Association of Environment and Occupations Factors With Semen Quality in Male Partners of Couples Trying to Conceive

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Research Article

Keywords: semen quality, male fertility, occupational factors, environmental factors, TTP

Posted Date: March 2nd, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1391533/v1

Abstract

Background: Sperm quality can be easily influenced by environment and occupations factors. Yet, due to complexity and diversity of factors we are facing in everyday life, there are difficulties in collecting patients' information in the outpatient department, which factors might influence sperm quality then lengthen TTP remain largely unexplored. This study aimed to discover potential semen quality related environment as well as occupation factors, and assist clinical decision making.

Methods: A total of 465 men were recruited from the pre-pregnancy consultation clinic in Guangzhou Women and Children's Medical Center between June 2020 to July 2021, which were aged 31-43 years, and we have collected their semen analysis results. Environment and occupation information was collected by questionnaires. Logistic regression was applied to evaluate the association of semen quality with environment and occupation factors.

Result: We found that living close to (<2km) high voltage line (283.4×106/ml vs 219.8×106/ml, P=0.030) and large substation (309.1×106/ml vs 222.4×106/ml, P=0.015) will influence sperm count. Experienced decoration in the past 6 months was also a significant factor to sperm count (194.2×106/ml vs 261.0×106/ml, P=0.025). Living close to (<2km) chemical plant will affect semen PH (7.5 vs 7.2, P=0.001). Domicile close to (<2km) a power distribution room will affect progressive sperm motility (37.2% vs 33.3%, P=0.030). Using computers will affect both progressive motility sperm (35.9% vs 37.6% vs 35.9% vs 28.6%, P=0.047) and sperm total motility (58.5% vs 56.5% vs 56.0% vs 41.0%, P=0.009).

Conclusion: Our result suggested that some of the environment and occupation factors: computer using, living and working surroundings (voltage line, substation and chemical plants, transformer room), and housing decoration may association with low semen quality. But no association we found of TTP with environment and occupation factors.

1. Introduction

As the problem of aging and birth rates falling arose worldwide, infertility has drawn more and more attention. Infertility is a disease defined as fail to conceive after 12 months of regular and unprotected sexual intercourse. In recently decades, affect by multiple negative factors, the infertility rate was significantly increase worldwide, which is about 12%-20%.[1] The infertility rate in China is about 12.5%, and is also in an increase. In up to 40% of the infertility couples, men have to be responsible for the inability to conceive.[2]

Causes of male infertility are vast. Except for the irreversible reasons (such as genetic), and the organic diseases like varicocele, we should also pay attention to people's daily factors. For example, occupations and environment, which may not be so influential as organic disorder and genopathy to male fertility, yet these factors are easy to be neglected. But for most of people, they tend to maintain only one or several similar occupations and seldom change their living environment, this may lead to the potential infertility related factors of environment and occupations influence people's fertility for their entire life. Furthermore, manifold factors can affect together as an additive effect, may result in an infertility phenotype even more serious than organic disorder. thus, in addition to clinical diagnosis or medical research on male infertility, attention also should be paid on the influence of occupations and environment factors on male fertility.

A mass of researches have been conducted about effect of occupations and environment factors on male fecundity, a study about occupations and semen quality indicated that sperm of the people in the transportation business have the lowest motility.[3] Another research had pointed out that occupations like famer, workers in printing factories and oil workers that close to toxic chemicals are related to poor male fertility.[4] Although many researches are supporting the view that occupations are relevant to semen quality, some articles have different standpoint, they drew a conclusion that occupation had no significant relation to semen quality.[5] This kind of discrepancy may due to variety of occupations and population differences, thus, more explorations are need.

Environmental factors are also related to male fertility and plenty of relevant researches had been conducted, including cellular telephones, computers, and television exposure, noise, toxic substance as well as home decorating. A meta-analysis conducted by J. A. Adams had shown that cellular telephones using may negative correlation with sperm motility but have no relationship with sperm concentration.[6] Seung-Ah Choe held a single fertility center cohort study which indicated that environmental noise will result in the low motility and abnormality of sperm. Another environmental factor, which is houses decorating is also potentially affect male infertility. Decoration will mainly three toxic substances correlate with semen quality: benzene, formaldehyde and ammonia. And these kinds of toxins are still existed after the decoration. Researches had shown that these substances are highly relevant to male infertility.[7–9]

TTP (Time-to-pregnancy), defined as the waiting time from couples stopped using contraceptives until conception. This is one of the essential indicators that reflect fecundability, and TTP had been already applied to evaluate the fertility in many researches. A study conducted in Africa discussed about if lifestyle factors had impacts on TTP, they found out that chewing khat may contributed to longer TTP.[10] Another study revealed the relationship between exposure to phthalates and TTP, based on a cohort study, they drew a conclusion that exposure to monomethyl phthalate would responsible for the longer TTP through damaged female fertility.[11]

Herein, based on our fertility cohort, more than 465 couples were enrolled to this research during June 2020 to July 2021. We had collected couples' essential information as well as occupation and environment expose questionnaires. In addition, we had finished these couples' pregnancy follow-up visits. This study intends to explore which occupation and environment factors related to low semen quality and understood the effect of the semen quality on the TTP.

2. Materials And Methods

2.1 Study population

We enrolled couples form pre-pregnancy consultation clinic of Guangzhou Women and Children's Medical Center in China, Guangzhou. They were invited to take part in a prospective cohort which focus on if lifestyles and environment factor influence fertility. Herein, after normalize female partners' confounding factors and excluded male partners who had a medical history of systemic diseases and infertility related disease (including varicocele, cryptorchidism, and azoospermia, etc.) totally 465 couples were included in this study between June 2020 to July 2021. Male partners aged 31 to 43, all of them have completed three questionnaires which were about environment, occupation, and basis information about demographic, respectively. All couples were of East Asian population.

2.2 Physical examination and Semen analysis

Physical examination and semen analysis was performed on the same day. Every participant's BMI would be recorded, testicles and scrotums were also examined to exclude patients of varicocele or other abnormal of reproductive organ.

We required our participants abstain from sex for three to seven days before the semen analysis and physical examination. Semen samples were collected in a sterile semen container by masturbation and placed in a 37°C incubator for 30 minutes to liquefy. After the liquefaction, semen analysis was performed by computer aid sperm analysis (CASA, SuiJia Software, Beijing, China) to evaluate semen PH, Semen volume, sperm concentration, sperm count, sperm progressive motility, total motility. All our operations and reference values of semen parameters were according to the newest guidelines of the World Health Organization (WHO)[12].

