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Analysis of nicotine dependence among daily smokers in China: evidence from a cross-sectional study in Zhejiang Province

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ABSTRACT

Objective The current study aimed to assess the level of nicotine dependence and its influencing factors among daily smokers in Zhejiang, China.

Setting The 2020 Global Adult Tobacco Survey was conducted in Zhejiang, China.

Participants 1244 daily smokers aged ≥15 years.

Measures Respondents were asked questions regarding their age, sex, residence, education level, occupation, household income, age of starting daily smoking and nicotine dependence.

Results The findings revealed that 17.4% of daily smokers were highly dependent on nicotine, and the mean Fagerström Test for Nicotine Dependence score of daily smokers was (3.1±2.4). Age, educational level, occupation and age of starting daily smoking had significant effects on high nicotine dependence, whereas residence, sex and yearly household income were not significant factors. Compared with the age group ≥60 years, the proportion of respondents with a higher nicotine dependence level was lower in the age group of 15–39 years (OR=0.45). Daily smokers with a higher education level had a lower nicotine dependence level than those with a lower education level: primary or less (OR=3.07) and secondary (OR=2.62). Government institution staff (OR=4.02), unemployed persons (OR=3.08) and industrial workers (OR=2.46) had significantly higher nicotine dependence levels than did workers in the other occupation categories. People who started daily smoking at ≤18 years of age had a higher nicotine dependence level (OR=2.25) than those who started later.

Conclusions This study elucidated that nearly one-fifth of daily smokers in Zhejiang, China, have high nicotine dependence levels. Improved health information on tobacco smoking is needed to encourage daily smokers to quit smoking, particularly among young males, unemployed persons and those with lower education levels.

INTRODUCTION

China is the world's largest consumer of tobacco products, with an estimated 308 million smokers.[1][2] The annual number of deaths caused by tobacco use now exceeds 2.4 million and is expected to increase in the coming decades.[3] Nicotine dependence contributes to the maintenance of tobacco use and difficulty with cessation. Nicotine dependence is a multidimensional phenomenon,[4] which can be measured using the Fagerström Test for Nicotine Dependence (FTND).[5] The FTND is a widely used six-item questionnaire that measures physical dependence on nicotine. The six items assess smoking rate, smoking soon after waking, smoking even when ill, difficulty refraining from smoking, reporting the first cigarette of the day as the most difficult to give up and smoking more heavily in the morning. The psychometric properties of the FTND have been validated among cigarette smokers in many countries,[6] although evidence of its validity in Chinese language studies is scarce.

Zhejiang is a small province in China, with a developed economy and dense population. Smoking is a very common societal phenomenon and an important social activity in Zhejiang.[7] The local government has implemented tobacco control measures to reduce smoking in the population. In the provincial

capital city, Hangzhou, the antismoking laws were revised in 2019 to ban smoking in all indoor public places. The local Center for Disease Control (CDC) launched a series of health promotion programmes targeting important populations for smoking prevention and control, such as males planning to conceive a baby with his partner[8] and college students.[9] Ninety-nine smoking cessation clinics[10] were created in Zhejiang, and several campaigns were launched to provide knowledge about tobacco to the public and educate smokers about the risks of smoking.

Although studies have indicated that these approaches played an important role in controlling tobacco use, the smoking rate was 21.9%[11] in Zhejiang in 2019, higher than that in other developed countries.[12] In 2020, the Global Adult Tobacco Survey was conducted, and 1244 daily smokers in Zhejiang completed the survey. We used the relevant data from this survey to analyse nicotine dependence and its influencing factors among daily adult smokers. The purpose of the study was to use the data related to this survey to assess the level of nicotine dependence among daily adult smokers and the factors influencing it to facilitate evidence-based strategies to help smokers quit.

