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Prevalence and coprevalence of modifiable risk factors for upper digestive tract cancer among residents aged 40–69 years in Yangzhong city, China: a cross-sectional study

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ABSTRACT

Objectives To describe the prevalence of modifiable risk factors for upper digestive tract cancer (UDTC) and its coprevalence, and investigate relevant influencing factors of modifiable UDTC risk factors coprevalence among residents aged 40–69 years in Yangzhong city, China.

Design Cross-sectional study.

Participants A total of 21 175 participants aged 40–69 years were enrolled in the study. 1962 subjects were excluded due to missing age, marital status or some other selected information. Eventually, 19 213 participants were available for the present analysis.

Main outcomes measures Prevalence and coprevalence of eight modifiable UDTC risk factors (overweight or obesity, current smoking, excessive alcohol consumption, insufficient vegetables intake, insufficient fruit intake and the consumption of pickled, fried and hot food) were analysed.

Results The prevalence of overweight/obesity, current smoking, excessive alcohol consumption, insufficient vegetables intake, insufficient fruit intake and the consumption of pickled, fried and hot food in this study was 45.3%, 24.1%, 16.2%, 66.1%, 94.5%, 68.1%, 36.0% and 88.4%, respectively. Nearly all (99.9%) participants showed one or more UDTC risk factors, 98.6% of the participants showed at least two risk factors, 92.2% of the participants had at least three risk factors and 69.7% of the participants had four or more risk factors. Multivariate logistic regression analysis revealed that men, younger age, single, higher education, higher annual family income and smaller household size were more likely to present modifiable UDTC risk factors coprevalence.

Conclusions The prevalence and coprevalence of modifiable UDTC risk factors are high among participants in Yangzhong city. Extra attention must be paid to these groups who are susceptible to risk factors coprevalence during screening progress. Relative departments also need to make significant public health programmes that aim to decrease modifiable UDTC risk factors coprevalence among residents aged 40–69 years from high-risk areas of UDTC.

Strengths and limitations of this study

- This is the first study examining the prevalence and coprevalence of modifiable upper digestive tract cancer (UDTC) risk factors and investigating relevant influencing factors in Yangzhong city, with large and representative residents from southeast China.
- Participants who volunteered to participate in our study are considered to be the high-risk group for UDTC, which is significantly important for the prevention and control of UDTC in China.
- A cross-section study cannot exam the causality or temporal relationship.
- The modifiable UDTC risk factors included in our study were self-reported by participants, which may contribute to recall and reporting bias, except body mass index.
- We only focus on the eight modifiable UDTC risk factors, which may underestimate the average number of modifiable UDTC risk factors among participants.

INTRODUCTION

According to WHO, more than 70% of the total deaths worldwide were related to non-communicable diseases (NCDs) in 2016.[1] Cancer is the second cause of NCDs, accounting for 22% of total global deaths related to NCDs. Globally, in 2018, an estimated 572 034 individuals were diagnosed with oesophageal cancer (OC), and 1 033 701 individuals were diagnosed with stomach cancer (SC), with approximately 50% of new cases occurring in China. There are an estimated 508 585 cancer deaths of OC and 782 685 cancer deaths of SC in 2018, accounting for 5.3% and 8.2% of cancer-cause deaths.[2] Apparently, upper digestive tract cancer (UDTC) (oesophagus, stomach) has become a significant morbidity and mortality source

related to cancer. According to the National Cancer Center,[3] OC has been the sixth most common cancer and the fourth most common cancer cause of cancer-related death. SC has been the second most common cancer and the third most common cancer cause of cancer-related death. The incidence rate of OC and SC was 17.87/100 000 and 29.31/100 000, the mortality rate of them was 13.68/100 000 and 21.16/100 000, respectively, in China in 2015.[3] Hence, UDTC has become a major public health challenge in China, and the disease burden of it is also considerable.[4] Due to the population health-seeking behaviour and the diseases' character, UDTC is mostly diagnosed at a late stage, which is leading to a low survival rate. It was estimated that its 5-year survival rate was less than 20% if diagnosed at an advanced stage but is as high as 95% if detected at an earlier stage.[5–7]