Our laboratory conducted quality control regularly to ensure the quality of the semen analysis results.

2.3 Environment and occupation questionnaires

According to the living and working habits of people in China, we design two individual questionnaires to access participants' environment and occupation exposure. We also designed elaborate questions for the low semen quality-related factors which were reported before, such as painters[13], drivers[14], and office staff[15]. We had also designed a few more question for the basis demographic characteristic. Our questionnaires would be performed as choice questions.

2.4 Ethics statement

The study was approved by the Ethics Review Committee of the Guangzhou Women and Children's Medical Center. Written informed consent was obtained from each participant.

2.5 Statistical analysis

Shapiro-Wilk test was applied to assessed the normality of the data. All the semen quality parameters did not conform to the normality except progressive motility (%). Data are presented as mean ± standard deviation. The relationship between semen quality parameters and environment and occupation factors were evaluated. Mann-Whitney U-test and Kruskal-Wallis H test for the skewed variables data and ANOVA for the normally distributed data.

To further explore the association between semen quality and environment and occupation factors. Binomial logistic regression was applied to the detect the independent predictors which were significantly affect semen quality, confounders were adjusted for the analysis: education, BMI, smoking, alcohol consuming and age. Relationship between TTP and semen quality-related environment and occupation factors was also performed by multinomial logistic regression, and confounders were also been adjusted. All P-value of less than 0.05 was taken to indicate statistical significance. Statistical analyses were performed using SPSS version 26.0 (SPSS Inc., Chicago, IL, USA).

3. Result

3.1. Characteristics of study population

As we shown in Table 1, there were totally 465 males of reproductive age enrolled in this study, the mean age and Body Mass Index (BMI) was 37.5 ± 5.7 and 23.85 ± 4.42, respectively. Every participant has a stable job and willing to accept our follow-up service. There were about 20.9% and 8.8% of our population are current alcohol consumers and smokers, respectively. Our study had included people of every degree of education.

Table 1
General characteristics of the study population(n = 465)

Variables	N (%) or Mean ± SD
Age, years	**37.5 ± 5.7**
Education, n (%)	
Primary school and below	**11(2.4)**
Junior high school	**90(19.4)**
High school	**140(30.1)**
College or university degree	**215(46.2)**
A master's degree	**7(1.5)**
N/A	**2(0.4)**
BMI, kg/m^2	**23.85 ± 4.42**
Alcohol consumers	
Yes, n (%)	**97(20.9)**
No, n (%)	**368(79.1)**
Smoker	
Yes, n (%)	**41(8.8)**
No, n (%)	**424(91.2)**

3.2. Semen quality

According to our current study, semen PH was 7.4±0.2, semen volume was 4.2±2.1ml, sperm concentration was 81.0±72.7·10^6/mL, sperm count was 344.1±412.9·10^6/mL, progressive motility sperm was 35.4±16.8%, total motility was 54.4±21.2% (Table 2).

Table 2

Summary of semen parameters of males

Variables	Mean±SD
pH value, Mean±SD	**7.4±0.2**
Semen volume(ml), Mean±SD	**4.2±2.1**
Sperm concentration (10^6 ml^{-1}), Mean±SD	**81.0±72.7**
Sperm count (10^6 ml^{-1}), Mean±SD	**344.1±412.9**
Sperm progressive motility (%), Mean±SD	**35.4±16.8**
Total motility (%), Mean±SD	**54.4±21.2**

3.3. Correlation between environment and occupation factors and semen quality

As we mentioned above, all semen parameters did not fit the normal distribution except progressive motility (%). Mann-Whitney U-test and Kruskal-Wallis H test were applied for the skewness distribution semen parameters data analysis. ANOVA was applied for the normal distribution semen parameters data. Our result suggested that male who lived within two kilometers of a high voltage line (283.4×10^6/mL vs. 219.8×10^6/mL; P = 0.030) or a substation (309.1×10^6/mL vs. 222.4×10^6/mL; P = 0.015) would increase the sperm count (10^6/mL). However, when there were power distribution room located within two kilometers from our participants' residences, their sperm progressive motility (%) were significant decrease (37.2% vs. 33.3%; P = 0.030). Living close to a chemical factory was another factor affecting semen quality, but in terms of our data in this research, although the semen PH was significantly increased (7.5 vs. 7.2; P = 0.001), but according to WHO's guideline, PH value above 7.2 and less than 7.8 is normal to a health man. Therefore, whether living close to a chemical factory is a negative factor to human semen quality, still need more researches to explore. Decoration materials' reproduction toxicity had got a lot of attention. Our research found out that if one's house undergone decoration within a half year, his sperm count would decrease (194.2×10^6 vs. 261.0×10^6; P = 0.025). Another factor which had drawn much attention in recent years was computers using. We had observed a decline of sperm progressive motility (within an hour: 35.9% vs. one to four hours: 37.6% vs. five to eight hours: 35.9% vs. more than 8 hours: 28.6%; P = 0.047) and sperm total motility (within an hour: 58.5% vs. one to four hours: 56.5% vs. five to eight hours: 56.0% vs. more than 8 hours: 41.0%; P = 0.009) in our participants who attach to computers every day (Table 3).

Table 3

Description of semen parameters in different residential environments and occupational exposures

