

# BMJ Open Cross-sectional study on influence of the family environment on the lifetime non-medical use of prescription drugs among Chinese adolescents in Guangdong: an analysis of sex differences

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## ABSTRACT

**Objectives** This study aimed to assess if adolescents had used any prescription drugs non-medically, to explore the associations between the family environment and non-medical use of prescription drugs (NMUPD) and to investigate whether there are any sex differences in the aforementioned associations.

**Design** A population-based cross-sectional study.

**Setting** A secondary analysis of the cross-sectional data collected from high school students in Guangdong who were sampled using a multistage, stratified-cluster, random-sampling method in the 2015 School-based Chinese Adolescents Health Survey.

**Participants** A total of 21 774 students aged 12–20 years.

**Data analysis** Multilevel logistic regression models were used to explore the univariable and multivariable relationship between family environment and NMUPD among adolescents. Adjusted ORs and corresponding 95% CI were calculated.

**Outcome measures** Questions regarding to adolescent's NMUPD (including sedative, opioid and stimulant) were surveyed in the study.

**Results** A total of 6.3% students reported lifetime NMUPD in this study. The most commonly used drugs were opioids (3.9%), followed by sedatives (3.2%) and stimulants (2.5%). Multilevel analyses indicated that living arrangements, family economic status, parental relationships, parental education levels, monthly pocket money, parental drinking and drug problems were significantly correlated to the NMUPD among all students. Among boys, living arrangements, family economic status, maternal education levels, monthly pocket money, parental drinking and drug problems were significantly related to different types of NMUPD. The same factors were related to girls' NMUPD, except for maternal education levels. Parental relationships and paternal education levels were also associated with girls' NMUPD.

**Conclusion** The family environment exerts an important influence on adolescents' NMUPD. Interventions targeted at families are highly recommended considering the negative effects of NMUPD. In addition, the child's sex might be taken into consideration when developing and implementing preventive strategies.

## Strengths and limitations of this study

- A large-scale, representative sample of adolescents living in Guangdong, China provided data for this cross-sectional study.
- Comprehensive dimensions of family environment were taken into consideration.
- Multilevel analyses were conducted on boys and girls separately to explore the sex difference.
- Data were collected based on subjective self-reported questionnaires, which may lead to information bias.
- The sample was restricted to Guangdong province instead of the whole country.

## INTRODUCTION

The non-medical use of prescription drugs (NMUPD) (eg, sedatives, tranquillisers and stimulants) is defined as using these drugs without a doctor's directions and for reasons other than the medication's intended purpose (such as 'to experiment' or 'to get high').<sup>1,2</sup> Over the last two decades, the NMUPD caused great concern due to sharp increases in drug use in the fields of psychiatry and neurology.<sup>3</sup> According to the US report in the 2015 National Survey on Drug Use and Health, prescription drugs were second only to marijuana in the prevalence of illicit use.<sup>4</sup> In Europe in 2015, the use of new psychoactive substances (narcotic or psychoactive substances that are not controlled by the United Nations drug conventions) seemed to be more common than the use of illicit drugs, such as cocaine and amphetamines.<sup>5</sup> In China, a survey conducted in 2012 in Guangdong Province illustrated that the overall prevalence of the lifetime non-medical use of opioids and sedatives was 7.5% and 4.8%, respectively.<sup>6</sup>

Adolescence is an important transition period from childhood to adulthood and it may be easily affected by the surrounding context.<sup>7</sup> During this period, adolescents may be responsible for their own medication management and especially vulnerable to the negative effects of NMUPD for their still developing brains.<sup>8</sup> Among different contexts, the family exerts a powerful influence on adolescent behaviours and expectations for the future.<sup>9–10</sup> Previous studies have indicated that the family environment was associated with adolescent NMUPD.<sup>11–16</sup> For example, family economic status,<sup>12</sup> family structures and relationships,<sup>13</sup> parent-adolescent attachment,<sup>14</sup> parental education levels<sup>15</sup> and substance use<sup>16</sup> are related to adolescent drug abuse. It is well established that Chinese adolescents usually face high levels of stress in school, especially during high school and in preparation for the college entrance examination.<sup>17</sup> Unsuitable habits or risk behaviours could be easily developed during this time<sup>18</sup> if parents do not pay enough attention to adolescents. Additionally, due to the previous family planning policy in China, most families have only one child.<sup>19</sup> Parents are one of the most important role models for adolescents. Thus, parental behaviours such as substance use may exert a deep influence on adolescent development. Previous research in China has also drawn similar conclusions.<sup>1</sup> Therefore, it is reasonable to hypothesise that a positive family environment will serve as a buffer against adolescent NMUPD.