METHODS
Setting
Data were obtained from the 2020 Global Adult Tobacco Survey in Zhejiang, China. The survey was conducted between May and October 2020, and 1244 daily smokers completed the survey. Mapping and listing were conducted by local CDC staff to identify target households. The fieldwork was conducted in Mandarin through face-to-face interviews, and households were visited up to three times

to interview the target person within that household. All survey interviewers and supervisors were trained, and written consent was obtained from all respondents, or from their parents or guardians in the case of minors prior to the visit.

Participants
A multistage stratified cluster sampling design was implemented in the survey. Ten regions were selected based on their geographic locations. Each region was partitioned into segments containing approximately 120 households (using mapping and listing to determine the number). Six segments were randomly selected, and every household in the selected segment was visited. One eligible household member aged ≥15 years from each participating household was randomly sampled for an interview. A total of 6562 residents completed the survey, among which 1244 were daily smokers and were included in our analysis.

Measures
High nicotine dependence
High nicotine dependence was the dependent variable measured using the FTND score. The FTND is a six-item self-reported measure of nicotine dependence. The test measures the time between waking up and the first cigarette (item 1: 'How soon after you wake up do you smoke your first cigarette?'), difficulty refraining from smoking in places where smoking is forbidden (item 2: 'Do you find it difficult to refrain from smoking in places where it is forbidden?'), difficulty quitting the first cigarette of the day (item 3: 'Which cigarette would you hate most to give up?'), the number of cigarettes smoked per day ('tem 4: 'How many cigarettes per day do you smoke?'), morning

Table 1 The Fagerström Test for Nicotine Dependence items, response options and scoring

Item	Response options	Numerical value
How soon after you wake up do you smoke your first cigarette?	Within 5 min	3
	6–30 min	2
	31–60 min	1
	After 60 min	0
Do you find it difficult to refrain from smoking in places where it is forbidden?	No	0
	Yes	1
Which cigarette would you hate most to give up?	The first one in the morning	1
	Any other	0
How many cigarettes per day do you smoke?	10 or less	0
	11–20	1
	21–30	2
	31 or more	3
Do you smoke more frequently during the first hours after waking up than during the rest of the day?	No	0
	Yes	1
Do you smoke when you are so ill that you are in bed most of the day?	No	0
	Yes	1

Table 2 Survey respondents' sociodemographic characteristics (n=1244)

Sociodemographic characteristic	N	%
Residence		
Urban	752	60.5
Rural	492	39.6
Sex		
Male	1224	98.4
Female	20	1.6
Age (years)		
15–39	174	14.0
40–59	568	45.7
≥ 60	502	40.4
Education level		
Primary or less	447	36.0
Secondary	482	38.8
High school	187	15.1
Undergraduate or above	126	10.1
Occupation		
Industrial worker	377	30.3
Government institution staff	48	3.9
Business/service worker	380	30.6
Unemployed	83	6.7
Retired	98	7.9
Other	252	20.3
Unknown	6	0.5
Yearly household income (yuan)		
<50 000	426	34.2
50 000–200 000	629	50.6
>200 000	115	9.2
Unknown	74	6.0
Age of starting daily smoking (years)		
≤ 18	284	22.8
>18	950	76.4
Unknown	10	0.8
Overall	1244	–

smoking (item 5: 'Do you smoke more frequently during the first hours after waking up than during the rest of the day?') and smoking during sickness (item 6: Do you smoke when you are so ill that you are in bed most of the day?'). Table 1 presents the FTND items, response options and the value of each response option. The possible FTND scores range from 0 to 10, and the nicotine dependence level was defined by the scores as: 0–2=extremely low; 3–4=low; 5=medium; 6–7=high; 8–10=extremely high. The cut-off point for high nicotine dependence was an FTND score of 6 based on previous studies.[13 14]

The self-reported independent variables included in the analysis were residence (urban, rural), sex (male,

female), age group (15–39 years, 40–59 years, ≥ 60 years), education level (primary or less, secondary, high school, undergraduate or above), occupation (industrial worker, government institution staff, business/service worker, unemployed, retired, other, unknown), yearly household income (<50 000 yuan, 50 000–200 000 yuan, >200 000 yuan, unknown) and age of starting daily smoking (≤18 years, >18 years, unknown).