Characteristic	N	pH value	Semen volume(ml)	Sperm concentration(10^6/ml)	Sperm count (10^6/ml)	Total motility (%)	Progressive motility (%)
High voltage line (within 2 km)							
Yes	207	7.5(7.2–7.6)	4.1(3.0-5.6)	64.9(37.9-103.7)	283.4(140.4–492.0)[a]	55.0(39.0-70.8)	36.0 ± 16.6
No	258	7.5(7.2–7.6)	4.0(2.5–5.3)	63.6(38.2-107.8)	219.8(102.2-435.4)	55.0(41.0–69.0)	34.6 ± 17.4
Large substation (within 2 km)							
Yes	124	7.5(7.2–7.5)	4.1(3.0–6.0)	66.1(38.3-108.7)	309.1(145.3–511.0)[a]	57.0(39.0–71.0)	36.6 ± 17.2
No	341	7.5(7.2–7.6)	4.0(2.5–5.4)	63.6(37.4-103.6)	222.4(119.9-423.4)	55.0(40.3–68.0)	34.7 ± 17.0
power distribution room(within 2 km)							
Yes	231	7.5(7.2–7.6)	4.1(3.0-5.6)	62.2(33.1–100.0)	256.4(127.8-497.8)	55.0(40.3–71.0)	37.2 ± 16.3[a]
No	234	7.4(7.2–7.6)	3.9(2.5–5.4)	64.2(41.0-108.2)	233.6(121.8-419.4)	55.0(37.5–68.0)	33.3 ± 17.5
A radio and television transmission tower (within 2 km)							
Yes	59	7.5(7.2–7.7)	3.5(2.5-6.0)	60.8(24.7–93.5)	234.7(97.9-537.2)	58.0(41.0–74.0)	35.7 ± 18.2
No	406	7.5(7.2–7.6)	4.0(3.0-5.5)	64.2(40.3–108.0)	254.4(127.8-457.6)	55.0(39.5–69.0)	35.1 ± 16.9
cell phone base station(within 2 km)							
Yes	138	7.4(7.2–7.5)	4.0(2.4-5.0)	53.7(29.2–99.8)	228.9(99.3-455.9)	55.0(41.0–68.0)	36.3 ± 16.4
No	327	7.5(7.2–7.6)	4.0(3.0-5.5)	65.6(40.0-108.0)	254.4(132.7-459.6)	55.0(36.0–70.0)	34.7 ± 17.3
Chemical plant(within 2 km)							
Yes	71	7.5(7.375-7.5)a	3.7(2.8-6.0)	63.4(35.5–126.0)	287.8(104.4–563.0)	57.0(41.8–72.0)	35.7 ± 18.9
No	394	7.2(7.2–7.4)	4.0(2.8–5.4)	64.0(38.0-103.6)	231.9(127.6–442.0)	55.0(39.0–69.0)	35.1 ± 16.7
Traffic artery(within 2 km)							
Yes	325	7.5(7.2–7.6)	4.0(2.9–5.4)	63.6(35.0-100.9)	224.6(120.6-463.7)	54.0(37.8–69.0)	34.9 ± 16.9
No	140	7.5(7.2–7.7)	4.1(2.8–5.5)	64.1(43.2-116.9)	263.4(145.4-437.4)	59.0(45.0-72.3)	36.1 ± 17.4
Drinking water							
Tap water	372	7.5(7.2–7.6)	4.0(2.8–5.5)	64.2(37.8-108.2)	262.3(128.3-474.9)	57.0(40.0–69.0)	34.4 ± 17.0
Bottled water	64	7.5(7.2–7.7)[a]	3.8(2.1–4.4)	65.1(49.8–91.8)	206.0(110.6–344.0)	52.0(40.0–67.0)	40.5 ± 17.4
spring water	6	7.6(7.4–7.8)	4.6(4.1–4.8)	25.1(13.0-33.7)	90.3(47.3-150.8)	39.0(31.5–41.5)	24.8 ± 7.3
Other	23	7.4(7.2–7.5)[a]	5.0(3.9–6.5)	56.5(42.8–93.8)	338.8(156.2-667.9)	59.0(48.0–75.0)	38.5 ± 16.0
buy a new car(within six months)							
Yes	54	7.5(7.2–7.6)	3.8(2.5–5.4)	78.9(51.7-137.5)	261.0(116.3-662.3)	55.0(41.5–66.5)	33.4 ± 17.0

The value of pH value、semen volume、sperm concentration、sperm count、total motility represent median (25th, 75th percentiles) ; the value of progressive motility represents the median and standard deviation.

Characteristic	N	pH value	Semen volume(ml)	Sperm concentration(10^6/ml)	Sperm count (10^6/ml)	Total motility (%)	Progressive motility (%)
No	411	7.5(7.2–7.6)	4.0(2.8–5.5)	61.3(37.8-103.8)	237.7(126.0-433.1)	55.0(39.0–70.0)	35.5 ± 17.0
Decorate within half a year							
Yes	48	7.5(7.2–7.8)	3.9(3.0-4.8)	58.3(24.0-96.2)	194.2(77.0-351.1)	58.0(33.5–70.0)	37.9 ± 17.4
No	417	7.5(7.2–7.6)	4.0(2.8–5.5)	64.2(38.7–108.0)	261.0(130.7-478.1)[a]	55.0(40.5–69.0)	34.9 ± 17.0
Purchase new furniture or painted furniture(within six months)							
Yes	70	7.5(7.3–7.7)[a]	3.9(2.2-5.0)	68.0(29.2-102.1)	201.1(83.1-463.1)	58.0(38.5–70.0)	37.9 ± 17.3
No	395	7.5(7.2–7.6)	4.0(2.9–5.5)	63.7(37.9-108.1)	254.4(128.3-442.4)	55.0(40.0–69.0)	34.7 ± 17.0
occupation							
Institutions, party organizations, enterprises, institutions	34	7.5(7.2–7.6)	3.0(2.0–5.0)	61.1(30.6–84.6)	165.3(99.3-333.8)	49.0(35.0–68.0)	31.0 ± 17.8
Professional skill worker	37	7.5(7.2–7.6)	3.9(2.1-5.0)	54.5(28.3–98.8)	176.6(108.6-425.8)	57.5(45.3–72.5)	40.6 ± 15.0
Administrative, law enforcement, and clerical personnel	42	7.5(7.2–7.5)	4.1(3.0-5.5)	68.9(46.8-121.3)	307.1(157.9-551.4)	51.5(39.5–66.0)	34.2 ± 18.3
Commercial and service industry personnel	56	7.5(7.2–7.8)	4.1(2.8–5.6)	80.0(39.1-116.1)	296.4(165.1-522.2)	58.0(42.3–68.0)	35.5 ± 17.6
Production personnel in agriculture, forestry, animal husbandry, fishery and water conservancy	15	7.4(7.2–7.5)	3.5(2.2–4.6)	89.6(36.0-151.8)	258.5(115.4-448.6)	63.5(28.0–84.0)	32.3 ± 12.8
Production and transportation equipment operators and related personnel	35	7.5(7.2–7.5)	4.8(3.3–7.6)	61.0(32.3–95.6)	301.0(125.2-525.6)	60.5(51.8–68.5)	35.3 ± 15.9
Unemployment	32	7.3(7.2–7.5)	4.1(2.9–5.4)	57.1(28.9–99.9)	203.8(145.7-386.5)	55.0(39.0-69.5)	35.6 ± 19.2
Retire	16	7.5(7.3–7.7)	3.7(3.0-4.8)	64.9(48.2–85.8)	258.6(146.6-424.1)	63.5(41.3–77.3)	38.1 ± 16.1
Other	86	7.5(7.2–7.6)	4.0(3.0-5.6)	58.1(37.9–99.3)	223.2(115.5-493.8)	54.0(34.0–69.0)	34.7 ± 17.0
Nature of work							
Chemical	11	316.1(114.4-676.1)	7.3(3.1–9.4)	53.5(41.0-67.3)	69.3(32.6-117.6)	67.3(53.5–71.6)	41.8 ± 13.0
Manufacturing	83	220.2(125.2-374.2)	6.0(4.1-8.0)	54.0(36.5–68.3)	58.3(32.3–93.4)	68.3(54.0-78.8)	35.8 ± 14.1
Catering	24	368.5(133.9–670.0)	5.4(4.4–9.4)	61.0(48.0–78.0)	93.7(42.0-137.0)	78.0(61.0-81.8)	38.6 ± 16.7
Transportation	13	295.6(82.0-532.5)	5.0(4.2-.)	56.0(45.0–67.0)	70.4(37.0-113.9)	67.0(56.0-.)	30.8 ± 12.3
Environmental protection	4	267.9(229.2–950.0)	5.8(4.8-.)	64.5(44.5–79.3)	70.0(53.6-165.3)	79.3(64.5-.)	36.8 ± 3.6
Medicine	26	333.8(126.9-642.6)	5.8(5.0–9.0)	70.0(49.0–84.0)	68.0(33.7-121.1)	84.0(70.0-93.2)	42.8 ± 19.6
Farming	47	194.7(107.2-479.9)	4.5(3.5–6.5)	59.0(32.5–80.5)	73.9(35.9-105.4)	80.5(59.0-89.1)	35.2 ± 18.7
Other	257	251.8(119.3-442.4)	5.5(4.0–7.0)	53.0(36.0–68.0)	62.6(37.8-107.7)	68.0(53.0-80.8)	33.9 ± 17.8
Radioactive material contact							
Yes	15	7.5(7.3–7.6)	4.8(3.4–5.8)	68.0(59.7-104.9)	342.3(243.7-555.4)	67.0(54.5–86.0)	47.6 ± 14.3