Generally, compared with girls, boys usually have higher probability of using prescription drugs without doctors' instruction. According to the US Youth Risk Behavior Surveillance (YRBS) 2015, male students had a higher prevalence of NMUPD than female ones.<sup>20</sup> Similar situation also exist in China, according to previous studies.<sup>1–21</sup> In addition, family could have different influences on boys and girls. For example, communication problems with their father significantly influenced boys' well-being yet girls were more sensitive to the communication problems with their mother.<sup>22</sup> Moreover, girls can be more easily affected by their parents' behaviours such as problematic drinking and communication, compared with boys.<sup>22</sup>

The monitoring system of NMUPD is well conducted in developed regions, such as North America and Europe. In China, large-scale surveys on the family environment and NMUPD have been sporadic. A healthy surveillance system is warranted to be established. Therefore, this study was conducted to assess whether Chinese high school students had used prescription drugs non-medically, to determine the influences of the family environment on the NMUPD and to investigate whether there are any sex differences in the aforementioned associations.

## METHODS

### Study design and participants

The current study used the secondary cross-sectional data collected from high school students in Guangdong who were sampled in the 2015 School-based Chinese

Adolescents Health Survey. Multistage stratified cluster sampling was adopted to randomly sample school students in Guangdong Province. In stage 1, the province was categorised into three levels based on per capita gross domestic product (most, medium and least developed). Then, two cities were randomly chosen from each level. In stage 2, schools were categorised into three types: junior high (grades 7–9), senior high (grades 10–12) and vocational high schools (grades 10–12). In each city, six junior high, four senior high and two vocational high schools were randomly selected, depending on their locations (urban or suburban). In stage 3, two classes were randomly chosen from each grade in the selected schools (figure 1). All eligible students within the class were investigated. A total of 21 780 students were invited to participate in this study and 21 774 (99.97%) of these students provided usable information. The final sample included 10 297 (47.3%) boys and 11 010 (50.6%) girls. The students' ages ranged from 12 to 20 years old, with the mean age of 15.4 ( $\pm 1.85$ ) years old. Most of the students (98.6%) in this study are Han nationality. Students were required to finish the self-report questionnaire anonymously in classrooms in the absence of teachers to avoid possible bias. The survey was conducted under the supervision of well-trained medical graduate students. Before the survey, participants were informed about the purpose and procedure of the study. In addition, they were told that participation was voluntary.

### Patient and public involvement

No patients or public were involved in the development of the research question, study design or data interpretation in this study.