Although the cause of UDTC is not clear, it is believed by researchers that the epidemic of UDTC in China is attributed to the multiplicity of demographic factors, diet, lifestyle, family health, environment, gastrointestinal history and genetic factors.[8] It is well known that tobacco, alcohol consumption, overweight or obesity, thermal irritation (drinking scalding liquids) and insufficient intake of vegetables and fruit, consumption of pickled and fried food are eight risk factors that can be altered by a tangible action for UDTC control.[9–13]

Although parts of these risk factors have decreased because of a set of interventions implemented by the Chinese government,[14 15] the others have increased and will continue to grow in the next decades because of the rapid transition of urbanisation, industrialisation and ageing.[16 17] Furthermore, several studies have indicated that these risk factors coprevalence was common in the population which would further increase the risk of UDTC.[18 19] A comprehensive assessment of the distribution and the status of UDTC risk factors coprevalence is significant for cancer prevention and control. Once we have such data, interventions can be planned and implemented efficiently to minimise these modifiable risk factors, thereby minimising the health risks of increasing UDTC-related morbidity and mortality.

The Yangzhong city of Jiangsu Province is one of the high-risk areas of UDTC, especially in rural areas.[8] In 2015, the incidence rate of OC was 69.2/100 000, the mortality rate of OC and SC was 70.24/100 0000 and 81.89/100 0000, respectively, in Yangzhong city, which is higher compared with the average of the nation.[20 21] Hence, Yangzhong city had been one of the project sites of the Upper Digestive Tract Cancer Early Diagnosis and Treatment (UDTCEDAT) since the 2006.[8] Many studies have estimated the risk factors for UDTC in different areas worldwide.[9–13] The results reveal that risk factors for UDTC are widespread. The modifiable risk factors are significantly crucial for the prevention and control of UDTC because these factors can be changed by some healthy education or other interventions implemented by doctors and government and improved with the increase of personal health awareness. However, the evidence on the coprevalence of these modifiable risk factors in high-risk areas is still limited. Thus, we aimed to report the prevalence and coprevalence of modifiable UDTC risk factors and analyse the relevant factors influencing modifiable UDTC risk factor coprevalence among residents aged 40–69 years in Yangzhong city, which is a high-risk area of UDTC.

METHODS

Study population

For the present study, we used secondary data collected from the screening of UDTC, focusing on the early diagnosis and treatment of UDTC among high-risk populations (aged 40–69 years) in Yangzhong city, China, from 2006 to 2017.[22] We use the method of multistage stratified cluster sampling to select the study sample. In the first stage, we stratified Yangzhong city into six regions (Sanmao, Baqiao, Youfang, Xinglong, Xilai and Xinba), covering the whole Yangzhong. In the second stage, we randomly selected clusters of three regions (Baqiao, Youfang and Xinglong) by region distribution and economic level based on Yangzhong Yearbook data. In the third stage, administration villages or neighbourhood communities in each chosen regions were randomly selected with probability proportional to size. In the fourth stage, each resident group or village group was selected from chosen administration villages or neighbourhood communities. In the fifth stage, all man or woman eligible from each household in the sites mentioned above were invited for cancer screening, unless they met the following exclusion criteria: (1) history of UDTC or mental disorder; (2) contraindications for endoscopic examinations and (3) inability to complete the whole interview or informed consent. Inclusion criteria for participants were as following: (1) aged 40–69 years; (2) permanent residents in Yangzhong City and (3) willing to accept endoscopic examination.

Before the screening, we obtained written informed consent from all participants after informing them about the backgrounds, objectives, procedures, benefits, confidentiality agreement of personal information and possible consequences of the whole programme. Then questionnaire-based interview, physical examinations, laboratory tests were performed by professional investigators. At last, the endoscopic examinations, pathological diagnosis and necessary therapy for participants were conducted by well-trained doctors in People's Hospital of Yangzhong city. The screening procedure follows China's cancer screening and early diagnosis and treatment technology programme strictly.[22] The data used in this study derived mainly from the questionnaire and physical examinations. Finally, a total of 21 175 individuals were surveyed, with a response rate of 60.9% (21 175/34 743), 1962 residents were excluded due to missing age, marital status or some other factors, leaving 19 213 participants available for the present survey. The sample size accounted for about 17.3% of the total target population

of Yangzhong city. We provided health education about UDTC and the potential role of modifiable risk factors related to UDTC to all eligible participants after collecting information relating to risk factors with the questionnaire. Besides, we combined active and passive follow-ups to collect outcome information for participants diagnosed with UDTC or precancerous lesions. We also performed a regular re-examination for patients according to the diagnosis.

