

Effects of Smoking Behavior and Cognition of Tobacco Control on Digital Entertainment and Mental Health of School-Age Children during Holidays

Long Yanghuan, PhD

Wang Qiang, Professor

Yu Zhenwei, Lecturer

Guo Yu, Assistant Professor

Liu Xiangyu, PhD

Shi Mengjie, PhD

Long Yanghuan, PhD in Design, School of Design, Jiangnan University, Wuxi, Jiangsu, China. Wang Qiang, Professor in Design, School of Design, Jiangnan University, Wuxi, Jiangsu, China. Yu Zhenwei, Lecturer in engaged in Statistics, Suzhou Institute of Technology, Jiangsu University of Science and Technology, Suzhou, Jiangsu, China. Guo Yu, Assistant Professor in Sociology and Law, Suzhou Institute of Technology, Jiangsu University of Science and Technology, Suzhou, Jiangsu, China. Liu Xiangyu, PhD in Design, School of Design, Jiangnan University, Wuxi, Jiangsu, China. Shi Mengjie, PhD in Design, School of Design, Jiangnan University, Wuxi, Jiangsu, China. Correspondence author: Wang Qiang; 13776075079@163.com

Objectives: We studied the consequences of parental domestic smoking behavior on children's digital entertainment and mental health during COVID-19, and put forward the initiative of family tobacco control to protect children's physical and mental health. **Methods:** From February 20 to February 23, 2021, using Sojump survey method, 800 smoking parents who live with children aged 6~12 answered the questionnaire online about basic information, children's digital entertainment status, strengths and difficulties (SDQ). **Results:** 60.8% of the children exposed to secondhand smoke spend more than 1 h on digital entertainment every day; abnormal detection rates of emotional symptoms, conduct problems, hyperactivity and inattention, peer interaction, pro-social behavior, and difficulty total scores are 29.2%, 38.2%, 6.5%, 80.3%, 22.0%, 40.0%, respectively. Single factor analysis suggests that there are statistical differences in the degree of impact of household monthly income and children's life under smoking parents on digital entertainment duration ($\chi^2 = 14.76, 10.88; P < 0.01$). Binary logistic regression analysis reveals that more than 1 hour of digital entertainment per day is an important factor that triggers school-age children's emotional symptoms, peer interactions, difficulties and high risks ($OR = 1.68, 1.89, 1.65; P < 0.05$). **Conclusions:** The greater the impact of parents' smoking on children's life, the higher the proportion of children's excessive digital entertainment. The excessive digital entertainment will bring many mental health hazards to children. In particular, the children long endurance to secondhand smoke are more possibly to have adverse reactions like emotional symptoms, misconduct issues,

hyperactivity and inattention.

Key words: Smoking; tobacco control; school-age children; digital entertainment

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INTRODUCTION

China is the worldwide largest tobacco producer and consumer. According to China adult tobacco survey in 2018, the adult smokers (>15 years) reached 308 million, with a smoking rate of 26.6%. There are 269 million smokers every day, with the current smoking rate of 23.3%. Although some smokers tried to quit smoking in the past year, 90.1% of the smokers did not take any measures or actions ¹. The resultant secondhand smoke is a severe public health threat, as 50.9% adults working indoors (217 million) exposed to secondhand smoke, and even higher number of 515 million at home ¹. During the holidays, especially during the COVID-19 outbreak, school-age children spend significantly more time at home due to the control policy of outdoor activities. Although China has implemented restrictions on smoking in public places, parents are free to smoke at home, which inevitably leads to children suffering from secondhand smoke.

