7.75 (2.31)/7	7.82 (2.36)/7	7.79 (2.57)/7	8.24 (2.91)/7	8.03 (2.57)/7[a]	7.82 (2.44)/7[b]	7.93 (2.51)/7
Score of psychoticism and paranoid ideation	20.96 (6.01)/19	20.72 (5.84)/19	20.20 (5.47)/18	20.07 (5.11)/18	19.83 (5.34)/18	20.87 (6.48)/19	20.91 (5.97)/19[a]	20.14 (5.42)/18[b]	20.53 (5.72)/19
Factor score of psychoticism	1.29 (0.37)/1.2	1.27 (0.36)/1.1	1.25 (0.34)/1.1	1.23 (0.30)/1.1	1.20 (0.30)/1.1	1.26 (0.39)/1.1	1.29 (0.37)/1.2[a]	1.23 (0.33)/1.1[b]	1.26 (0.35)/1.1
Factor score of paranoid ideation	1.34 (0.43)/1.2	1.33 (0.42)/1.2	1.29 (0.38)/1.2	1.30 (0.39)/1.2	1.30 (0.43)/1.2	1.37 (0.49)/1.2	1.34 (0.43)/1.2[a]	1.30 (0.41)/1.2[b]	1.32 (0.42)/1.2
Factor score of psychoticism and paranoid ideation	1.31 (0.38)/1.2	1.30 (0.36)/1.2	1.26 (0.34)/1.1	1.25 (0.32)/1.1	1.24 (0.33)/1.1	1.30 (0.40)/1.2	1.31 (0.37)/1.2[a]	1.26 (0.34)/1.1[b]	1.28 (0.36)/1.2

Data are n (%), mean (SD), or mean (SD)/median.
[a,b]Same superscript letter means that the two groups do not differ significantly from each other at the 0.05 level and different letters mean the two groups differ significantly from each other at the 0.05 level.

(68.7%) reported experiencing 1 or more psychoticism or paranoid ideation items within the last year. 275 (5.6%) and 468 (10.1%) students scored ≥2 in psychoticism and paranoid ideation, respectively. According to a previous study about Chinese university students that suggested a cutoff point of ≥2 (Huang and Li, 2009), the cutoff point in the current study was set at 2.01 and 2.20 using the mean plus one standard deviation and, there were 3.31% and 3.35% of the participants with positive psychoticism or paranoid ideation, respectively. Out of 4620 participants, 2372 (51.3%) reported rural birth (including 1888 countryside birth, 484 township birth) and 2248 (48.7%) reported urban birth (including 795 county-level city birth, 803 prefecture-level city birth, 457 provincial capital city birth, and 193 municipality birth). The distributions of factor score of psychoticism and paranoid ideation were shown in Table S1 (supplementary materials). We observed significant differences in age, gender, and per capita annual income between urban birth group and rural birth group. Compared to urban birth group, individuals born in rural reported more childhood adversities and had higher scores of PEs. There is no significant difference in frequency of winter birth, ethnic minorities, and positive family history of psychotic disorders between the two groups. Details are given in the supplementary materials.

3.2. Effects of gender, birth/upbringing place, and childhood adversities on the severity of psychoticism and paranoid ideation

We firstly assessed the effects of potential factors on the scores of psychoticism, paranoid ideation, and the sum score of the both, respectively. When the birth place was separately put into the model with other variables for variable selection, gender, birth place, childhood neglect, and childhood physical abuse were selected as independent variables (Table S2). Females, participants with lower urbanicity level of birth place (the only exception is for paranoid ideation in the six-level model of urbanicity) and those who experienced childhood trauma presented severe psychoticism and paranoid ideation.

When the upbringing place was put into the model separately with other variables for variable selection, gender, upbringing place, childhood neglect, and childhood physical abuse were selected as independent variables. We found a more crucial effect of upbringing place on the severity (scores) of psychoticism and paranoid ideation as compared to the birth place (2-level model). The participants who were exposed to the rural area during their upbringing period were apt to present severe psychotic and paranoid symptoms. Female participants and those who experienced childhood trauma presented severe psychoticism and paranoid ideation. In both cases in which childhood trauma was measured as either the 2-divided indices (childhood neglect and physical abuse) or a merged index, the results remained stable (Table 2). Fig. S1 presented the box plot of the score of psychoticism and paranoid ideation by gender, birth place, upbringing place, and childhood trauma (supplementary materials).

Table S3 showed the results of further analyses of the cumulative effect of quantitative upbringing environment on the scores of psychoticism, paranoid ideation, and the sum score of the both. We found a stable effect of the "rurality score" on psychoticism and

paranoid ideation implying that the more years and higher rurality level, as opposed to urbanicity level, of birth place or upbringing place, the more severe symptoms the participants were inclined to present. This indicates a potential dose-response relationship between early life rural environment exposure and subsequent psychotic and paranoid symptoms.