Questionnaire data collection

Before implementing data collection, training sessions organised by the expert group on UDTCEDAT were provided for all staff. The aim of this study, the standard measurement methods, how to perform questionnaires properly and the concrete study procedure were included in the training contents. At the end of the training sessions, all staff participated in the assessment and proved to be qualified.

We use uniformly structured questionnaires to collect information through face-to-face interviews. Each questionnaire took approximately 25 mins to complete. The questionnaire information included demographic factors (gender, birthday, address, ID, marital status and household size), socioeconomic characteristic (education and annual family income), behavioural factors (excessive alcohol consumption, current smoking), dietary habits (insufficient fresh vegetables intake and insufficient fruit intake, consumption of pickled, fried and hot food) and body mass index (BMI).

Physical examination

Physical examination included height and weight. Height and weight measurements were taken by height scale and digital weight, respectively, with the help of trained examiners based on a standardised programme. All subjects were asked to remove any footwear, hats, and heavy clothing before height and weight were measured. Height was measured to the nearest 0.1 cm, while weight was measured to the nearest 0.1 kg. BMI was calculated by dividing body weight (in kilograms) by the square of height (in metres).

Assessment criteria

Definitions of UDTC modifiable risk factors and the coprevalence of these risk factors

Eight modifiable UDTC risk factors were defined based on current national guidelines or related references. Overweight/obesity was defined as BMI ≥24.0 kg/m^2.[23–25] Current smoking was defined as self-reported having used any tobacco products, including cigarettes, cigars or pipes daily continuously.[26] Excessive alcohol consumption, insufficient fresh vegetables and fruit intake were defined according to the Dietary Guidelines for Chinese residents (2016).[27] Accordingly, excessive alcohol consumption was defined as consumption of more than 25 g (for males) or 15 g (for females) alcohol drinks per day after calculating pure alcohol based on the type of alcohol they chose, insufficient vegetables intake as self-reported consumption of vegetables less than seven times per week and insufficient fruit intake as self-reported consumption of fruit less than seven times per week.[27] Besides, self-reported consumption of pickled, fried or hot food at least once a week were classified as 'yes' in dietary habits, respectively.

Based on considering the literature and the average number of risk factors in the research population, coprevalence of modifiable UDTC risk factors was defined as presenting at least four related risk factors in one individual.[24 28]

Covariates

Covariates included in this study were demographic and socioeconomic information ascertained by questionnaire, including age (40–44 years, 45–49 years, 50–54 years, 55–59 years, 60–64 years, 65–69 years), gender (male and female), marital status (single, currently married, divorced/widowed/separated), educational status (no institutional education, primary school, junior high school, senior high school and higher), household size (0–3, 4–5, ≥6) and annual family income (tertiles: lower, middle and higher).[29]

Statistical analysis

Descriptive statistics were applied to describe the sociodemographic characteristics of the sampled population. The difference in continuous variables was analysed by student's t-test and by χ^2 test to assess the differentials in the prevalence values among categorical variables. Differences in men and women, the prevalence of each modifiable UDTC risk factor and the distribution of modifiable UDTC risk factors coprevalence (0, 1, 2, 3 and ≥4) in sociodemographic and other characteristics were described in the overall population, respectively. Multiple logistic regression models were adopted to explore the association between relevant characteristics and UDTC risk factors coprevalence. Only the variables that we found statistically significant at $p<0.05$ in the univariate analysis were included in the multiple logistic regression models. The result of multiple logistic regression analyses was presented in terms of adjusted ORs and their respective 95% CIs. All statistical analyses were performed by SPSS software V.17.0. A two-sided $p<0.05$ was considered to be statistically significant.