Statistical analysis
SPSS V.18.0 (SPSS Inc) was used for all analyses. Missing values need to be removed in order to clean the data. Standard descriptive statistics were conducted on the demographic variables and other parameters that might associate with high nicotine dependence. Logistic regression was applied to identify the factors associated with high nicotine dependence. P values <0.05 were considered statistically significant (two sided).

Patient and public involvement
Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

RESULTS
General information
The study was conducted in 10 counties/county-level cities; valid interviews were conducted with 1244 daily smokers (1224 males and 20 females). Our sample population had an average age of 56.0±14.2 (range: 21–96) years. There were 752 urban residents and 492 rural residents among the respondents. The most common education level was completed primary school or less (36.0%), followed by completed secondary school (38.8%), completed high school (15.1%) and completed college or above (10.1%). Regarding income levels, 34.2% reported yearly household income less than 50 000 yuan, 50.6% reported incomes between 50 000 to 200 000 yuan and 9.2% reported incomes more than 200 000 yuan. The average age at which the respondents started daily smoking was 22.2±6.1 years, and 22.8% started daily smoking when they were ≤18 years old (table 2).

Daily smokers' nicotine dependence levels
This was a retrospective study that used data obtained using FTND questionnaires from 1244 daily smokers. Table 3 shows the response frequencies for each FTND item score. The mean FTND score was 3.1±2.4 (range: 0–10). The distribution of nicotine dependence among daily smokers ranged from: very low (46.9%), low (27.3%), medium (8.4%), high (12.4%) and very high (5.1%).

High nicotine dependence (FTND≥6) was observed in 17.4% of daily smokers. The prevalence of high nicotine dependence varied with age, education, occupation and age of starting daily smoking. The younger respondents tended to have a lower nicotine dependence level; among

the youngest age group (≤39 years), 6.9% had high nicotine dependence. Education level was negatively associated with high nicotine dependence, which was observed in 24.4% of respondents with an education level of primary or less and 17.8% of respondents with secondary education. The unemployed respondents had the highest nicotine dependence level (28.9%). A high nicotine dependence level was observed in a higher proportion of respondents who began daily smoking at ≤18 years of age (27.1%) than those who began smoking at >18 years of age (14.7%) (table 4).

Factors associated with high nicotine dependence

A multivariate logistic regression analysis was conducted on seven factors (residence, sex, age, education level, occupation, yearly household income and age of starting daily smoking). Among these factors, age, education, occupation and age of starting daily smoking had significant effects on the nicotine dependence level, whereas the effects of residence, sex and yearly household income were not significant (table 4). Compared with the age group ≥60 years, the proportion of respondents with high nicotine dependence was lower in the age group of 15–39 years (OR=0.45). A lower nicotine dependence level was observed among people with a higher education level than among those with less education: primary or less (OR=3.07) and secondary (OR=2.62). In the occupation category, government institution staff (OR=4.02), unemployed persons (OR=3.08) and industrial workers (OR=2.46) had significantly higher nicotine dependence levels than did workers in the other occupations. Respondents who started daily smoking at ≤18 years of age had higher nicotine dependence levels than those who started daily smoking at >18 years of age (OR=2.25).

DISCUSSION

We investigated nicotine dependence among daily smokers in Zhejiang, China, and its influencing factors. The average FTND score of daily smokers was 3.1, and more than one-sixth of respondents were highly dependent on nicotine. Age, educational level, occupation and age of starting daily smoking were strongly associated with high nicotine dependence.