As evidence suggested, family history of psychotic disorders, birth season, and status of ethnic minority may play critical roles in introducing subsequent PEs in general population. However, in our analyses, family history, birth season, and status of ethnic minority were neither statistically significant nor significantly affected the model when entered into the selected regression equation. No significant interactive effects amongst the risk factors were detected by GLM.

We then performed the generalized ordered logit model of multiple regression analysis to assess the effects of gender, birth/upbringing environment and the childhood trauma on the graded factor scores of psychoticism, paranoid ideation and the merged factor score of the both. The results showed that gender and birth place mainly played a role between groups ranked 0 (representing raw value of factor score 1.0) and those ranked 1 and 2 (representing raw value of factor score 1.1–4.0) in factor scores rather than between groups ranked 0 and 1 (representing raw value of factor score 1.0–1.9) and those ranked 2 (representing raw value of factor score 2.0–4.0). The effects of upbringing place, childhood neglect, physical abuse, and the merged index childhood trauma affected almost each group ranked from 0 to 2 (Tables S4 & 5).

Further exploratory analyses of the effect of the number of risk factors (female, rural birth/upbringing, childhood trauma) on graded factor score of psychoticism, paranoid ideation, and the merged factor score of the both showed that participants with more risk factors were inclined to present more severe symptoms of PEs. The likelihood of the participants with three risk factors to be ranked in groups with 1 or more graded factor score was 4.126 times (95% CI 3.075–5.537) as those with no risk factor (Table 3, Figs. 1 & 2).

4. Discussion

In the present study performed in a comprehensive university in China, we investigated the prevalence of PEs and found 3.31% and 3.35% of university students having positive psychoticism or paranoid ideation experience, respectively. We also found that childhood neglect and physical abuse, rural birth and upbringing, and being a female increased the risk of PEs significantly. Furthermore, upbringing place, childhood neglect and physical abuse played an important role across the severity of PEs. Other findings include that an additive effect of risk factors on the severity of PEs, which suggested that individuals with more risk factors were apt to have more severe PEs.

The current study shows that childhood adversities, such as neglect and physical abuse, are closely correlated with PEs. Our findings are in agreement with previous studies (Linscott and van Os, 2013; Morgan et al., 2009). Besides, the accumulated evidence from a meta-analysis also showed that difficult and unpleasant experiences in childhood contribute to the development of psychosis, across the spectrum from experiences to disorder (Morgan and Gayer-Anderson, 2016). In addition, Wigman et al. reported in a female twin study that childhood trauma and prospectively recorded stressful life events were associated with the persistence of PEs (Wigman et al., 2011). Findings from longitudinal studies and a dose-dependent relationship suggest a causal association between childhood adversities and the development of psychosis (Bentall et al., 2012; Croft et al., 2018; Longden et al., 2016). In recent years, some psychological and biological explanatory mechanisms explaining the correlation between traumatic events and psychotic symptoms have been proposed (Misiak et al., 2017), such as dysfunctional cognitive schemas, affective dysregulation, insecure attachment styles, hypothalamic-pituitary-adrenal (HPA) axis dysregulation, immune-inflammatory mechanisms, gene × environment interactions and epigenetics. These psychological and biological models are culturally stable, which may explain why our findings are consistent with those from western countries.

Our study also confirmed the gender difference in association with PEs, and found that females have increased risk of PEs (McGrath et al., 2015). The previous studies found a correlation between childhood physical and sexual abuse and subsequent psychosis in females instead of males (Fisher et al., 2009; Gayer-Anderson et al., 2015; Misiak et al., 2016). And this sex difference might be explained by psychological mechanisms, emotional processing, coping strategies and HPA axis response (Misiak et al., 2017). In our study, only neglect and physical abuse were included in the assessment of childhood trauma, while social support and other crucial dimensions of childhood trauma such as sexual abuse, medical illness, bullying, and emotional/psychological abuse had not been evaluated. In future studies, the adversity type need to be further differentiated, and other important facets such as social support, emotional processing, coping strategies, putative interactions amongst risks, and psychological or biological mediators should also be considered.