Patient and public involvement

No participants or public were included in the design phase of this study. No participants were asked to advise on interpretation or writing up of results. Dissemination of the result of the research to participants and relevant participants community was prohibited. All the participants had the right to receive the result of health check if they wanted.

RESULTS

Sociodemographic and other characteristics of participants

The description of sociodemographic and other characteristics of 19 213 participants are presented in table 1.

Table 1 Sociodemographic and socioeconomic characteristics of participants in Yangzhong city, China

Category	Total (n=19213)	Men (n=8268)	Women (n=10945)	t/χ^2 value	P value
No, n(%)	19213 (100.0)	8268 (43.0)	10945 (57.0)		
Age, years, mean (SD)	53.2±7.8	53.5±7.8	52.9±7.8	5.61	<0.001
Age group, n (%)				33.29	<0.001
40–44	3142 (16.4)	1270 (15.4)	1872 (17.1)		
45–49	3937 (20.5)	1642 (19.9)	2295 (21.0)		
50–54	3743 (19.5)	1560 (18.9)	2183.0 (19.9)		
55–59	3571 (18.6)	1582 (19.1)	1989 (18.2)		
60–64	3088 (16.1)	1416 (17.1)	1672 (15.3)		
65–69	1732 (9.0)	798 (9.7)	934 (8.5)		
Marrige, n (%)				93.41	<0.001
Single	203 (1.1)	137 (1.7)	66 (0.6)		
Currently married	18285 (95.2)	7907 (95.6)	10378 (94.8)		
Divorced, widowed or separated	725 (3.8)	224 (2.7)	501 (4.6)		
Education, n (%)				886.879	<0.001
No institutional education	1594 (8.3)	228 (2.8)	1366 (12.5)		
Primary school	8510 (44.3)	3436 (41.6)	5074 (46.4)		
Junior high school	7591 (39.5)	3647 (44.1)	3944 (36.0)		
Senior high school and higher	1518 (7.9)	957 (11.6)	561 (5.1)		
Annual family income, n (%)				0.04	0.981
lower	8585 (44.7)	3689 (44.6)	4896 (44.7)		
Middle	5420 (28.2)	2338 (28.3)	3082 (28.2)		
Higher	5208 (27.1)	2241 (27.1)	2967 (27.1)		
Household size, n, mean (SD)	4.0±1.4	4.0±1.4	4.0±1.4	−3.17	0.002
BMI, kg/m^2, mean (SD)	23.8±3.0	23.9±3.0	23.7±3.0	3.47	0.001

BMI, body mass index.

Of the participants (40–69 years, mean age 53.2±7.8 years) surveyed, 57.0% were women, with a mean age of 52.9±7.8 years. More than 95.0% (man 95.6%, woman 94.8%) of participants were married, nearly half (44.3%) (man 41.6%, woman 46.4%) had an education level of primary school, 44.7% (man 44.6%, woman 44.7%) had a lower level of annual family income and the mean of household size and BMI were 4.0±1.4 (man 4.0±1.4, woman 4.0±1.4) and 23.8±3.0 kg/m^2 (man 23.9±3.0, woman 23.7±3.0), respectively. The differences between men and women in age, marriage, education, household size and BMI were significant (all p<0.01) (table 1). In addition, of the cancer cases diagnosed in this study, the majority of the oesophagus was squamous (54/57), while adenocarcinoma predominated in gastric (29/33) and cardia (35/36) cancers.

Prevalence of modifiable UDTC risk factors

The prevalence of overweight or obesity, current smoking and excessive alcohol consumption in this study was 45.3%, 24.1% and 16.2%, respectively. The prevalence of current smoking and excessive alcohol consumption in men was significantly higher than in women (all p<0.001). In addition, insufficient vegetables intake, insufficient fruit intake and the consumption of pickled, fried and hot food in participants accounted for 66.1%, 94.5%, 68.1%, 36.0% and 88.4%, respectively. The prevalence of consumption of pickled and hot food was higher in women than in men (all p<0.05) (table 2). As shown in table 3, there were significant differences in age, marriage status, education level, and annual family income in the eight UDTC risk factors (all p<0.05). The prevalence of these eight modifiable UDTC risk factors tends to be higher in single participants, except for overweight or obesity (all p<0.001). Moreover, the prevalence of excessive alcohol consumption, insufficient vegetables intake, insufficient fruit intake and the consumption of pickled, fried and hot food varied significantly with the household size (all p<0.001) (table 3).