Parents' smoking behavior affects children in many ways. In terms of behavior, children will observe and imitate their parents' behavior, and the potential risk of children becoming smokers in the future will be increased ². In terms of family relations, children in families with parent-child conflicts will also be more likely to smoke ³. On the contrary, parents' active participation in smoking ban helps prevent teenagers from smoking ⁴. Enhancing parents' knowledge of the complex consequences of smoking, including the impact on children's health, will help strengthen their confidence in quitting smoking. However, we can't overestimate parents' actual smoking control effect, as there is a huge contrast between smoking parents' positive attitudes and passive behaviors on banning smoking in the family. A study shows that more than 80% of parents agree to ban smoking at home, but in fact only about 26%

of parents completely restrict smoking at home ⁵. Parents' smoking has direct influence on children. Even with good family management, parents smoking will lead to children's smoking in the future. Therefore, it is very important for parents to lessen smoking or even quit. In terms of health hazards, children exposed to secondhand smoke may cause diseases including respiratory diseases, middle ear infections, allergic diseases and asthma ⁶. Therefore, some studies have pointed out that the implementation of smoke banning legislation has great benefits for reducing the prevalence of secondhand smoke induced diseases. Before the legislation, the prevalence of secondhand smoke induced diseases in families was 9.7%, but after the legislation, the proportion decreased by 47.4% ⁷, indicating that the legal force has a significant effect on protecting the health of children and their families.

It is worth noting that the increase in home time will incur changes in children's lifestyles (such as digital entertainment, sleep conditions, exercise, etc.). The primary school age is an important stage for the continuous development of children's cognitive abilities, language skills, physical functions, and social emotions. Digital entertainment refers to a series of entertainment activities based on digital technology and equipment (such as televisions, computers, tablets, game consoles, and mobile phones), including animation, cartoons, and online games ⁸. With the continuous development of modern technology, digital entertainment equipment is widely popularized among children ⁹. More and more studies have shown that excessive use of digital entertainment equipment can increase children's health risks, possibly cause mental health problems such as anxiety, depression ¹⁰.

Generally speaking, previous studies focused on the influence of parents' smoking on children's health and the influence of digital

entertainment on children's health, while ignoring the comprehensive impact of household smoking on children's digital entertainment and mental health of school-age children during the COVID-19, which is the aim of this paper. This study can encourage family members to change their smoking behavior, help create a smoke-free family environment, and help the government to formulate tobacco control policies to protect children.

METHODS

Objects

From February 20 to February 23, 2021, an online survey was carried out using Sojump platform. The research team members posted the survey link and QR code to social platforms such as WeChat group, moments, and selected school-age children and parents in Jiangsu and non-Jiangsu areas as the research objects. Inclusion criteria: ① Voluntarily participate in the survey; ② Children's age is 6~12 years old; ③ At least one smoking parent; ④ No less than 6 hours of parenting time during the daytime of during the investigation period. Exclusion criteria: ① Fail to complete the questionnaire as required; ② Children diagnosed with autism and ADHD. A total of 813 questionnaires were collected, including 800 valid questionnaires (98.4%). Where, in the past month, 23.1% have two smoking parents, and 76.9% have only one smoking parents. Age distribution of school-age children: 257 were aged 6~8, 185 were aged 8~10, and 358 were aged 10~12. 123 (15.4%) believe that smoking parents have great impact on their lives. Before filling the questionnaire, the participants were informed of the purpose of the study and offered informed consent.

Method

Basic information survey form

On the basis of literature review, the researcher designed a basic information questionnaire form, including the school-age children's age, gender, place of residence,

myopia or not, main caregivers, education level of the parents, the number of children in the family, and household monthly income, parents' willingness to quit smoking, the number of smoking parents, and the influence of parents smoking on their children's life, etc.

Status of digital entertainment

Parents filled in the average daily time that children spent on digital entertainment from January 18 to February 18, 2021. Digital entertainment duration is divided into 6 levels: 0~30min/d, 30min~1h/d, 1~2h/d, 2~3h/d, 3~4h/d, >4h/d. Digital entertainment carriers on which school-age children spent the most time was ranked, including mobile phones, TVs, computers, tablets, and game consoles. Digital entertainment content on which school-age children spent the most time was ranked, including cartoons, online games, film and television works, online literature, short videos, online music, and social communication. The amount of digital entertainment consumption of school-age children in one month was divided into four levels: 0~10yuan/m, 10~50yuan/m, 50~100yuan/m, >100yuan/m. According to the standards of the American Academy of Pediatrics, the use of digital entertainment equipment for more than 1h/d is defined as excessive use¹¹.