Nicotine addiction is the key driver of smoking. Exposure to nicotine in the form of tobacco smoking can be harmful to the nervous, respiratory, immune and cardiovascular systems and can impact human development.[15] High levels of nicotine dependence are also associated with lower quality of life, lower work productivity as well as higher healthcare utilisation.[16] The FTND scores obtained in this study are much higher than those reported in Germany and Norway (2.8)[6] but lower than that reported in a survey conducted in China in 2008 (3.49).[17] This decline may be related to the widespread implementation of tobacco control measures including the raising of taxes on tobacco and the implementation of tobacco control policies in public places. The Chinese government raised the tobacco excise tax in 2015, which led to a 7.8% decrease in annual cigarette sales.[18] In addition, most cities in Zhejiang Province have regulated smoking in public places in recent years by including them in the legislation of Civilized Behavior Promotion Regulation, and the provincial capital city of Hangzhou implemented stricter Regulations on Smoking Control in Public Places in 2019 to further restrict smoking behaviour. The reduction in nicotine dependence among daily smokers may also be related to the promotion of standardised smoking cessation clinics in Zhejiang Province in recent years, and the next step is to explore the actual intervention effects of smoking cessation clinics on the level of nicotine dependence among heavy tobacco users through a controlled study.

Aiming to optimise strategies to achieve smoking cessation among daily smokers, we analysed several sociodemographic characteristics of nicotine dependence. Results grouped by age showed that older adults were more likely to be highly dependent on nicotine, which is consistent with previous findings.[19] The main reason may be that older people have been smoking longer and are more susceptible to addictive behaviours. To a certain extent, age confers more unrealistic optimism in older people, and the harms of smoking and the benefit from

Table 3 The percentage response frequencies for each item of the Fagerström Test for Nicotine Dependence (FTND)

FTND item	Percentage of responses for each score (n=1244)			
	0	1	2	3
Item 1: how soon after you wake up do you smoke your first cigarette?	37.8	20.1	23.0	19.1
Item 2: do you find it difficult to refrain from smoking in places where it is forbidden?	77.3	22.8	–	–
Item 3: which cigarette would you hate most to give up?	64.4	35.6	–	–
Item 4: how many cigarettes per day do you smoke?	31.9	53.4	6.2	8.5
Item 5: do you smoke more frequently during the first hours after waking up than during the rest of the day?	83.4	16.6	–	–
Item 6: do you smoke when you are so ill that you are in bed most of the day?	82.7	17.3	–	–

Table 4 Factors associated with high nicotine dependence

Covariate	Percentage	Adjusted OR	95% CI	P value
Residence				
Urban	17.0	0.93	0.67 to 1.29	0.661
Rural	18.3		Reference	
Sex				
Male	17.5	1.86	0.40 to 8.61	0.428
Female	20.0		Reference	
Age (years)				
15–39	6.9	0.45	0.20 to 0.99	0.047
40–59	15.9	0.89	0.60 to 1.34	0.584
≥ 60	23.1		Reference	
Education level				
Primary or less	24.4	3.07	1.15 to 8.18	0.025
Secondary	17.8	2.62	1.03 to 6.71	0.044
High school	8.6	1.26	0.45 to 3.55	0.655
Undergraduate or above	5.6		Reference	
Occupation				
Industrial worker	25.7	2.46	1.45 to 4.15	0.001
Government institution staff	12.5	4.02	1.31 to 12.30	0.015
Business/service worker	12.6	1.68	0.95 to 2.99	0.075
Unemployed	28.9	3.08	1.56 to 6.05	0.001
Retired	16.3	1.54	0.71 to 3.32	0.271
Others	10.7		Reference	
Household yearly income (yuan)				
<50 000	23.9	1.77	0.89 to 3.51	0.104
50 000–200 000	14.0	1.37	0.70 to 2.67	0.360
>200 000	10.4		Reference	
Age of starting daily smoking (years)				
≤18	27.1	2.25	1.59 to 3.17	<0.001
>18	14.7		Reference	