The value of pH value、semen volume、sperm concentration、sperm count、total motility represent median (25th, 75th percentiles) ; the value of progressive motility represents the median and standard deviation.

Characteristic	N	pH value	Semen volume(ml)	Sperm concentration(10^6/ml)	Sperm count (10^6/ml)	Total motility (%)	Progressive motility (%)
No	369	7.5(7.2–7.6)	4.0(3.0-5.5)	62.5(36.0-105.1)	248.9(121.7-441.1)	55.5(40.0–69.0)	34.6 ± 17.0
Unknown	81	7.4(7.2–7.7)	3.9(2.5–5.2)	67.4(41.3–115.0)	233.6(126.0-524.9)	51.0(35.0–69.0)	36.2 ± 17.2
Toxic substances contact							
Yes	30	7.5(7.2–7.6)	4.2(2.3–5.8)	74.3(42.2-170.2)	342.3(137.2–681.0)	55.0(47.5–77.0)	39.6 ± 12.8
No	364	7.5(7.2–7.6)	4.0(3.0-5.5)	62.6(37.9-101.8)	234.8(124.3-432.1)	56.0(39.0–69.0)	35.0 ± 16.8
Unknown	71	7.5(7.2–7.7)	3.4(2.1-5.0)	67.1(34.7-123.3)	247.3(120.8-523.1)	53.5(35.5–72.0)	34.2 ± 19.7
Average daily mobile phone talk time(within six months)							
Less than 10 minutes	201	7.5(7.2–7.6)	4.0(2.5-5.0)	60.9(35.7–99.3)	204.9(106.2-392.8)	54.0(39.0–68.0)	34.9 ± 16.7
10–30 minutes	188	7.5(7.2–7.6)	4.0(2.8–5.4)	65.1(40.9-115.1)	263.6(128.3-442.4)	59.0(42.0–72.0)	36.2 ± 16.6
30–60 minutes	40	7.4(7.2–7.5)	4.6(3.0–6.0)	80.4(37.9-109.8)	276.0(140.7-665.4)	49.5(37.3–67.0)	37.0 ± 17.8
60 minutes and above	35	7.2(7.2–7.5)	4.5(3.4–8.5)	65.2(39.1-110.5)	346.9(201.7-613.7)	53.0(28.5–69.0)	29.6 ± 20.0
where to carry your phone							
Pockets near the waist	29	7.5(7.2–7.8)	3.0(2.0–5.0)	61.1(40.9-162.8)	206.0(122.2-366.7)	46.0(33.0–68.0)	27.9 ± 15.2
Hang on the chest or put it in a pocket near the chest	5	7.4(7.0-.)	7.3(7.0-.)	125.0(61.3-.)	922.2(429.4-.)	54.0(42.0-.)	31.9 ± 21.9
Pants pocket	142	7.4(7.2–7.5)	4.1(2.8-6.0)	65.2(41.3-130.9)	305.7(126.3-560.2)	59.0(41.0–71.0)	36.6 ± 18.0
Put in the bag	265	7.5(7.2–7.6)	4.0(2.8-5.0)	62.2(32.5–99.9)	229.5(114.7-374.8)	54.0(39.8–69.3)	34.7 ± 16.7
Other locations	24	7.5(7.2–7.7)	4.0(3.0-6.6)	66.2(51.2–88.7)	237.4(182.0-547.2)	56.5(39.8–63.8)	40.8 ± 13.6
Whether to shut down cellphone while sleeping							
Yes	46	7.5(7.3–7.7)	3.8(2.4–7.5)	61.7(40.8-100.4)	209.3(125.1-393.8)	55.0(41.0-68.8)	37.9 ± 18.2
No	419	7.5(7.2–7.6)	4.0(2.8–5.3)	64.1(37.7-105.1)	253.1(124.6-459.5)	55.0(39.0-69.3)	34.9 ± 16.9
If it is not turned off, whether the phone is placed on the bed or placed within 1 meter from the bed							
Yes	331	7.5(7.2–7.6)	4.0(2.8–5.4)	65.1(37.9-115.1)	234.7(126.2-463.1)	55.0(39.0–68.0)	35.6 ± 17.3
No	134	7.5(7.2–7.6)	4.0(2.8–5.5)	59.0(37.8–90.3)	254.4(117.1-431.2)	57.0(41.0–73.0)	34.1 ± 16.2
Stop using mobile phone during planned pregnancy							
Have been using	422	7.5(7.2–7.6)	4.0(2.8–5.5)	64.0(36.5-106.9)	258.4(121.7-485.5)	55.0(39.5–69.5)	35.1 ± 17.2
In the past six months	14	7.4(7.2–7.5)	4.5(3.0-5.8)	49.0(30.0-74.3)	195.5(110.6-304.9)	57.5(37.0-66.8)	30.6 ± 16.6
3 months before pregnancy	29	7.5(7.2–7.7)	3.3(2.3–4.5)	66.7(49.9-102.4)	198.0(157.9-297.5)	54.0(42.0–70.0)	38.6 ± 15.2