Coprevalence of modifiable UDTC risk factors

The prevalence of zero to eight modifiable UDTC risk factors participants had simultaneously in the study (overweight/obesity, current smoking, excessive alcohol consumption, insufficient vegetables intake, insufficient fruit intake, the consumption of pickled, fried and hot

Table 2 Prevalence of modifiable UDTC risk factors in Yangzhong city adults aged 40–69

Factor	Total (n=19213)	Men (n=8268)	Women (n=10945)	χ^2 value	P value
BMI, n (%)				2.62	0.106
Overweight or obesity	8695 (45.3)	3797 (45.9)	4898 (44.8)		
Normal weight or underweight	10518 (54.7)	4471 (54.1)	6047 (55.2)		
Current smoking, n (%)				6093.25	<0.001
No	14589 (75.9)	3988 (48.2)	10601 (96.9)		
Yes	4624 (24.1)	4280 (51.8)	344 (3.1)		
Excessive alcohol consumption, n (%)				3197.31	<0.001
No	16109 (83.8)	5504 (66.6)	10605 (96.9)		
Yes	3104 (16.2)	2764 (33.4)	340 (3.1)		
insufficient vegetables intake, n (%)				0.32	0.572
No	6519 (33.9)	2787 (33.7)	3732 (34.1)		
Yes	12694 (66.1)	5481 (66.3)	7213 (65.9)		
insufficient fruit intake, n (%)				0.10	0.749
No	1055 (5.5)	459 (5.6)	596 (5.4)		
Yes	18158 (94.5)	7809 (94.4)	10349 (94.6)		
Pickled food consumption, n (%)				8.38	<0.05
No	6138 (31.9)	2734 (33.1)	3404 (31.1)		
Yes	13075 (68.1)	5534 (66.9)	7541 (68.9)		
Fried food consumption, n (%)				1.00	0.318
No	12293 (64.0)	5323 (64.4)	6970 (63.7)		
Yes	6920 (36.0)	2945 (35.6)	3975 (36.3)		
Hot food consumption, n (%)				27.10	<0.001
No	2221 (11.6)	1070 (12.9)	1151 (10.5)		
Yes	16992 (88.4)	7198 (87.1)	9794 (89.5)		

BMI, body mass index; UDTC, upper digestive tract cancer.

food) was 0.1%, 1.3%, 6.4%, 22.6%, 23.2%, 22.4%, 17.5%, 5.5% and 1.0%, respectively (data shown partly in table 4). Among them, nearly all (99.9%) participants showed one or more modifiable UDTC risk factors, 98.6% showed two or more modifiable UDTC risk factors, 92.2% had three or more modifiable UDTC risk factors and 69.7% presented at least four modifiable UDTC risk factors. The average count of modifiable UDTC risk factors per participant in this study is 4.39. The prevalence of coprevalence of modifiable UDTC risk factors was higher in men than in women (p<0.001). The prevalence of coprevalence of modifiable UDTC risk factors was the highest in the age group 50–54 and among single participants (all p<0.001). There was an increasing trend towards modifiable UDTC risk factors coprevalence with increasing education and annual family income (all p<0.001). Moreover, modifiable UDTC risk factors coprevalence was the highest among those participants who had 0–3 family members (p<0.001) (table 4).

The multivariable logistic regression analysis revealed that men were more likely to have four or more modifiable UDTC risk factors compared with women (OR 2.302, 95% CI 2.145 to 2.471). The prevalence of modifiable UDTC risk factors coprevalence increased with age and then decreased, peaking at 50–54 (OR 2.044, 95% CI 1.825 to 2.288). Participants who were married (OR 0.511, 95% CI 0.330 to 0.792) were less likely to have four or more modifiable UDTC risk factors than those who were single. In addition, we divided the education into four groups, which showed that increasing the level of education was a risk factor for modifiable UDTC risk factors coprevalence. Compared with participants who had a higher level of annual family income, those who had middle (OR 0.218, 95% CI 0.197 to 0.241) and lower (OR 0.223, 95% CI 0.201 to 0.247) level of annual family income were less likely to have four or more modifiable UDTC risk factors. Modifiable UDTC risk factors coprevalence were less common among participants who had more than six family members than those who had less than three ones (OR 0.598, 95% CI 0.527 to 0.678) (table 5).