quitting are often underestimated by older age groups.[20] Therefore, research into the characteristics of nicotine dependence in older people should be a priority to facilitate the development of targeted smoking cessation interventions. Moreover, the age analysis also showed that people who started daily smoking at ≤18 years of age were more likely to report high-level nicotine dependence. Studies have demonstrated that an earlier age of smoking initiation is independently associated with the formation of daily smoking habits and nicotine dependence.[21] Thus, it is critical to implement effective interventions to delay or prevent tobacco exposure in adolescence. A survey of American adolescents found that those who first used tobacco at ages younger than 13 years were significantly more likely to develop nicotine dependence.[22] The age threshold for adolescent tobacco exposure in the Chinese social context warrants further exploration,

and implementing more stringent interventions for this priority population may lead to greater public health benefits.

In general, smokers of low socioeconomic status are prone to a higher degree of nicotine dependence.[23] In this survey, we found that nicotine dependence among daily smokers was significantly negatively associated with education level. Smokers with less education may not have sufficient health knowledge or may lack awareness of nicotine-related harms and health maintenance, which could lead to lower responsiveness to public tobacco control interventions. In addition, the prevalence of nicotine dependence varied by occupation, and the highest dependence levels were observed in unemployed persons and industrial workers. This finding is in line with previous results, which attributed more flexible Chinese tobacco prices[18] to enable people of different occupations and

income levels to afford cigarettes. However, it was notable that government institution staff also showed high levels of nicotine dependence. One possible explanation is that government workers, especially at the grassroots level, suffer from high levels of daily work stress. This survey was also conducted during the COVID-19 pandemic, which may have led this population to rely more on smoking to relieve stress. Further research on the possible psychological conditions that influence smoking and nicotine dependence in the context of the COVID-19 pandemic is warranted.

Smoking is a social norm in China, where cigarette gifting and sharing are a prevalent part of Chinese customs and strongly contribute to smoking initiation. Nicotine dependence is considered to be one of the biggest barriers to successful smoking cessation. Evidence suggests that patients with higher levels of nicotine dependence are less likely to quit.[24] Having baseline information on the level of nicotine dependence and influencing factors in daily smokers can help to develop more targeted and graded cessation intervention strategies, as well as early interventions that focus on nicotine-related factors in a timely manner. An example would be to focus more targeted tobacco control measures on young males, unemployed or less educated smokers.

The strengths of this study include the sufficiently large sample size and the high representativeness resulting from the well-established sampling method. However, there were several limitations that need to be noted. First, the study is a cross-sectional survey only, which is incapable of causal inference. Second, the survey used respondent reports to provide information, which may be subject to recall bias due to social desirability. Third, nicotine dependence is relatively difficult to measure. The FTND, which we used, may also not be an accurate indicator of the extent of addiction among smokers. Future investigations into biological indicators of nicotine dependence could be considered.

CONCLUSIONS

In summary, a population-based cross-sectional survey was used to study nicotine dependence in daily smokers. The results showed that Chinese daily smokers had high nicotine dependence levels, particularly among young males, the unemployed and those with less education. Further tailored smoking cessation programmes will be developed and implemented according to the distribution of nicotine dependence and related factors.