The value of pH value、semen volume、sperm concentration、sperm count、total motility represent median (25th, 75th percentiles) ; the value of progressive motility represents the median and standard deviation.

Characteristic	N	pH value	Semen volume(ml)	Sperm concentration(10^6/ml)	Sperm count (10^6/ml)	Total motility (%)	Progressive motility (%)
Use mobile phones to watch videos, play games, and surf the Internet							
Never used	9	7.5(7.5–7.6)	3.0(1.8–8.5)	80.4(37.1-118.4)	241.2(119.0-502.7)	63.5(42.3–71.3)	28.0 ± 11.9
Less than 10 minutes	28	7.4(7.4–7.8)	4.1(3.0-5.3)	54.4(22.9-102.2)	266.3(87.4–401.0)	53.0(31.0–72.0)	32.2 ± 20.6
10–30 minutes	91	7.2(7.2–7.5)	5.0(3.0–6.0)	70.6(36.9-114.6)	246.0(145.2–555.0)	61.0(46.5–72.5)	35.3 ± 14.1
30–60 minutes	115	7.2(7.2–7.6)	4.0(2.8–5.6)	63.9(42.3-103.4)	258.4(150.0-437.7)	57.0(44.0–71.0)	36.9 ± 17.0
60 minutes and above	222	7.2(7.2–7.6)	3.9(2.7-5.0)	64.2(33.9-103.9)	224.6(108.1-474.9)	53.0(35.0–68.0)	35.0 ± 17.7
Watch TV frequency (on average at least once a week)							
Yes	274	7.5(7.2–7.6)	4.0(2.8–5.6)	63.5(36.5–98.9)	224.6(116.8-436.9)	55.0(37.0–71.0)	34.9 ± 17.4
No	191	7.5(7.2–7.6)	4.0(2.8–5.3)	65.2(38.3-121.6)	255.8(146.3-506.3)	55.0(41.0–68.0)	35.7 ± 16.5
Types of TV screens							
CRT	16	7.3(7.3–7.5)	4.0(3.3–6.8)	61.1(26.5-106.6)	179.0(89.5-731.5)	61.0(29.0-70.5)	33.2 ± 14.9
Plasma or back head	5	7.2(7.0-.)	5.5(2.5-.)	286.5(10.4-.)	1575.6(25.9-.)	50.0(20.0-.)	34.0 ± 22.4
Liquid crystal	393	7.5(7.2–7.6)	4.0(2.7–5.4)	63.5(36.1–103.0)	234.7(122.2–433.0)	55.0(39.0–69.0)	35.4 ± 17.1
Other	51	7.4(7.2–7.6)	3.8(3.0-5.3)	77.0(41.7-121.3)	334.2(144.7-606.4)	53.0(40.5–72.0)	34.8 ± 17.3
Average TV watching time per day							
Less than 1 hour	298	7.5(7.2–7.6)	4.0(2.7–5.3)	60.3(34.4-103.1)	226.2(111.0-413.6)	54.0(39.5–68.0)	35.3 ± 17.2
1–3 hours	147	7.4(7.2–7.6)	4.2(3.0–6.0)	70.4(40.3-109.8)	295.6(132.7-561.2)	58.0(38.0-72.5)	35.0 ± 17.2
3 hours and above	20	7.4(7.2–7.5)	3.7(2.9–4.6)	79.8(38.8–107.0)	237.0(127.0-418.7)	56.0(42.8–79.5)	35.9 ± 13.7
Computer using per day							
Less than 1 hour	186	7.5(7.2–7.6)	4.0(2.7–5.3)	62.3(36.3-100.3)	268.2(131.2-422.2)	58.5(41.3–71.0)[a]	35.9 ± 16.9
1 to 4 hours	69	7.5(7.3–7.8)	4.6(3.0-5.9)	65.6(37.3–107.0)	253.1(103.2-608.9)	56.5(46.0-74.8)	37.6 ± 19.0[a]
5–8 hours	146	7.5(7.2–7.7)	3.6(2.6–5.4)	67.4(45.7-121.1)	234.8(129.8-492.6)	56.0(38.0-68.5)	35.9 ± 16.2
8 hours and above	64	7.3(7.2–7.5)	4.0(3.0-5.5)	50.3(29.5–97.0)	170.4(97.4-424.9)	41.0(29.5–55.5)	28.6 ± 16.0
Frequency of using or exposing to the following pesticides(Within 6 months)							
Never	416	7.5(7.2–7.6)	4.0(2.8–5.5)	63.9(38.0-103.9)	236.3(123.0-459.8)	55.0(40.0–69.0)	34.9 ± 17.1
Herbicide	18	7.5(7.3–7.8)	4.3(2.8–6.5)	65.4(43.0-99.9)	299.4(142.0-502.9)	63.5(55.5–75.3)	40.3 ± 15.9
Fungicide	21	7.5(7.3–7.8)	4.0(2.9–4.7)	63.9(38.1-106.9)	233.6(161.0-298.8)	54.0(31.0–73.0)	37.9 ± 16.9
Insecticide	10	7.4(7.2–7.5)	4.5(3.6-7.0)	57.0(10.0-154.0)	404.3(39.3-673.7)	39.0(17.5–83.0)	33.2 ± 18.7

The value of pH value、semen volume、sperm concentration、sperm count、total motility represent median (25th, 75th percentiles) ; the value of progressive motility represents the median and standard deviation.