Strengths and difficulties questionnaire (SDQ) (parent version)

The questionnaire was developed by American psychologist G Robert in 1997 to assess the social and mental health of children¹². In 2005, domestic scholar Kou Jianhua et al. carried out the Sinicization revision for the parents of children aged 3~17, and developed a norm for the Shanghai area¹³. The questionnaire contains a total of 25 items, which are divided into five dimensions: emotional symptoms, conduct problems, hyperactivity and inattention, peer interaction, and pro-social behavior. The scores of the first 4 dimensions are added to calculate the total difficulty score, which reflects

negative emotions and behaviors, while the pro-social behavior dimension reflects positive behaviors. A 3-level scoring method was used (0 point means non-conformity, 1 point means somewhat conformity, and 2 points mean complete conformity). Except for the pro-social behavior dimension, higher scores in other dimensions indicate a higher risk of emotional and behavioral problems. According to previous studies, the scores of each factor are classified into normal and high-risk (including borderline abnormalities). The questionnaire has good reliability and validity, with Cronbach's α coefficient of 0.752¹³.

Quality control

This survey implemented an online questionnaire. The same IP address can only be answered once, and all entries can be submitted after completion. Questionnaires that take less than 90 seconds to fill out, that are obviously filled in incorrectly, or that are filled out regularly will be eliminated to control the data quality.

Statistical Processing

After exporting all data, SPSS21.0 was used for statistical analysis. Measurement data were expressed as mean $\pm$ standard deviation, and count data were expressed as frequency (n) and percentage (%). Considering that the data type studied in this paper is the difference between categorical data, the method of chi-square test was used for processing. The binary logistic

regression method was used to analyze the factors influencing school-age children's mental health. $P < 0.05$ is considered as statistically significant.

RESULTS

The Status Quo of Digital Entertainment among School-Age Children from Smoking Families and Single Factor Analysis

The top 3 digital entertainments for school-age children from smoking families during holidays are mobile phones (54.4%), TVs (15.1%), and computers (10.6%). The top 3 digital entertainment contents that consume the longest time are animation cartoons (37.5%), online games (18.4%), and film and television works (15.8%). 60.8% school-age children spend more than 1 h on digital entertainment, 30.8% spend more than 2 h, 10.8% spend 4 h and more. 30.9% school-age children spend less than 10 yuan on digital entertainment, 24.8% spend 10 to 50 yuan, 22.8% spend 50 to 100 yuan, and 21.6% spend more than 100 yuan.

The difference of digital entertainment duration during school-age children holidays is statistically significant ($P < 0.05$) regarding the influence of parents smoking at home on their children and family economic situation. School-age children believing parents smoking at home has great influence on their children and those with household monthly income of more than 2,000 yuan have higher possibility of excessive digital entertainment. See Table 1.

Table 1
Comparison of Digital Entertainment duration of School-Age Children from Smoking Families

Variable	N (%)	Digital entertainment duration n (%)		χ^2	P
		0-1h/day	>1h/day		
Child gender	Male	465(58.1%)	190(40.9%)	1.207	0.272
	Female	335(41.9%)	211(63.0%)		
Child age	6 to 8 years old	257(32.1%)	110(42.8%)	2.424	0.298
	8 to 10 years old	185(23.1%)	73(39.5%)		
	10 to 12 years old	358(44.8%)	131(36.6%)		
Place of Residence	City	505(63.1%)	188(37.2%)	2.349	0.125
	Village	295(36.9%)	126(42.7%)		
child's main caregiver	Father	531(66.4%)	218(41.1%)	3.534	0.316
	Mother	153(19.1%)	59(38.6%)		
	Elderly	69(8.6%)	23(33.3%)		
	Others	47(5.9%)	14(29.8%)		
Father's education level	Junior college and below	534(66.8%)	218(40.8%)	1.669	0.196
	College and above	266(33.3%)	96(36.1%)		
Mother's education level	Junior college and below	544(68.0%)	222(40.8%)	1.732	0.188
	College and above	256(32.0%)	92(35.9%)		
Household monthly income	below 2,000 yuan	72(9.0%)	41(56.9%)	14.76	0.001**
	2000 yuan to 5000 yuan	292(36.5%)	123(42.1%)		
	Above 5000 yuan	436(54.5%)	150(34.4%)		
Number of children in the family	1	413(51.6%)	156(37.8%)	0.782	0.377
	2 or more	387(48.4%)	158(40.8%)		
Parents' willingness to quit smoking	Yes	455(56.9%)	171(37.6%)	1.23	0.267
	No	345(43.1%)	143(41.4%)		
Two smoking parents	Yes	185(23.1%)	79(42.7%)	1.203	0.273
	No	615(76.9%)	235(38.2%)		
The impact of household smoking on children	not at all	160(20.0%)	81(50.6%)	10.879	0.004**
	Slightly affected	517(64.6%)	189(36.6%)		
	Greatly affected	123(15.4%)	44(35.8%)		