In our study, rural birth and upbringing were identified to be risk factors of PEs. This is different from previous studies that were carried out in developed countries (Linscott and van Os, 2013). A longitudinal study from the UK found that urban upbringing was associated with an approximately 2-fold increased childhood psychotic symptoms (Newbury et al., 2016). However, a recent international population-based study used survey data in 42 low- and middle-income countries (not including China) showed that urbanicity was not associated with elevated odds for PEs in developing countries (DeVylder et al., 2018). This discrepancy in findings between developed countries and low- and middle-income countries raises important issues on the relationship between urbanicity and PEs. Evidence from developed countries strongly links social risks, including deprivation, inequality, and social

Table 2
Effects of gender, upbringing place, childhood physical abuse, and childhood neglect on psychoticism and paranoid ideation.

	Score of psychoticism		Score of paranoid ideation		Score of psychoticism and paranoid ideation	
	B	95% CI	B	95% CI	B	95% CI
Divided indices of CT						
Gender	0.425**	(0.205, 0.645)	0.375***	(0.217, 0.534)	0.800**	(0.440, 1.160)
Upbringing place	0.645***	(0.426, 0.864)	0.235**	(0.077, 0.393)	0.880***	(0.521, 1.238)
Neglect	0.837***	(0.596, 1.077)	0.571***	(0.397, 0.745)	1.410***	(1.015, 1.804)
Physical abuse	0.745***	(0.466, 1.025)	0.542***	(0.340, 0.744)	1.287***	(0.828, 1.745)
Merged indices of CT						
Gender	0.400**	(0.180, 0.620)	0.354**	(0.195, 0.512)	0.754**	(0.393, 1.114)
Upbringing place	0.676***	(0.456, 0.896)	0.257**	(0.099, 0.416)	0.933***	(0.573, 1.294)
Neglect and physical abuse	0.965***	(0.741, 1.188)	0.678***	(0.517, 0.839)	1.644***	(1.278, 2.011)

CT — childhood trauma.
** $p < 0.01$.
*** $p < 0.00001$.

Table 3
Effects of number of risk factors on graded factor score of psychoticism and paranoid ideation.

Number of risk factors	Factor score of psychoticism		Factor score of paranoid ideation		Factor score of psychoticism and paranoid ideation	
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI
0[a]	1	–	1	–	1	–
1	1.802***	(1.436, 2.262)	1.378**	(1.102, 1.724)	1.659**	(1.322, 2.082)
2	2.707***	(2.157, 3.396)	2.080***	(1.665, 2.597)	2.604***	(2.073, 3.271)
3	4.121***	(3.095, 5.487)	3.033***	(2.308, 3.987)	4.126***	(3.075, 5.537)

[a] Participants with 0 risk factor as a reference group.
*** $p < 0.00001$.
** $p < 0.01$.

isolation, to raised rates of psychosis in urban settings (March et al., 2008). Mechanisms through which such risks influence psychosis remain uncharacterized, and they may include effects of social stress (Mizrahi, 2016) and possibly exposure to socially distributed biological factors like pollutants (Attademo et al., 2017). Overall, Chinese society is a family-oriented society, in which the family connections and supports are quite different from that of western countries. Does urban upbringing face more social stress than rural bringing in China? Longitudinal multi-point surveys by Yang et al. showed that the frequency of life events and the scores of depression and anxiety symptoms of rural adolescents were significantly higher than those of urban adolescents (Yang et al., 2015). Moreover, in China, the rural setting varies largely from that in developed countries. The rural birth and upbringing may be a proxy of poor economic condition, nutritional status, medical condition, lower parental income and so on (Ma, 2016; Sicular et al., 2007). Li et al. found both rural-to-urban migrants and rural residents in China scored higher than urban residents in all the SCL-90 global indices and subscales (Li et al., 2009). All of these suggest that Chinese rural areas may be under more severe social stress than its urban areas. A recent study by Richardson et al. reported that the risk for psychosis is also elevated in nonurban areas with low social cohesion and high poverty (which are typically features of urban environments in previous studies) (Richardson et al., 2018). Thus, further studies are required to clarify this heterogeneity by using more sophistic assessments for urbanization and adjusting other confounding factors such as depressive and anxiety symptoms.

Severe PEs were found in individuals with more risk factors. The additive effect of the environmental risks suggested that when individuals were exposed to more risk factors in the early lifetime they are more likely to develop PEs and present more severe PEs in the early adulthood, which is consistent with findings of previous studies performed in developed countries (Guloksuz et al., 2015; Pries et al., 2018). Risk factors whose effect may be explained by their direct psychological or biological mechanisms, such as childhood trauma and gender, have been found to have a stable effect on PEs. While the role of urbanicity, whose effect might be explained by culturally relevant mechanisms, is inconsistent across contexts.