Characteristic	N	pH value	Semen volume(ml)	Sperm concentration(10^6/ml)	Sperm count (10^6/ml)	Total motility (%)	Progressive motility (%)
Frequently use or contact with the following organic solvents(Within 6 months)							
Never	421	7.5(7.2–7.6)	4.0(2.8–5.3)	63.5(37.8-103.8)	233.6(122.2-433.1)	55.0(40.0–69.0)	35.0 ± 17.0
Coating	16	7.2(7.2–7.5)	4.3(2.2-6.0)	69.0(33.4-111.3)	371.6(98.3-664.2)	50.0(38.0-67.3)	38.1 ± 17.0
Paint	7	7.5(7.0-.)	3.5(3.2-.)	101.1(41.6-.)	353.8(133.1-.)	74.0(35.0-.)	43.5 ± 12.0
Adhesive	11	7.6(7.3–7.7)	3.9(2.0-5.6)	61.1(21.8-156.6)	297.5(73.0-498.6)	55.0(25.0–78.0)	39.7 ± 23.1
Industrial cleaners	10	7.5(7.4-8.0)	6.0(3.8-8.0)	64.2(52.9-103.9)	513.4(150.8-716.6)	67.0(35.0–75.0)	31.3 ± 14.7
Exposure to vibration							
Yes	62	7.5(7.2–7.5)	4.1(3.1–5.7)	76.9(41.2-114.3)	294.1(147.6-570.5)	57.5(46.0–74.0)	35.0 ± 17.0
No	244	7.5(7.2–7.6)	4.0(2.7–5.5)	61.5(37.8-102.9)	227.6(119.9-430.8)	54.0(37.0-68.8)	35.5 ± 17.0
Exposure to noise							
Never	181	7.5(7.2–7.7)	4.0(2.5–5.1)	63.5(43.9-107.8)	246.0(138.8-426.7)	57.0(42.0–69.0)	36.5 ± 16.8
Occasionally	251	7.5(7.2–7.5)	4.0(3.0-5.7)	66.1(34.8-104.1)	262.1(121.7-461.5)	54.0(36.0–70.0)	34.6 ± 17.5
Often	33	7.5(7.3–7.6)	4.1(3.4–7.5)	50.5(27.7-100.9)	163.4(114.3-613.9)	55.0(45.0–67.0)	33.3 ± 14.7
Exposure to radiation(Within 6 months)							
Never	388	7.5(7.2–7.6)	4.0(2.8–5.5)	61.2(35.5-103.8)	229.5(116.6-445.8)	54.5(37.0-68.3)	34.8 ± 17.0
Occasionally	73	7.5(7.2–7.6)	4.2(2.9-6.0)	77.5(45.9-125.3)	270.1(149.4-511.8)	59.0(47.0–74.0)	38.2 ± 17.1
Often (almost every working day)	4	-	-	-	-	-	29.8 ± 17.6
Nature of occupation							
Furniture manufacturing	7	7.4(7.3–7.5)	5.6(2.7–7.6)	70.2(35.7-106.9)	237.6(148.1–641.0)	57.0(39.8–70.5)	37.0 ± 17.3
Electronics manufacturing	31	7.5(7.2–7.9)	4.0(2.8-6.0)	54.2(41.8–80.7)	199.6(123.9-465.4)	53.0(35.0–73.0)	34.2 ± 13.9
Food processing industry	10	7.5(7.2–7.6)	5.0(3.4–6.8)	93.7(34.9-159.8)	505.9(159.6-945.6)	62.0(32.0-77.5)	29.9 ± 19.5
Toy processing industry	14	7.5(7.4–7.7)	4.8(2.0-6.8)	82.5(13.4-176.9)	267.9(107.0-827.4)	63.0(41.0–82.0)	33.8 ± 10.7
Footwear Industry	7	7.5(7.3–7.7)	2.7(2.2–3.8)	84.9(51.3-123.7)	334.0(181.8-416.2)	69.0(53.0–76.0)	41.3 ± 8.8
Chemical manufacturing	9	7.5(7.2–7.7)	3.5(2.0–7.0)	91.4(64.2–196.0)	481.3(150.8-640.1)	56.0(52.0–68.0)	47.9 ± 11.9
Taxi or long-distance transportation	3	7.2(7.2-.)	6.0(3.3-.)	122.1(100.8-.)	604.5(402.9-.)	67.0(17.0-.)	37.7 ± 25.3
Other	384	7.5(7.2–7.6)	4.0(2.8–5.1)	63.6(35.7-103.6)	234.2(115.5-423.4)	55.0(39.0–69.0)	35.0 ± 17.5
Standing or lifting heavy objects for long periods at work							
Yes	77	7.5(7.2–7.6)	4.1(2.5–6.5)	65.6(41.7-123.7)	334.2(137.1-532.8)	55.0(41.5–69.0)	35.7 ± 17.9
No	388	7.5(7.2–7.6)	4.0(2.8–5.3)	63.5(33.9-101.1)	226.2(121.9–433.0)	55.0(39.0–70.0)	35.1 ± 16.9

The value of pH value、semen volume、sperm concentration、sperm count、total motility represent median (25th, 75th percentiles) ; the value of progressive motility represents the median and standard deviation.

Characteristic	N	pH value	Semen volume(ml)	Sperm concentration(10^6/ml)	Sperm count (10^6/ml)	Total motility (%)	Progressive motility (%)
Frequent use of microwave or induction cooker(Within a year)							
Yes	186	7.5(7.2–7.7)	4.0(2.6–5.4)	66.1(41.7-103.7)	260.4(134.5-438.8)	55.0(41.0-67.8)	36.9 ± 16.2
No	279	7.5(7.2–7.5)	4.0(3.0-5.5)	61.1(35.4-107.8)	234.8(121.8-472.8)	55.5(36.3–70.8)	34.0 ± 17.5
Exposure to chemicals at work							
Yes	31	7.5(7.2–7.7)	3.6(2.5–5.3)	87.1(54.8-132.9)	356.7(142.7-660.6)	54.0(43.3–72.0)	40.3 ± 12.7
No	434	7.5(7.2–7.6)	4.0(3.0-5.5)	62.2(37.7-103.2)	234.2(122.1–433.0)	55.0(39.0–69.0)	34.8 ± 17.3
Which type of chemical agents are exposed to at work							
Organic solvents such as formaldehyde	454	7.5(7.2–7.6)	4.0(2.8–5.5)	62.5(37.4-103.9)	234.8(122.0-438.8)	55.0(39.0–69.0)	35.2 ± 17.2
Carbon disulfide	4	7.5(7.2-.)	6.0(4.5-.)	115.0(64.2-.)	517.6(513.4-.)	67.0(21.0-.)	34.3 ± 11.5
Lead and its compounds	4	7.6(7.5-.)	3.5(3.0-.)	67.8(42.0-.)	245.4(126.0-.)	61.0(44.0-.)	34.7 ± 6.6
Benzene or benzene homologues (toluene, xylene)	3	7.5(7.2-.)	3.0(2.0-.)	135.2(74.3-.)	466.3(148.3-.)	48.0(44.0-.)	40.5 ± 6.4
The value of pH value、semen volume、sperm concentration、sperm count、total motility represent median (25th, 75th percentiles) ; the value of progressive motility represents the median and standard deviation.							