Note: *P < 0.05, **P < 0.01, the same below

Current Status of the Mental Health of School-Age Children from Smoking Families and Single Factor Analysis

40.0% have abnormal difficulty total score, 17.4% are in marginal state. Where, dimension with the highest abnormal detection rate is peer interaction (80.4%), followed by conduct problems (38.2%) and emotional status (29.2%), as shown in Table 2.

Table 2
Abnormal Detection Rate of SDQ Dimensions in School-Age Children from Smoking Families
[n (%)]

Dimension	Normal	Edge	Abnormal
Emotional status	454(56.8)	112(14.0)	234(29.2)
Conduct problem	401(50.1)	93(11.6)	306(38.2)
Hyperactivity	651(81.4)	97(12.1)	52(6.5)
Peer interaction	74(9.2)	83(10.4)	643(80.4)
Pro-social behavior	441(55.1)	183(22.9)	176(22.0)
Total difficulty score	341(42.6)	139(17.4)	320(40.0)

There are statistical differences between the normal and high-risk detection rates of the total difficulty score factor in terms of child age, the main caregiver, household monthly income, the statistics of smoking parents, the influence of parents smoking on their children, and digital entertainment duration ($P < 0.05$).

Logistic Regression Analysis of the Mental Health of School-Age Children from Smoking Families

The variables with statistical differences in univariate analysis are used as independent variables, and SDQ factors are used as dependent

variables (normal=0, high risk=1) to perform logistic regression analysis. The independent variables are assigned with values as follows, monthly income: <2000 yuan=0, 2000~5000 yuan=1, >5000 yuan=2; the impact of smoking on children at home: no impact=0, a little impact=1, great impact=2; age: 6~8 years old = 0, 8~10 years old = 1, 10~12 years old = 2; main caregivers: father = 0, mother = 1, elderly = 2, others = 3; two smoking parents: no=0, yes=1; digital entertainment duration 0 ~ 1h/d=0, >1h/d=1. The main results suggest that excessive digital entertainment is a high risk factor for school-age children to develop emotion, peer interaction difficulties, as shown in Table 3.

Table 3
The Analysis of Logistic Regression on High Risk in the Mental Health of School-Age Children from Smoking Families