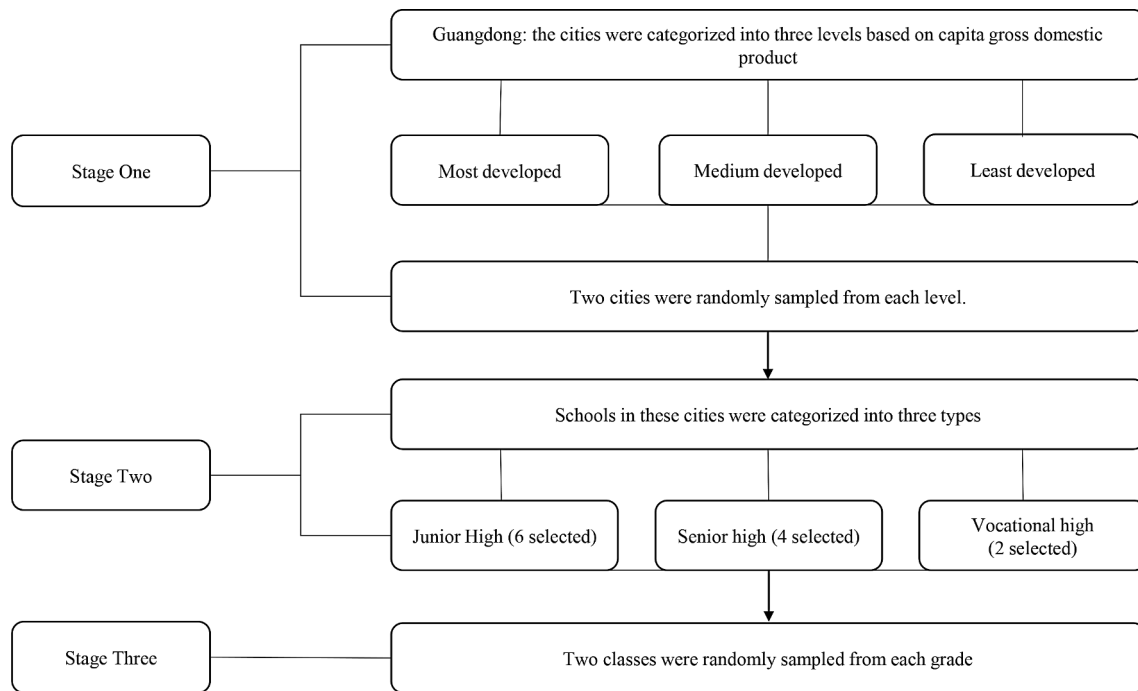
## Measures

### Dependent variables

Lifetime NMUPD (including opioids, sedatives, stimulants and the non-medical use of any of these drugs) was measured by asking students the following question: 'have you ever taken the following medications not to treat sickness but just for fun or the feeling caused by the medication without a doctor's prescription (responses were coded as 1=yes and 0=no)?'. Opioids included compound cough syrup with codeine, compound licorice tablets, tramadol hydrochloride and diphenoxylate. Stimulants included paracetamol caffeine aspirin powder. Sedatives included compound aminopyrine phenacetin tablets (barbiturates), diazepam or triazolam (benzodiazepines), phenobarbital and scopolamine hydrobromide tablets (barbiturates). All the drugs mentioned above were listed in the questionnaire for participants to choose. The list was generated based on the report of Guangdong Food and Drug Administration, previous articles,<sup>21–23</sup> advises from experts in substance misuse and paediatricians. The chosen drugs were reported to be easily obtained or widely misused by previous surveys.

### Family environment and sociodemographic factors

Living arrangements were assessed by asking students with whom they live (with two biological parents, with one



**Figure 1** Flowchart of the sampling procedure.

single parent, or with relatives other than parents). Family economic status was measured by asking students about their perceptions of their family's current economic level (ranging from below average to above average). Pocket money was measured by asking students about the amount of pocket money they have per month (<200¥, 200–399¥ and >400¥, which equal to <25€, 25–50€ and >50€). Parental marital status was measured by asking students whether their parents' relationships were harmonious, conflicting, apart or divorced, or others (eg, parent had passed away). Parental education level was assessed by asking students if either of their parents had received a high level of education (university and higher). Parental smoking and drinking patterns were assessed by asking students whether their father or mother ever smoked more than once a week or had been drunk in the last 12 months. Parental drug use was assessed by asking whether their parents ever use the mentioned prescription drugs without any medical intentions. Other sociodemographic variables included sex (1=male, 2=female), nationality (1=Han nationality, 0=other nationality) and age.

#### Statistical analysis

All data were entered by two investigators using Epidata V.3.1. Statistical analyses were conducted using SPSS V.22.0. Descriptive analyses were used to describe demographics, family related characteristics and the prevalence of the NMUPD across sex. To assess any differential relationships by sex, analyses were conducted separately for boys and girls. All variables that were significant at a 0.25 level in the univariate analysis<sup>24</sup> or widely reported to be associated with family dimensions were further submitted to multivariate analysis to identify independent risk factors for the NMUPD. Considering this

study was a complex sampling design using multistage sampling, students were grouped into schools and might not be independent, therefore multilevel logistic regression models were fitted in which schools were treated as clusters. We used the procedure 'generalised estimated equation' in SPSS to perform multilevel logistic regression models. The associations between influential factors and dependent variables were measured by ORs and 95% CI and all the multivariate analysis were adjusted for demographic characteristics and school cluster. Statistical significance was evaluated at the 0.05 level using two-sided tests.

## RESULTS

### Sample characteristics and prevalence stratified by sex and NMUPD

Basic demographic information across sex is illustrated in [table 1](#). The results showed that family environment and NMUPD situation among adolescent were different between boys and girls. The proportions of students who reported non-medical use of sedatives, opioids, stimulants and any of these drugs were 3.2%, 3.9%, 2.5% and 6.3%, respectively. Furthermore, the overall prevalence of NMUPD among boys and girls is summarised, respectively. Among boys, the lifetime prevalence of the non-medical use of sedatives, opioids, stimulants and any of these drugs was 3.2%, 4.6%, 3.1% and 7.1%, respectively. Among girls, the lifetime prevalence of the non-medical use of sedatives, opioids, stimulants and any of these drugs was 3.1%, 3.2%, 2.1% and 5.7%, respectively.