The strengths of the present study include the large sample size and the detailed assessments of PEs, demographic characteristics, and childhood adversities. Therefore, we had sufficient statistical power to identify the association between childhood adversities and PEs. Notably, birth and upbringing places were recorded from birth to before 16 years old, which provided detailed information about childhood upbringing environment. However, the present study has several limitations. Firstly, the study is not a designed epidemiological survey in the general population, and the sample is not totally representative of the general Chinese rural and urban populations. Secondly, the types of childhood adversity assessed in this study were restricted to neglect, physical abuse and parent-child separation. Other dimensions of adversity and protective factors that might neutralize the effects of urbanicity/rural upbringing and childhood trauma have not been considered. Thirdly, the psychoticism and paranoid ideation subscales of SCL-90-R were used to assess PEs, which was not a tool specifically designed for PEs and measures only symptom distress without frequency. Besides, although a priori based on the rating criteria of the scale, the approach to group the factor score into ordinal data was, to our knowledge, first used and needs further verification and validation. Fourthly, multiple comparisons, although not independent, were uncorrected and could potentially make some of the results somewhat liberal. Finally, all information including PEs, previous or current status of mental disorders, a family history of mental disorders and childhood trauma was based on self-report data and may result in potential bias. The reports of childhood trauma in participants with severe PEs might be

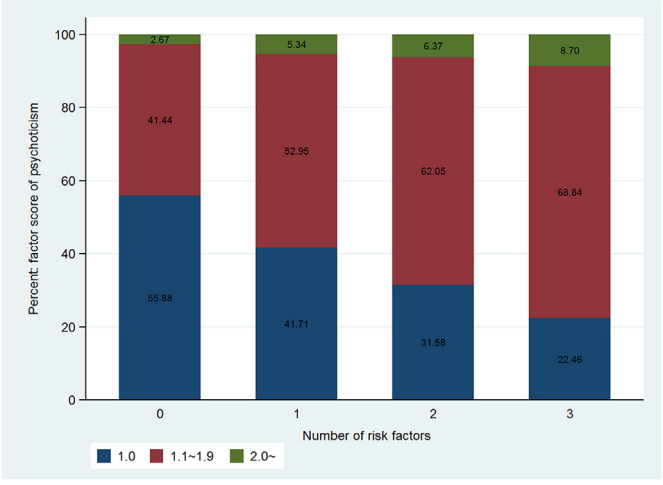

Fig. 1. Proportion of participants with ordinal range of factor score of psychoticism by number of risk factors.

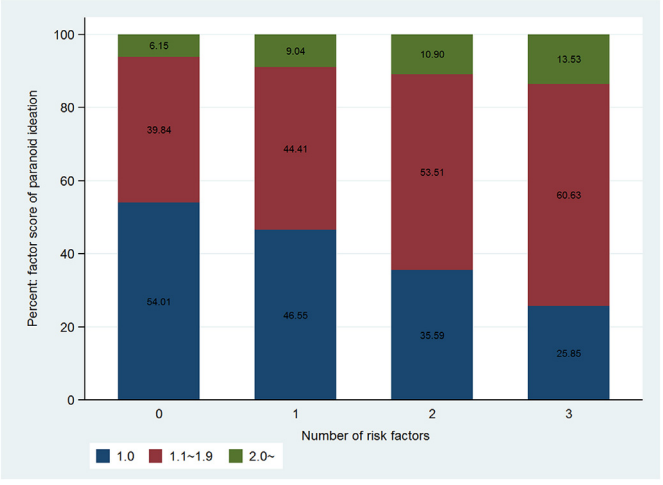

Fig. 2. Proportion of participants with ordinal range of factor score of paranoid ideation by number of risk factors.

different as compared to normal individuals due to the presence of psychotic symptoms or searching for explanations on their PEs.

Taken together, our study replicated the findings in western societies that stress the impact of adverse social environments especially childhood adversities on the risk and severity of PEs. The discrepancy in findings between developed countries and China as regard to the effect of urbanicity on PEs has important implications, pressing us to carefully interpret the meanings of city living across contexts, and to explain how and why observed associations between city living and psychosis differ across these contexts. The mechanisms of social environments contributing to PEs and mental disorders need to be further explored with comprehensive design to take into account the cultural differences. Our findings also suggested that upbringing environment and adverse events in childhood should be recorded in order to assess the risk and develop comprehensive care plans while addressing mental health issues of the students.

Conflict of interest

The authors have declared no conflicts of interest in relation to the subject of this study.

Contributors

C.W., Q.W., W.D., W.G., and T.L. conceived of and designed the study. X.L., Y.Z., W.W., and L.H. revised the questionnaire and collected the data. W.D., W.G., W.T., and T.C. conducted the survey. C.W. and Q.W. analysed the data and wrote the first draft of the manuscript. T.L. oversaw the analyses and edited the manuscript. All authors contributed to and approved the final manuscript.

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Appendix A. Supplementary data

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