DISCUSSION

As far as we know, this is the first large population-based survey investigated the prevalence and coprevalence of eight modifiable UDTC risk factors and described the sociodemographic and socioeconomic factors associated

Table 3 Prevalence of modifiable UDTC risk factors by relevant characters in Yangzhong city adults aged 40–69

Category	Overweight or obesity	Smoking	Drinking	Vegetables	Fruit	Pickled food	Fried food	Hot food
Age group, years, n (%)								
40–44	1492 (47.5)	533 (17.0)	348 (11.1)	1888 (60.1)	2902 (92.4)	2033 (64.7)	782 (24.9)	2971 (94.6)
45–49	1953 (49.6)	827 (21.0)	540 (13.7)	2648 (67.3)	3735 (94.9)	2594 (65.9)	1451 (36.9)	3894 (98.9)
50–54	1729 (46.2)	1068 (28.5)	723 (19.3)	2506 (67.0)	3538 (94.5)	2669 (71.3)	1325 (35.4)	3723 (99.5)
55–59	1607 (45.0)	987 (27.6)	695 (19.5)	2314 (64.8)	3380 (94.7)	2366 (66.3)	1312 (36.7)	3464 (97.0)
60–64	1271 (41.2)	796 (25.8)	537 (17.4)	2131 (69.0)	2949 (95.5)	2158 (69.9)	1285 (41.6)	2343 (75.9)
65–69	643 (37.1)	413 (23.8)	261 (15.1)	1207 (69.7)	1654 (95.5)	1255 (72.5)	765 (44.2)	597 (34.5)
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Marrige, n (%)								
Single	77 (37.9)	73 (36.0)	43 (21.2)	177 (87.2)	200 (98.5)	169 (83.3)	143 (70.4)	186 (91.6)
Currently married	8334 (45.6)	4439 (24.3)	2979 (16.3)	12 087 (66.1)	17 253 (94.4)	12 424 (67.9)	6518 (35.6)	16 304 (89.2)
Divorced, widowed or separated	284 (39.2)	112 (15.4)	82 (11.3)	430 (59.3)	705 (97.2)	482 (66.5)	259 (35.7)	502 (69.2)
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Education, n (%)								
No institutional education	692 (43.4)	75 (4.7)	76 (4.8)	781 (49.0)	1479 (92.8)	1286 (80.7)	675 (42.3)	1198 (75.2)
Primary school	3699 (43.5)	2030 (23.9)	1328 (15.6)	5898 (69.3)	8149 (95.8)	4785 (56.2)	2205 (25.9)	7194 (84.5)
Junior high school	3521 (46.4)	2045 (26.9)	1373 (18.1)	4878 (64.3)	7087 (93.4)	5819 (76.7)	3146 (41.4)	7187 (94.7)
Senior high school and higher	783 (51.6)	474 (31.2)	327 (21.5)	1137 (74.9)	1443 (95.1)	1185 (78.1)	894 (58.9)	1413 (93.1)
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Annual family income, n(%)								
Lower	3711 (43.2)	2128 (24.8)	1551 (18.1)	4844 (56.4)	8234 (95.9)	5535 (64.5)	1300 (15.1)	7168 (83.5)
Middle	2458 (45.4)	1303 (24.0)	857 (15.8)	3566 (65.8)	4953 (91.4)	2923 (53.9)	1521 (28.1)	4876 (90.0)
Higher	2526 (48.5)	1193 (22.9)	696 (13.4)	4284 (82.3)	4971 (95.4)	4617 (88.7)	4099 (78.7)	4948 (95.0)
P value	<0.001	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Household size, n (%)								
0–3	3583 (45.6)	1916 (24.4)	1381 (17.6)	5137 (65.4)	7384 (94.1)	5512 (70.2)	2989 (38.1)	7051 (89.8)
4–5	4285 (44.6)	2285 (23.8)	1428 (14.8)	6574 (68.4)	9159 (95.2)	6216 (64.6)	3153 (32.8)	8467 (88.0)
≥6	827 (47.4)	423 (24.2)	295 (16.9)	983 (56.3)	1615 (92.5)	1347 (77.1)	778 (44.6)	1474 (84.4)
P value	0.064	0.601	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Smoking, current smoking; drinking, excessive alcohol consumption; vegetables, insufficient vegetables intake, fruit, insufficient fruit intake; pickled food, the consumption of pickled food, fried food, the consumption of fried food; hot food, the consumption of hot food.
UDTC, upper digestive tract cancer.