3.4. Independent predictors of low semen quality in Binomial logistic regression analysis

Table 4 shows the binomial logistic analysis results. Abnormal semen quality parameters were defined by the guidelines of World Health Organization.[12] After adjusting for age, smoking, alcohol consume, BMI and education state, we observed that shorten the time of using computers a day is a protective factor to total sperm motility (OR = 0.75; 95% CI: 0.59–0.96;P = 0.022) and progressive sperm motility (OR = 0.80; 95% CI: 0.65–0.99; P = 0.036). And living close to high voltage line is a positive factor for higher sperm concentration (OR = 0.29; 95% CI: 0.09–0.97; P = 0.044). But living close to a chemical plant is a significant risk factor of low semen concentration (OR = 5.60; 95% CI: 1.97–15.93; P = 0.001).

Table 4
Binomial regression model to explore the relationship between occupational environmental factors and semen quality

	pH value (< 7.2vs ≥ 7.2)		Semen volume (< 1.5ml vs ≥ 1.5ml)		Sperm concentration (< 15 × 10^6/ml vs ≥ 15 × 10^6/ml)		Sperm count (< 39 × 10^6/ml vs ≥ 39 × 10^6/ml)		Total motility (< 40% vs ≥ 40%)		Progressive motility (< 32% vs ≥ 32%)	
Characteristic	OR (95%CL)	*P*	OR (95%CL)	*P*	OR (95%CL)	*P*	OR (95%CL)	*P*	OR (95%CL)	*P*	OR (95%CL)	*P*
High voltage line (within 2 km)	1.37(0.40–4.68)	0.613	0.34(0.08–1.44)	0.143	0.29(0.09–0.97)	0.044	0.62(0.23–1.66)	0.344	1.41(0.75–2.67)	0.288	0.95(0.56–1.63)	0.856
Large substation (within 2 km)	2.66(0.67–10.63)	0.166	1.00(0.21–4.76)	1.000	0.32(0.08–1.35)	0.122	0.41(0.13–1.32)	0.134	1.26(0.61–2.61)	0.529	1.38(0.74–2.59)	0.308
Power distribution room(within 2 km)	0.40(0.11–1.49)	0.171	1.49(0.44–5.04)	0.522	1.38(0.52–3.70)	0.52	2.11(0.83–5.37)	0.117	0.82(0.42–1.58)	0.549	0.63(0.36–1.08)	0.091
Chemical plant(within 2 km)	0.00(0.00-.)	0.997	0.31(0.03–2.79)	0.294	5.60(1.97–15.93)	0.001	2.67(0.98–7.24)	0.054	0.54(0.24–1.25)	0.149	0.94(0.49–1.82)	0.853
Decorate within half a year	0.00(0.00-.)	0.998	5.83(0.91–37.46)	0.063	0.91(0.22–3.71)	0.898	0.86(0.21–3.49)	0.830	1.65(0.59–4.56)	0.339	1.51(0.62–3.69)	0.367
Purchase new furniture or painted furniture	1.31(0.26–6.59)	0.743	0.32(0.04–2.47)	0.277	2.59(0.74–9.05)	0.136	1.65(0.49–5.56)	0.420	0.84(0.34–2.07)	0.697	0.56(0.25–1.28)	0.168
Computer hours per day	0.77(0.49–1.20)	0.241	0.82(0.51–1.34)	0.430	0.96(0.65–1.43)	0.855	0.96(0.66–1.39)	0.808	0.75(0.59–0.96)	0.022	0.80(0.65–0.99)	0.036

3.5. Multinomial logistic regression analysis of TTP

465 couples take part in our research, 111 couples had given birth to a child so far. Base on this 111 couples' TTP and questionnaires data, we analyze that if semen quality risk factors will prolong the TTP. But our results did not show any significant difference among different TTP groups (Table 5).

Table 5
Logistic regression model to explore the relationship between occupational environmental factors and TTP

Characteristic	TTP (≤ 6month vs > 6month)		TTP (≤ 3month vs 4-6month vs 7-12month vs > 12month)	
	OR (95%CL)	*P*	OR (95%CL)	*P*
High voltage line (within 2 km)	0.63(0.23–1.73)	0.374	1.86(0.52–6.65)	0.341
Large substation (within 2 km)	0.76(0.24–2.36)	0.628	0.98(0.24–4.09)	0.981
Power distribution room(within 2 km)	1.96(0.66–5.81)	0.225	0.47(0.12–1.81)	0.269
Chemical plant(within 2 km)	1.88(0.59–5.97)	0.282	0.72(0.14–3.61)	0.69
Decorate within half a year	0.42(0.07–2.66)	0.358	0.35(0.05–2.53)	0.301
Purchase new furniture or painted furniture	0.80(0.20–3.23)	0.753	3.29(0.68–15.84)	0.138
Computer hours per day	1.06(0.72–1.58)	0.758	-	-
Computer hours per day(within an hour)	-	-	0.69(0.14–3.44)	0.647
Computer hours per day(one to four hours)	-	-	1.39(0.24–8.05)	0.711
Computer hours per day(five to eight hours)	-	-	0.24(0.05–1.32)	0.102

4. Discussion

In the past two decades, people have noticed the decreasing trend in human semen quality.[16] The possible reason for the decrease are various. It can be owned to the unhealthy diet habits, or the alcohol or cigarettes intake.[17, 18] But such negative factors can be avoided by following doctors' advice. While getting ready for pregnancy, couples can quit smoking or drinking as well as be aware of their diet habits, such as refrain from taking high fat food usualness.