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REFERENCES

1 Li Q, Hsia J, Yang G. Prevalence of smoking in China in 2010. *N Engl J Med* 2011;364:2469–70.
2 Chinese Center for Disease Control and Prevention. China adult tobacco survey 2018 fact sheet 2018.
3 GBD 2019 Tobacco Collaborators. Spatial, temporal, and demographic patterns in prevalence of smoking tobacco use and attributable disease burden in 204 countries and territories, 1990-2019: a systematic analysis from the global burden of disease study 2019. *Lancet* 2021;397:2337–60.
4 Meneses-Gaya ICde, Zuardi AW, Loureiro SR, *et al*. Psychometric properties of the Fagerström test for nicotine dependence. *J Bras Pneumol* 2009;35:73–82.
5 Heatherton TF, Kozlowski LT, Frecker RC, *et al*. The Fagerström test for nicotine dependence: a revision of the Fagerström tolerance questionnaire. *Br J Addict* 1991;86:1119–27.
6 Fagerström K, Furberg H. A comparison of the Fagerström test for nicotine dependence and smoking prevalence across countries. *Addiction* 2008;103:841–5.
7 Xu Y, Xu S, Wu Q, *et al*. Association between secondhand smoke exposure at home and cigarette gifting and sharing in Zhejiang, China: a repeat cross-sectional study. *BMJ Open* 2016;6:e010058.
8 Xu Y, SY X, QQ W. Analysis on factors associated with intention to quit smoking in pre-pregnancy male smokers in four cities of Zhejiang. *Chin J Health Manage* 2016;10:297–301.
9 Xu Y, SY X, QQ W. Evaluation of the effect of a tobacco control intervention for college students under the advocate-promoting model in Zhejiang Province, China. *Chin J Health Manage* 2019;13:510–5.
10 Xu Y, SY X, QQ W. Service competence evaluation of 99 smoking cessation clinics in Zhejiang Province. *Prev Med* 2020;32:1220–5.
11 Zhejiang news client. World No Tobacco Day | The adult smoking rate in Zhejiang is 21.92%, How difficult is it to quit smoking? Available: https://zj.zjol.com.cn/news.html?id=1211480 [Accessed 4 Aug 2022].
12 Department of Comprehensive Statistics of National Bureau of Statistics. *China statistical yearbook for regional economy 2019*. Beijing: China Statistics Press, 2019.
13 Fagerstrom KO, Heatherton TF, Kozlowski LT. Nicotine addiction and its assessment. *Ear Nose Throat J* 1990;69:763–5.
14 Ma Y, Wen L, Cui W, *et al*. Prevalence of cigarette smoking and nicotine dependence in men and women residing in two provinces in China. *Front Psychiatry* 2017;8:254.
15 McGrath-Morrow SA, Gorzkowski J, Groner JA, *et al*. The effects of nicotine on development. *Pediatrics* 2020;145:e20191346.
16 Schnoll RA, Goren A, Annunziata K, *et al*. The prevalence, predictors and associated health outcomes of high nicotine dependence using three measures among US smokers. *Addiction* 2013;108:1989–2000.
17 Yang T, Shiffman S, Rockett IRH, *et al*. Nicotine dependence among Chinese City dwellers: a population-based cross-sectional study. *Nicotine Tob Res* 2011;13:556–64.
18 Goodchild M, Zheng R. Early assessment of China's 2015 tobacco Tax increase. *Bull World Health Organ* 2018;96:506–12.

19 Grant BF, Shmulewitz D, Compton WM. Nicotine use and DSM-IV nicotine dependence in the United States, 2001-2002 and 2012-2013. *Am J Psychiatry* 2020;177:1082–90.

20 Yong H-H, Borland R, Siahpush M. Quitting-related beliefs, intentions, and motivations of older smokers in four countries: findings from the International tobacco control policy evaluation survey. *Addict Behav* 2005;30:777–88.

21 Põld M, Pärna K. Nicotine dependence and factors related to smoking cessation among physicians in Estonia. *Int J Environ Res Public Health* 2020;17:3217.

22 Sharapova S, Reyes-Guzman C, Singh T, *et al*. Age of tobacco use initiation and association with current use and nicotine dependence among US middle and high school students, 2014-2016. *Tob Control* 2020;29:49–54.

23 Pennanen M, Broms U, Korhonen T, *et al*. Smoking, nicotine dependence and nicotine intake by socio-economic status and marital status. *Addict Behav* 2014;39:1145–51.

24 Rojewski AM, Tanner NT, Dai L, *et al*. Tobacco dependence predicts higher lung cancer and mortality rates and lower rates of smoking cessation in the National lung screening trial. *Chest* 2018;154:110–8.