with these among Yangzhong city residents aged 40–69 from southeast China. The present study revealed that the prevalence and coprevalence of overweight or obesity, current smoking, excessive alcohol consumption, insufficient vegetables intake, insufficient fruit intake and consumption of pickled, fried and hot food were high, which implied the health risk of UDTC residents have in Yangzhong city. We found that the prevalence of insufficient fruit intake and hot and pickled food consumption were the top three modifiable UDTC risk factors in the population surveyed. Besides, 69.7% of the participants presented at least four UDTC risk factors.

Table 4 The different number and coprevalence of modifiable UDTC risk factors in residents by relevant characters in Yangzhong city adults aged 40–69

Category	None (0)	Single (1)	Two (2)	Three (3)	Non-coprevalence(≤3)	Coprevalence(≥4)	χ^2 value	P value
Total	14 (0.1)	244 (1.3)	1235 (6.4)	4336 (22.6)	5829 (30.3)	13 384 (69.7)		
Gender, n (%)							632.397	<0.001
men	2 (0.0)	64 (0.8)	356 (4.3)	1293 (15.6)	1715 (20.7)	6553 (79.3)		
women	12 (0.1)	180 (1.6)	879 (8.0)	3043 (27.8)	4114 (37.6)	6831 (62.4)		
Age group, years, n (%)							373.748	<0.001
40–44	1 (0.0)	66 (2.1)	193 (6.1)	891 (28.4)	1151 (36.6)	1991 (63.4)		
45–49	0 (0.0)	26 (0.7)	165 (4.2)	857 (21.8)	1048 (26.6)	2889 (73.4)		
50–54	0 (0.0)	15(.4)	112 (3.0)	759 (20.3)	886 (23.7)	2857 (76.3)		
55–59	0 (0.0)	48 (1.3)	175 (4.9)	724 (20.3)	947 (26.5)	2624 (73.5)		
60–64	0 (0.0)	33 (1.1)	273 (8.8)	712 (23.1)	1018 (33.0)	2070 (67.0)		
65–69	13 (0.8)	56 (3.2)	317 (18.3)	393 (22.7)	779 (45.0)	953 (55.0)		
Marrige, n (%)							67.346	<0.001
Single	0 (0.0)	0 (0.0)	9 (4.4)	16 (7.9)	25 (12.3)	178 (87.7)		
Currently married	12 (0.1)	201 (1.1)	1130 (6.2)	4167 (22.8)	5510 (30.1)	12 775 (69.9)		
Divorced, widowed or separated	2 (0.3)	43 (5.9)	96 (13.2)	153 (21.1)	294 (40.6)	431 (59.4)		
Education, n (%)							417.766	<0.001
No institutional education	4 (0.3)	56 (3.5)	241 (15.1)	379 (23.8)	680 (42.7)	914 (57.3)		
Primary school	8 (0.1)	71 (0.8)	503 (5.9)	2396 (28.2)	2978 (35.0)	5532 (65.0)		
Junior high school	2 (0.0)	107 (1.4)	428 (5.6)	1367 (18.0)	1904 (25.1)	5687 (74.9)		
Senior high school and higher	0 (0.0)	10 (0.7)	63 (4.2)	194 (12.8)	267 (17.6)	1251 (82.4)		
Annual family income, n (%)							1078.75	<0.001
Lower	6 (0.1)	102 (1.2)	588 (6.8)	2500 (29.1)	3196 (37.2)	5389 (62.8)		
Middle	5 (0.1)	105 (1.9)	470 (8.7)	1403 (25.9)	1983 (36.6)	3437 (63.4)		
Higher	3 (0.1)	37 (0.7)	177 (3.4)	433 (8.3)	650 (12.5)	4558 (87.5)		
Family member, n (%)							17.913	<0.001
0–3	5 (0.1)	165 (2.1)	438 (5.6)	1642 (20.9)	2250 (28.7)	5600 (71.3)		
4–5	7 (0.1)	68 (0.7)	627 (6.5)	2318 (24.1)	3020 (31.4)	6597 (68.6)		
≥6	2 (0.1)	11 (0.6)	170 (9.7)	376 (21.5)	559 (32.0)	1187 (68.0)		