**Table 1** Baseline characteristic across sex

| Variables                | Total         | Boys          | Girls         | P value |
|--------------------------|---------------|---------------|---------------|---------|
|                          |               | n (%)         | n (%)         |         |
| Total                    | 21 774 (100)  | 10 297 (47.3) | 11 010 (50.6) |         |
| Living arrangement       |               |               |               |         |
| With parents             | 16 756 (77.0) | 7 808 (75.8)  | 8 604 (78.1)  | <0.001  |
| With single parent       | 2 017 (9.3)   | 993 (9.6)     | 981 (8.9)     |         |
| With other relatives     | 3 001 (13.8)  | 1 496 (14.5)  | 1 425 (12.9)  |         |
| Economic status          |               |               |               |         |
| Above average            | 5 784 (26.6)  | 2 893 (28.2)  | 2 775 (25.3)  | <0.001  |
| Average                  | 13 293 (61.0) | 6 044 (58.9)  | 6 976 (63.6)  |         |
| Below average            | 2 628 (12.1)  | 1 330 (13.0)  | 1 223 (11.1)  |         |
| Missing                  | 69 (0.3)      |               |               |         |
| Parental marriage status |               |               |               |         |
| Harmonious               | 13 279 (61.0) | 6 374 (61.9)  | 6 633 (60.2)  | 0.004   |
| Conflicting              | 7 237 (33.2)  | 3 373 (32.8)  | 3 688 (33.5)  |         |
| Separated or divorced    | 1 078 (5.0)   | 464 (4.5)     | 602 (5.5)     |         |
| Other                    | 180 (0.8)     | 86 (0.8)      | 87 (0.8)      |         |
| Paternal education level |               |               |               |         |
| Low                      | 19 215 (88.2) | 8 956 (88.2)  | 9 839 (90.5)  | <0.001  |
| High                     | 2 263 (10.4)  | 1 196 (11.8)  | 1 031 (9.5)   |         |
| Missing                  | 296 (1.4)     |               |               |         |
| Maternal education level |               |               |               |         |
| Low                      | 20 005 (91.9) | 9 360 (92.1)  | 10 212 (93.8) | <0.001  |
| High                     | 1 509 (6.9)   | 807 (7.9)     | 677 (6.2)     |         |
| Missing                  | 260 (1.2)     |               |               |         |
| Pocket money (¥)         |               |               |               |         |
| 0–200                    | 17 251 (79.2) | 8 112 (78.8)  | 8 750 (79.5)  | 0.183   |
| 200–400                  | 2 856 (13.2)  | 1 356 (13.2)  | 1 447 (13.1)  |         |
| >400                     | 1 667 (7.7)   | 829 (8.1)     | 813 (7.4)     |         |
| Parental smoking         |               |               |               |         |
| Father                   | 10 820 (49.7) | 4 957 (48.1)  | 5 631 (51.1)  | <0.001  |
| Mother                   | 53 (0.2)      | 18 (0.2)      | 34 (0.3)      |         |
| Both                     | 120 (0.6)     | 57 (0.6)      | 61 (0.6)      |         |
| Neither                  | 10 781 (49.5) | 5 265 (51.1)  | 5 284 (48.0)  |         |
| Parental drinking        |               |               |               |         |
| Father                   | 5 256 (24.1)  | 2 544 (24.7)  | 2 588 (23.5)  | 0.013   |
| Mother                   | 265 (1.2)     | 106 (1.0)     | 155 (1.4)     |         |
| Both                     | 563 (2.6)     | 256 (2.5)     | 300 (2.7)     |         |
| Neither                  | 15 690 (72.1) | 7 391 (71.8)  | 7 967 (72.4)  |         |
| Parental NMUPD           |               |               |               |         |
| Yes                      | 670 (3.1)     | 313 (3.0)     | 336 (3.1)     | 0.959   |
| No                       | 21 104 (96.9) | 9 984 (97.0)  | 10 674 (96.9) |         |
| Any kinds of NMUPD       |               |               |               |         |
| Yes                      | 1 381 (6.3)   | 730 (7.1)     | 623 (5.7)     | <0.001  |
| No                       | 20 393 (93.7) | 9 567 (92.9)  | 10 387 (94.3) |         |
| Sedatives                |               |               |               |         |

Continued

Table 1 Continued

| Variables  | Total         | Boys        | Girls         | P value |
|------------|---------------|-------------|---------------|---------|
|            |               | n (%)       | n (%)         |         |
| Yes        | 686 (3.2)     | 334 (3.2)   | 336 (3.1)     | 0.432   |
| No         | 21 088 (96.8) | 9963 (96.8) | 10 674 (96.9) |         |
| Opioids    |               |             |               |         |
| Yes        | 842 (3.9)     | 476 (4.6)   | 350 (3.2)     | <0.001  |
| No         | 20 932 (96.1) | 9821 (95.4) | 10 660 (96.8) |         |
| Stimulants |               |             |               |         |
| Yes        | 555 (2.5)     | 315 (3.1)   | 228 (2.1)     | <0.001  |
| No         | 21 219 (97.5) | 9982 (96.9) | 10 782 (97.9) |         |

NMUPD, non- medical use of prescription drugs.

### Multilevel multivariate logistic regression analyses: all adolescents

The results of the final logistic regression model of the NMUPD among all surveyed adolescents are shown in [table 2](#). The risk factors of NMUPD included living with neither of their biological parents, poor familial economic status, conflicting parents, more monthly pocket money and parental substance use. For example, adolescents who came from low-income families had a higher probability of using sedatives (adjusted OR (AOR)=1.52, 95% CI 1.18 to 1.96), opioids (AOR=1.31, 95% CI 1.03 to 1.66), stimulants (AOR=1.52, 95% CI 1.15 to 2.00) and any of these drugs (AOR=1.35, 95% CI 1.11 to 1.63). In contrast, higher levels of parental education (beyond college) appeared as a protective variable of adolescents' misusing stimulants and any drugs surveyed (OR <1).

### Multilevel multivariate logistic regression analyses: boys

The results of the final multilevel logistic regression model for different kinds of NMUPD among boys are shown in [table 3](#). The risk factors of NMUPD included not living with parents, below-average family economic status, more monthly pocket money and parental substance use. Maternal education level was a protective factor of the non-medical use of stimulants (AOR=0.56, 95% CI 0.33 to 0.96) and any of the surveyed drugs (AOR=0.54, 95% CI 0.37 to 0.77).