Variable		B	S.E	Wals χ^2	P	OR(95%CI)
emotion	Monthly income	-0.19	0.134	2.008	0.156	0.827
	Impact of smoking parents	0.17	0.148	1.319	0.251	1.185
	Age	-0.111	0.1	1.214	0.270	0.895
	Main caregiver	0.273	0.098	7.687	0.006**	1.313
	Two smoking parents	-1.54	0.204	56.935	0.000**	0.214
	Digital entertainment duration	0.516	0.185	7.792	0.005**	1.675
conduct	Monthly income	-0.144	0.132	1.192	0.275	0.866
	Impact of smoking parents	0.296	0.151	3.848	0.050	1.344
	Age	-0.145	0.098	2.173	0.140	0.865
	Main caregiver	0.433	0.098	19.684	0.000**	1.543
	Two smoking parents	-2.228	0.24	85.979	0.000**	0.108
	Digital entertainment duration	0.227	0.18	1.597	0.206	1.255
Hyperactivity	Monthly income	-0.178	0.226	0.619	0.431	0.837
	Impact of smoking parents	0.336	0.229	2.157	0.142	1.4
	Age	0.083	0.176	0.225	0.636	1.087
	Main caregiver	0.076	0.16	0.223	0.637	1.078
	Two smoking parents	-1.169	0.307	14.457	0.000**	0.311
	Digital entertainment duration	0.255	0.314	0.661	0.416	1.291
Peer interaction	Monthly income	0.73	0.18	16.497	0.000**	2.075
	Impact of smoking parents	0.527	0.212	6.166	0.013*	1.695
	Age	0.15	0.145	1.071	0.301	1.162
	Main caregiver	0.102	0.15	0.463	0.496	1.107
	Two smoking parents	-0.046	0.304	0.022	0.881	0.956
	Digital entertainment duration	0.635	0.26	5.941	0.015*	1.887
Pro-social behavior	Monthly income	0.051	0.223	0.053	0.818	1.053
	Impact of smoking parents	-0.309	0.205	2.263	0.133	0.734
	Age	0.108	0.179	0.363	0.547	1.114
	Main caregiver	-0.23	0.152	2.291	0.130	0.794
	Two smoking parents	0.562	0.308	3.339	0.068	1.754
	Digital entertainment duration	-0.55	0.321	2.945	0.086	0.577
Total Difficulty Score	Monthly income	-0.053	0.134	0.156	0.693	0.948
	Impact of smoking parents	0.296	0.157	3.553	0.059	1.344
	Age	-0.128	0.1	1.662	0.197	0.879
	Main caregiver	0.398	0.104	14.617	0.000**	1.488
	Two smoking parents	-2.143	0.243	77.727	0.000**	0.117
	Digital entertainment duration	0.502	0.183	7.515	0.006**	1.653

DISCUSSION

Digital Entertainment for School-Age Children at Holiday in Smoking Families

The results of this study show that mobile phones are the most frequently used digital entertainment tool for children, and cartoons are their favorite entertainment content. 60.8% children have digital entertainment duration > 1 hour. The proportion of digital entertainment duration > 1 hour in this study is less than the 74% reported in Australia abroad¹⁴. This may be related to the fact that this study excludes the time that children spend on digital media for learning. It is worth noting that most children's digital entertainment duration is still higher than one hour per day recommended by the American Academy of Pediatrics¹¹.

This research shows statistical differences in digital entertainment duration regarding family economic situation. When the household monthly income is less than 2,000 yuan, people have less excessive digital entertainment than moderate digital entertainment. When the monthly income exceeds 2,000 yuan, the number with excessive digital entertainment rises rapidly. When it reaches more than 5,000 yuan, the number of people with excessive digital entertainment is even twice the number of people with moderate digital entertainment. There may be two reasons for this. First, low-income households have less digital entertainment equipment than middle- and high-income households, so relatively low proportion of children have excessive digital entertainment. Another reason may be that the parents of middle- and high-income families still need to work during holidays, having less time to accompany their children and thus indulging children's use of digital entertainment products to a certain extent.

What's more, we find that the consequences of parental smoking on kids' lives also has statistical differences in digital entertainment time. In other words, the greater the impact of parents' smoking on children's lives, the higher the proportion of children's excessive digital entertainment. There may be two reasons. First, parents' smoking addiction will easily induce an

increase in the possibility of children's game addiction. From a psychological point of view, addictive behavior is a response to the dysfunction of the whole family system, which will lead to a vicious circle of addictive behavior, and children will copy and imitate their parents' addictive behavior patterns¹⁵. Parents' smoking addiction will have some acquiescence to children's game addiction behavior. Meanwhile, parents' smoking could have negative influence on family relations, which leads to the decrease of parent-child interaction and emotional ties, making children more addicted to digital virtual world. Second, the games in children's digital entertainment are often competitive, or imply a setting similar to gambling mechanism. A study on the relationship between parents' long-term smoking at home and children's gambling behavior found that compared with children who have never been exposed to secondhand smoke, children living with secondhand smoke in a long term increased their probability of evolving in gambling by 18% at the age of 12¹⁶. That is to say, the higher the exposure to smoking in the early age of children, the greater the children's participation in gambling activities. This conclusion also explains to some extent that children growing up in secondhand smoke environment are more likely to indulge in digital games. Based on the above findings, it is necessary to pay more attention to school-age children in families where secondhand smoke is serious.