In our experience, by following our guidance to quit smoking and drinking at least six months before trying to get pregnant, male-partners of couples who visited our clinic would always have a better physical condition and semen quality, their wives' chances of successful pregnancy are usually accordingly increased. Such clinical advices are easy to be accepted, like changing their diet, stop smoking and drinking for only half a year are not difficult for couples who really want to give birth to a child. After all, these advices cost nothing but have a relative remarkable effect. But when it comes to environmental and occupational factors, on account of these factors are always connected to people's working and living surroundings which are usually much more stable than diet habits, it's another kind of stories. On the basis of our clinic experience, when we pointed out that one's should avoid contacting reproduction toxic substance that existed in their working place[19], they always shown reluctant. We considered it as an easy thing to understand, it's impossible for an organic chemical worker to completely isolate from chemicals, and the uncertain futures of quitting their jobs are usually unacceptable. Similarly, to avoid some of the negative factors like noise[20,] and electromagnetic radiation[6, 21] around one's domicile, they may have to move their house. In some ordinary persons' view, to quit a job or move houses for giving birth to a child is not that worthy, even more so for couples had already raised a child. Under these circumstances, this problem had stuck into a dead loop, the negative factors are kept affecting people's fertility as long as they still exist, but changing their jobs and domicile are remaining unable to afford to most of people.

In this research, we analysis several factors that may affect semen quality. Based on the clinical experience and consensus, we made questionnaires for our interested factors. We have got some positive result which indicated these factors may affect male's fertility. Firstly, we found that living close to power lines and substations are the positive factors for the higher level of sperm count. Besides, living close to a power distribution room is a positive factor to higher sperm progressive motility. Research on effect of electric field to semen quality is relative rare, and controversy is existed.[22] Three independent but relevant questions were all indicated that electric field may be a beneficial to better sperm quality, but more experiments should be conducted to verify its effect. Another result shown that living close to a chemical factory was a negative factor to semen concentration. This result is in accord with other researches, amounts of industrial chemicals will do harm to reproductive system and reduce semen quality.[13, 23] There are few works had analyzed the relationship between computer using and semen quality, but related factors (sitting for a long time,[24] electromagnetic wave[25] and radiation,[26] et al.) had been reported to be related to lower semen quality. To figure out the mechanisms of such multi-angle effects factors are quite challenging but also essential job, especially in the current condition when computers are widely used. Secondly, we explored the possibility of semen quality related occupations and environment factors affect TTP. Although in our current research, we did not find the correlation, but there are reports revealed that the relationship between semen quality and TTP[27], as well as occupations and environment factors were also reported to be associated to TTP.[28, 29] In the following researches, we will increase our sample size to verify our results, and continue exploring the if occupation and environment affect male fertility and TTP.

According to our result, we can draw a preliminary conclusion that some of the occupations, and environment factors will affect males' semen quality. These kinds of factors usually damage human fertility without noticing, because the influence of these factors doesn't appear as acute diseases. In such condition, people won't take the negative factors seriously until they notice infertility problems arise. Fortunately, the negative impact of most factors in our everyday life are reversible, the easiest way is to keep away from these factors, to avoid their continually damage to our reproduction system. But during our clinic work, how do our doctors efficiently collect patients' background information to figure out want kind of factors they are facing with and how can we help them? As there are number of factors that affect fertility, demanding doctors to ask our patients relevant questions in detail is not only impractical but also inefficient. To solve this question, we are trying to combine AI (artificial intelligent) analysis and specific questionnaires. Patients finish answering questionnaires during the waiting time, AI analyzes the high-risk factor the patients are facing and score their lifestyle. With the help of AI system, doctors of fertility consultation clinic will receive accurate diagnostic advices and save a lot of time for patients. We are exploring the possibilities of AI participates in fertility consultation, and it's relieved that we have got positive response from our doctors and patients.

There were several limitations to our current findings. Firstly, the population of our study is limited to Southern Chinese population, and none of our patients was from other ethnic groups who assess to this study. Secondly, our research was only stay at epidemiology level, the mechanisms of how high-risk factors affect human sperm quality is still waiting to be explored, and this is what we are going to process.

In summary, our research shown that computer using, living and working surroundings (voltage line, substation and chemical plants, transformer room) and housing decoration are potentially influencing semen quality. But a larger sample size is needed to confirm our previous results. In addition, the specific mechanisms of how risky factors affect semen quality are still unknown, further research is needed.

Declarations

Ethics statement

The present study protocol was reviewed and approved by the Ethics Review Committee of the Guangzhou Women and Children's Medical Center (□□□□□□ □□2016102416□□). All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all patients for being included in the study.

Conflict of Interest:

Hanran Mai, Junyi Ke, Miaomiao Li, Menghua He, Yanxia Qu, Fan Jiang, Simian Cai, Yufen Xu, Lanyan Fu, Lei Pi, Huazhong Zhou, Di Che, Xiaoqiong Gu, Liandong Zuo declare that they have no conflict of interest.

Availability of data and material:

Our patients' data were all kept in an independent database, which is run by the data center of our medical center.

Due to the restricted power given by our patients according to the informed consent, we can't share our data and our data center won't allow it. An inform consent form file was attached. It was made under the supervision of the ethics board of Guangzhou Women and Children Medical Center.

For the above reason, we state that:

The data in our database cannot be shared.

Consent for publication:

Our manuscript didn't contain any individual person's data; all personal information was strictly control by data center and the ethics board.

For the above reason, we state that:

Our manuscript didn't contain any individual person's data.

Acknowledgements:

We would like to thank the Clinical Biological Resource Bank of Guangzhou Women and Children's Medical Center for curating clinical data.

Author Contribution:

Hanran Mai, Junyi Ke and Miaomiao Li contributed equally to this study.

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All authors have read and approved the manuscript.

Funding:

This study was funded by the Guangdong Provincial Science and Technology Plan (China, 2017A030223003), Guangzhou Medical and Health Technology Projects (China, 20191A011021 and 20191A011033), the Guangdong Natural Science Foundation (China, 2019A1515012061), the Guangzhou Institute of Pediatrics/Guangzhou Women and Children's Medical Center Fund (China, GCP-2019-003, GCP-2019-006,YIP-2018-019, and YIP-2019-050), Guangzhou Science and Technology Program Key Projects (China,201904010486), and the Guangzhou Health Commission(China,20211A011034).

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