### Multilevel multivariate logistic regression analyses: girls

[Table 3](#) demonstrates that age, living arrangements, family economic status, parent relationships, paternal education levels, monthly pocket money and parental substance use were significantly associated with different kinds of NMUPD among girls. Notably, girls with well-educated fathers had lower probabilities of using sedative (AOR=0.49, 95% CI 0.30 to 0.79), opioids (AOR=0.58, 95% CI 0.37 to 0.91), stimulants (AOR=0.14, 95% CI 0.05 to 0.38) or any of the prescription drugs in the study (AOR=0.51, 95% CI 0.35 to 0.72).

### DISCUSSION

This is the large-scale study aimed to investigate the influence of family environment on adolescents' NMUPD. This study found that NMUPD is prevalent among Chinese adolescents and the prevalence was higher for boys than girls. In addition, negative family environment such as incomplete family structure, unpleasant family relationship, low socioeconomic status and parental substance use were positively related to adolescents' NMUPD.

Approximately 6.3% of the students reported lifetime NMUPD, with 7.1% among boys and 5.7% among girls. The most common drugs used for non-medical purposes were opioids, at ~3.9%. These prevalence rates were lower than the results revealed in surveys from other countries. The 2015 YRBS reported that 16.8% of the students had taken prescription drugs without a doctor's prescription at least once during their lifetime.<sup>20</sup> According to the 2015 monitoring the future national survey, 5.9% of the 12th graders had used sedatives and 18.3% had used any prescription drug without a doctor's prescription during lifetime.<sup>2</sup> It was demonstrated that Asians had lower levels of prescription drug misuse and Chinese were less likely to report lifetime prescription drug misuse, compared with other ethnic subgroups.<sup>25</sup> Furthermore, the variance across studies might be caused by the methodologies of the studies, the differences in the nature of the samples.

Moreover, the family environment had influences on adolescents' NMUPD through different domains, such as family structure, economic status, parental relationships and parents' behaviour. First, living in a single-parent family or living without their biological parents was positively associated with adolescents' NMUPD. It is consistent with prior studies which suggested that adolescents living with two biological parents were less likely to report different kinds of NMUPD,<sup>13</sup> providing a 32% reduction in the odds of NMUPD.<sup>26</sup> Adolescents who lived with their biological parents can be more bonded and connected with their parents,<sup>27</sup> and better parent-child attachment has been proven as a protective factor of adolescents' substance misuse.<sup>28</sup> Second, similar with

**Table 2** Adjusted OR (AOR) and 95% CIs of lifetime NMUPD among all adolescents

| Variables                       | Any                  | Sedative             | Opioid               | Stimulant            |
|---------------------------------|----------------------|----------------------|----------------------|----------------------|
|                                 | AOR (95% CI)         | AOR (95% CI)         | AOR (95% CI)         | AOR (95% CI)         |
| <b>Living arrangement</b>       |                      |                      |                      |                      |
| With parents                    | 1.00                 | 1.00                 | 1.00                 | 1.00                 |
| With single parent              | 1.48 (1.21 to 1.80)* | 1.49 (1.13 to 1.95)* | 1.26 (0.98 to 1.63)  | 1.74 (1.34 to 2.27)* |
| With other relatives            | 1.43 (1.23 to 1.67)* | 1.52 (1.23 to 1.88)* | 1.48 (1.22 to 1.78)* | 2.03 (1.64 to 2.52)* |
| <b>Economic status</b>          |                      |                      |                      |                      |
| Above average                   | 1.00                 | 1.00                 | 1.00                 | 1.00                 |
| Average                         | 0.91 (0.80 to 1.05)  | 0.84 (0.70 to 1.02)  | 0.96 (0.81 to 1.14)  | 0.83 (0.67 to 1.03)  |
| Below average                   | 1.35 (1.11 to 1.63)* | 1.52 (1.18 to 1.96)* | 1.31 (1.03 to 1.66)* | 1.52 (1.15 to 2.00)* |
| <b>Parental marriage status</b> |                      |                      |                      |                      |
| Harmonious                      | 1.00                 | 1.00                 | 1.00                 |                      |
| Conflicting                     | 1.30 (1.16 to 1.47)* | 1.26 (1.06 to 1.49)* | 1.29 (1.11 to 1.50)* |                      |
| Separated or divorced           | 1.19 (0.92 to 1.54)  | 1.12 (0.79 to 1.59)  | 1.26 (0.91 to 1.74)  |                      |
| Other                           | 0.82 (0.35 to 1.88)  | 0.70 (0.22 to 2.24)  | 1.46 (0.73 to 2.92)  |                      |
| <b>Paternal education level</b> |                      |                      |                      |                      |
| Low                             | 1.00                 | 1.000                |                      | 1.00                 |
| High                            | 0.76 (0.59 to 0.97)* | 0.58 (0.42 to 0.80)* |                      | 0.48 (0.30 to 0.75)* |
| <b>Maternal education level</b> |                      |                      |                      |                      |
| Low                             | 1.00                 |                      |                      | 1.00                 |
| High                            | 0.71 (0.52 to 0.97)* |                      |                      | 0.49 (0.27 to 0.89)* |
| <b>Pocket money (¥)</b>         |                      |                      |                      |                      |
| 0–200                           | 1.00                 | 1.00                 | 1.00                 | 1.00                 |
| 200–400                         | 1.24 (1.05 to 1.46)* | 1.24 (0.99 to 1.56)  | 1.24 (1.01 to 1.53)  | 1.32 (1.03 to 1.69)* |
| >400                            | 1.71 (1.42 to 2.06)* | 1.61 (1.24 to 2.09)* | 1.66 (1.32 to 2.09)* | 1.95 (1.49 to 2.55)* |
| <b>Parental drinking</b>        |                      |                      |                      |                      |
| Father                          | 1.53 (1.35 to 1.73)* | 1.39 (1.16 to 1.65)* | 1.57 (1.34 to 1.83)* | 1.54 (1.28 to 1.87)* |
| Mother                          | 1.34 (0.85 to 2.12)  | 1.51 (0.83 to 2.73)  | 1.56 (0.89 to 2.70)  | 1.26 (0.61 to 2.58)  |
| Both                            | 2.08 (1.58 to 2.74)* | 2.30 (1.62 to 3.27)* | 2.30 (1.66 to 3.18)* | 2.38 (1.61 to 3.51)* |
| Neither                         | 1.00                 | 1.00                 | 1.00                 | 1.00                 |
| <b>Parental NMUPD</b>           |                      |                      |                      |                      |
| Yes                             | 2.86 (2.29 to 3.56)* | 2.97 (2.23 to 3.96)* | 2.69 (2.05 to 3.52)* | 3.17 (2.33 to 4.32)* |
| No                              | 1.00                 | 1.00                 | 1.00                 | 1.00                 |