The Mental Health Status of School-Age Children and Its Influencing Factors in Smoking Families

The results of this study show that school-age children have a higher rate of abnormal peer interaction and conduct problems. Except hyperactivity, the abnormal detection rate of other SDQ factors is higher than that under normal life. Where, peer interaction has the highest abnormal proportion of 80.3%. During the epidemic, school-age children exhibit more emotional and behavioral problems, which may be related to the increase of children's home time

and less time out for activities during this period. Although the implementation of restriction policy during the normalized epidemic prevention and control period is not very strict, children still choose to go out less due to concerns about the epidemic, which reduces their opportunities to interact with friends and affect their mental health.

Logistic regression analysis found that excessive digital entertainment is an important factor affecting school-age children's psychological problems. This study found that school-age children with more than 1 h digital entertainment per day are at higher risk of emotional and behavioral problems. A study in Australia also showed that school-age children who overuse television, computer, and video games will suffer from poor mental state and a series of behavioral problems¹⁷.

It is important to inform that this study found that children with two smoking parents are at higher risk of emotional symptoms, behavior problems, hyperactivity and inattention. Tobacco smoke exposure will lead to the whole household pollution of secondhand and thirdhand smoke, and children will absorb this pollution¹⁸, thus affecting their health and causing serious psychological crisis. A study on the correlation between secondhand smoke and mental disorder in American children based on biological research method shows that major depressive disorder, generalized anxiety disorder, attention-deficient/hyperactivity disorder, and conductive disorder are positively correlated with children's exposure to secondhand smoke¹⁹. In this study, the second-hand smoke exposure of non-smokers was measured by serum cotinine level, and the conclusion is in good agreement with ours. Moreover, his research further pointed out that compared with boys, girls are less likely to have major depressive disorder and conduct disorder. Another British study also confirmed that secondhand smoke exposure is related to children's poor mental health. In the study, 910 non-smoking children were tested with salivary cotinine level and self-report. Furthermore, the strengths and differences questionnaire (SDQ)

was used to evaluate their Psychological distress. It was found that there is a statistical significance between hyperactivity & conductive disorder and the exposure to secondhand smoke²⁰. The survey results support our research conclusion. In addition, this study also points out that children with higher exposure to second-hand smoke often live in areas with poor economic conditions. Compared with those in public places, children aged 8 to 12 who live in second-hand smoke in their family are associated with SDQ scores, which means that second-hand smoke in poor families will cause greater harm to children's mental health. However, we can't ignore the influence of genetic factors on children's mental health. Psychological diseases caused by adult smoking are often associated with childhood behavioral disorders^{21,22}. This genetic tendency is inherited by the offspring of smoking parents, and the genetic vulnerability may also affect children's mental health.

This study has certain limitations. First, although research has found correlation between children's digital entertainment duration in smoking families and mental health, the causal mechanism between the two cannot be determined. Second, the questionnaire was filled out by parents, and there may be deviations between cognition and facts for smoking parents who may suffer from common mental disorders such as depression²³. Finally, this study is based on random sampling, and the representativeness of the research objects is subject to certain restrictions.

CONCLUSION

To sum up, during the COVID-19 outbreak, the families where smoking parents have a greater impact on the lives of school-age children have a higher proportion of children who are over-engaged in digital entertainment. This is related to the bad demonstration brought by parents' smoking addiction, and children's vulnerability to digital entertainment addiction. Moreover, children long exposed to secondhand smoke are likely to form gambling psychology, thus stimulating them to participate in

competitive digital games. Excessive digital entertainment will bring harm to children's mental health, especially children long exposed to secondhand smoke will be more prone to adverse reactions such as emotional symptoms, conduct problems, hyperactivity and inattention. This may be caused by parenting crisis caused by parents' smoking behavior, or potential genetic factors, which needs further research. This study provides more reasons to promote tobacco control at home, so as to avoid children's physical and psychological health risks caused by tobacco exposure.

Author Declaration

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