Models are adjusted for sex, age, nationality and school clusters.

\*P<0.05.

NMUPD, non-medical use of prescription drugs.

previous studies,<sup>21–29</sup> this study found that conflicting parental relationships were related to the increase risk of adolescents' NMUPD. A possible explanation is that parental conflict is one of the predictive factors of poor parenting, such as low monitoring, high hostility and bad discipline, which are further related to more substance use.<sup>30</sup> Contrarily, positive family processes, such as close connections between family members, will lead to better parental monitoring,<sup>27</sup> and better monitoring could reduce the level of prescription drugs misuse.<sup>31</sup>

Additionally, this study gave information about relationship between familial economic status and adolescents'

NMUPD. Adolescents with more pocket money were more likely to engage in the NMUPD and this effect increased with higher amounts of money. These results are consistent with those of a prior study showing that adolescents with more pocket money might be more likely to use prescription drugs non-medically.<sup>21</sup> However, the present study indicated negative association between family economic status and the NMUPD among all adolescents. Similarly, previous investigations revealed that compared with wealthy families, individuals from low-income ones were more likely to use opioids, tobacco and cannabis.<sup>32–33</sup> One explanation offered to such association

**Table 3** Adjusted ORs and 95% CIs of lifetime NMUPD among boys and girls

| Variables                | Boys                 |                      |                      |                      | Girls                |                      |                      |                      |
|--------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|                          | Any                  | Sedative             | Opioid               | Stimulant            | Any                  | Sedative             | Opioid               | Stimulant            |
|                          | AOR (95% CI)         | AOR (95% CI)         | AOR (95% CI)         | AOR (95% CI)         | AOR (95% CI)         | AOR (95% CI)         | AOR (95% CI)         | AOR (95% CI)         |
| Living arrangement       |                      |                      |                      |                      |                      |                      |                      |                      |
| With parents             | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 |
| With single parent       | 1.47 (1.15 to 1.87)* | 1.32 (0.92 to 1.90)* | 1.26 (0.93 to 1.70)  | 1.75 (1.23 to 2.49)* | 1.65 (1.24 to 2.19)* | 1.72 (1.18 to 2.50)* | 1.45 (0.99 to 2.14)  | 1.86 (1.26 to 2.75)* |
| With other relatives     | 1.55 (1.27 to 1.89)* | 1.68 (1.27 to 2.23)* | 1.58 (1.25 to 2.00)* | 2.48 (1.90 to 3.24)* | 1.30 (1.03 to 1.65)* | 1.37 (1.00 to 1.88)  | 1.38 (1.02 to 1.86)* | 1.57 (1.09 to 2.24)* |
| Economic status          |                      |                      |                      |                      |                      |                      |                      |                      |
| Above average            | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 |
| Average                  | 0.95 (0.79 to 1.15)  | 0.88 (0.67 to 1.15)  | 1.00 (0.80 to 1.26)  | 0.87 (0.66 to 1.14)  | 0.89 (0.73 to 1.10)  | 0.82 (0.63 to 1.08)  | 0.82 (0.63 to 1.22)  | 0.88 (0.63 to 1.22)  |
| Below average            | 1.38 (1.07 to 1.77)* | 1.58 (1.12 to 2.23)* | 1.42 (1.05 to 1.93)* | 1.59 (1.12 to 2.26)* | 1.34 (1.01 to 1.80)* | 1.47 (1.01 to 2.15)* | 1.67 (1.07 to 2.60)* | 1.67 (1.07 to 2.60)* |
| Parental marriage status |                      |                      |                      |                      |                      |                      |                      |                      |
| Harmonious               | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 |
| Conflicting              | 1.60 (1.34 to 1.90)* | 1.61 (1.28 to 2.04)* | 1.58 (1.26 to 1.98)* | 1.60 (1.34 to 1.90)* | 1.61 (1.28 to 2.04)* | 1.58 (1.26 to 1.98)* | 1.58 (1.26 to 1.98)* | 1.58 (1.26 to 1.98)* |
| Separated or divorced    | 1.14 (0.78 to 1.67)  | 1.08 (0.65 to 1.78)  | 1.43 (0.89 to 2.30)  | 1.14 (0.78 to 1.67)  | 1.08 (0.65 to 1.78)  | 1.43 (0.89 to 2.30)  | 1.43 (0.89 to 2.30)  | 1.43 (0.89 to 2.30)  |
| Other                    | 0.86 (0.26 to 2.80)  | 1.03 (0.24 to 4.33)  | 0                    | 0.86 (0.26 to 2.80)  | 1.03 (0.24 to 4.33)  | 0                    | 0                    | 0                    |
| Paternal education level |                      |                      |                      |                      |                      |                      |                      |                      |
| Low                      | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 |
| High                     | 0.51 (0.35 to 0.72)* | 0.49 (0.30 to 0.79)* | 0.58 (0.37 to 0.91)* | 0.51 (0.35 to 0.72)* | 0.49 (0.30 to 0.79)* | 0.58 (0.37 to 0.91)* | 0.58 (0.37 to 0.91)* | 0.58 (0.37 to 0.91)* |
| Maternal education level |                      |                      |                      |                      |                      |                      |                      |                      |
| Low                      | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 |
| High                     | 0.54 (0.37 to 0.77)* | 0.56 (0.33 to 0.96)* | 0.56 (0.33 to 0.96)* | 0.54 (0.37 to 0.77)* | 0.56 (0.33 to 0.96)* | 0.56 (0.33 to 0.96)* | 0.56 (0.33 to 0.96)* | 0.56 (0.33 to 0.96)* |
| Pocket money (¥)         |                      |                      |                      |                      |                      |                      |                      |                      |
| 0-200                    | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 |
| 200-400                  | 1.18 (0.94 to 1.48)  | 1.15 (0.83 to 1.59)  | 1.29 (0.98 to 1.68)  | 1.24 (0.90 to 1.71)  | 1.34 (1.05 to 1.69)* | 1.38 (1.01 to 1.90)* | 1.44 (0.98 to 2.10)  | 1.44 (0.98 to 2.10)  |
| >400                     | 1.73 (1.35 to 2.22)* | 1.48 (1.03 to 2.14)* | 1.76 (1.31 to 2.37)* | 1.50 (1.04 to 2.16)* | 1.70 (1.28 to 2.25)* | 1.80 (1.25 to 2.60)* | 2.61 (1.77 to 3.86)* | 2.61 (1.77 to 3.86)* |
| Parental drinking        |                      |                      |                      |                      |                      |                      |                      |                      |
| Father                   | 1.54 (1.30 to 1.83)* | 1.34 (1.04 to 1.72)* | 1.58 (1.29 to 1.93)* | 1.33 (1.03 to 1.72)* | 1.51 (1.25 to 1.81)* | 1.44 (1.12 to 1.84)* | 1.58 (1.24 to 2.00)* | 1.81 (1.36 to 2.42)* |
| Mother                   | 0.78 (0.34 to 1.81)  | 0.85 (0.27 to 2.74)  | 1.13 (0.45 to 2.82)  | 0.28 (0.04 to 2.04)  | 1.82 (1.05 to 3.16)* | 1.97 (0.98 to 3.96)  | 1.93 (0.97 to 3.88)  | 2.48 (1.13 to 5.45)* |
| Both                     | 2.46 (1.70 to 3.56)* | 2.66 (1.63 to 4.33)* | 2.74 (1.80 to 4.18)* | 2.51 (1.52 to 4.13)* | 1.79 (1.19 to 2.69)* | 2.06 (1.25 to 3.41)* | 1.98 (1.18 to 3.31)* | 2.08 (1.10 to 3.92)* |
| Neither                  | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 |
| Parental NMUPD           |                      |                      |                      |                      |                      |                      |                      |                      |
| Yes                      | 3.50 (2.61 to 4.68)* | 4.10 (2.83 to 5.95)* | 2.87 (2.01 to 4.10)* | 4.15 (2.83 to 6.08)* | 2.29 (1.63 to 3.21)* | 2.00 (1.26 to 3.17)* | 2.46 (1.62 to 3.74)* | 2.15 (1.25 to 3.70)* |
| No                       | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 | 1.00                 |

Models are adjusted for age, nationality and school clusters.

\*P<0.05.

NMUPD, non-medical use of prescription drugs.

is that adolescents from low-income families may have less access to proper medical attention or guidance on using drugs. In addition, family economic hardship may influence young people's substance use by causing parents' emotional distress, which subsequently cause parental conflict and poor parenting style.<sup>30</sup>

In this study, parental substance use was significantly related to adolescents' NMUPD. Adolescents had higher probability of NMUPD if their parents (especially their fathers) had been drunk in the last 12 months or had ever used prescription drugs without medical intentions. Previous studies have also indicated that parental substance use was a risk factor for adolescents' substance use.<sup>1 34</sup> Parental substances misuse may provide an unclear guidance and give adolescents a wrong idea that this behaviour is acceptable.<sup>35</sup> Thus, adolescents may adopt the same behaviours.<sup>36</sup> Evidence showed that parental disapproval of substance use was negatively related with adolescents' NMUPD.<sup>37</sup> Furthermore, parents' NMUPD could facilitate adolescents' access to those drugs. Previous studies have shown that family was one of the most common sources for adolescents' access to medications,<sup>38</sup> and this availability increases adolescents' chances of using these drugs.<sup>39</sup>

The stratification analyses in this study demonstrated that family conflict was related to a higher probability of the NMUPD among girls but not boys. Evidence suggests that girls are more emotionally sensitive than boys when it comes to dealing with stress or other negative situation,<sup>40</sup> so they might be more vulnerable to their parents' and family relationships. Moreover, the results showed that girls were more affected by their fathers' education levels while boys were more affected by their mothers' education levels, indicating that parents' genders have different impacts on boys and girls. According to a previous study, father-daughter relationships were potentially related to dealing with psychosocial stress among girls,<sup>41</sup> indicating that fathers may have a more profound influence on their daughter's behaviour. In addition, in this study, except for fathers' drinking habits, girls were more likely than boys to be affected by their mothers' drinking problems. Previous studies have drawn the same conclusions.<sup>35</sup> In China, females usually drink and smoke less than males. Study has showed that teenage girls would feel more comfortable to communicate with their mothers about substance use.<sup>42</sup> Therefore, as teenage girls' first role model, mothers' influence might be unique when they have problems with substance use.

### Strengths and limitations

Several limitations of the study should be noted. First, this study only investigated students who were in school, but not those who dropped out of school or did not attend school on the day that the survey was conducted. Therefore, this sample may under-represent the true level of NMUPD. Second, it was a cross-sectional study; thus, the associations cannot be construed as causal. Third, the self-report questionnaire might introduce information bias like recall bias and dishonesty about drug use, although such method is

commonly used and quality control was conducted to the best of our ability. Fourth, only lifetime NMUPD was assessed in this study. Recent (1 year) and current (1 month) use will be considered in our future study. What is more, this study was only conducted in Guangdong province, which reduces the generalisability. Lastly, although NMUPD may be correlated with other substance use, in this study we did not collect information about other substance use. Other substance use (eg, smoking, drinking) will be included in our future study.

Despite these limitations, there are some strengths of this study. It was conducted based on a large-scale sample of adolescents in Guangdong Province. Economic difference across the whole province was taken into consideration during sampling procedure, which strengthen the representative of the sample. Furthermore, the influence of the family environment was comprehensively discussed from different dimensions, such as family socioeconomic status and parental behaviours. Third, different influences of the family environment on NMUPD across sex were explored separately in this study, which enable parents and government to address such problem differently based on the sex of adolescents.

### CONCLUSION

This study explored the prevalence of adolescents' NMUPD and the influence of the family environment. The findings suggested that a negative family environment was highly related to adolescents' NMUPD. First, growing up with both biological parents is very important for adolescents. It would be better for adolescents if parents are more involved in children's lives, especially when they are divorced or when one of the biological parents has passed away. Second, the study indicated that it is important for parents to create a harmonious atmosphere for adolescents. If the family relationship is unpleasant, it would be better for parents to pay extra attention to their children's daily behaviour. Third, this study suggested that parental substance use has a negative influence on adolescents. We recommended parents to engage in healthy behaviours and provide clear guidance around drugs use when they are with their kids. Additionally, we suggested parents keeping track of their medicines so they would be aware if any of them are missing. These findings also serve as a reminder to parents that they should pay attention to the different dimensions of the family environment as they affect their children based on sex. Furthermore, a stricter regulation to limit the sale of prescription drugs to adolescents, effective interventions and policies enacted by the government to prevent the NMUPD are highly recommended. The child's sex plays a role in the association and we suggest that it should be taken into consideration when these interventions are made.

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