UDTC, upper digestive tract cancer.

The prevalence of overweight or obesity (45.3%) in our study was higher than that observed in Nanjing (35.6%),[23] and nationwide population (42.0%),[30] but our findings were closed to that observed in some other regional.[24 31] The prevalence of current smoking in this population (24.1%) was much higher than that in a cross-sectional study in Shenzhen (10.5%)[24] and Barbados (9.2%),[32] which was consistent with a survey in Nanjing (24.5%).[23] However, the rate was not as high as reported (28.1%) in the China national nutrition and chronic disease survey (2015).[30] Our findings showed a high prevalence of excessive alcohol consumption in the Yangzhong population

Table 5 The multivariable logistic regression analysis of modifiable UDTC risk factors coprevalence

Category	Wald	P value	β	SE	OR	95% CI
Gender, n(%)						
Women	–	–	–	–	1.000	–
Men	533.13	<0.001	0.834	0.036	2.302	2.145 to 2.471
Age group, years, n (%)						
40–44	–	–	–	–	1.000	–
45–49	48.302	<0.001	0.381	0.055	1.464	1.315 to 1.631
50–54	153.543	<0.001	0.715	0.058	2.044	1.825 to 2.288
55–59	143.780	<0.001	0.710	0.059	2.033	1.811 to 2.283
60–64	32.963	<0.001	0.351	0.061	1.421	1.260 to 1.602
65–69	10.685	<0.001	−0.229	0.070	0.796	0.694 to 0.913
Marrige, n (%)						
Single	–	–	–	–	1.000	–
Currently married	9.054	0.003	−0.671	0.223	0.511	0.330 to 0.792
Divorced, widowed or separated	10.813	0.001	−0.777	0.236	0.460	0.289 to 0.731
Education, n (%)						
No institutional education	–	–	–	–	1.000	–
Primary school	17.448	<0.001	0.256	0.061	1.291	1.145 to 1.456
Junior high school	51.436	<0.001	0.485	0.068	1.624	1.423 to 1.855
Senior high school and higher	40.562	<0.001	0.604	0.095	1.829	1.519 to 2.202
Annual family income, n (%)						
Higher	–	–	–	–	1.000	–
Middle	874.464	<0.001	−1.524	0.052	0.218	0.197 to 0.241
Lower	799.154	<0.001	−1.502	0.053	0.223	0.201 to 0.247
Household size, n (%)						
0–3	–	–	–	–	1.000	–
4–5	82.359	0.429	−0.334	0.037	0.716	0.666 to 0.770
≥6	64.364	<0.001	−0.514	0.064	0.598	0.527 to 0.678
Constant	64.447	<0.001	1.878	0.234	–	–

UDTC, upper digestive tract cancer.

(16.2%) relative to the national average of 11.1% in men and 2.0% in women.[30] The rate of excessive alcohol consumption we found was similar to Barbados, Nanbu and the prospective study of China Kadoorie Biobank, where excessive alcohol consumption rates were around 14.5%, [32] 16.7%[19] and 14.9%,[33] respectively. We found higher levels of insufficient intake of vegetables (66.1%) in this population than those observed in the Tanzania[34] and Hubei Province[35] where the insufficient intake of vegetables or fruit is 55.8% and 29.7%, respectively, while the levels of insufficient intake of fruit (94.5%) in our study were also much higher than that observed in the region mentioned above.[34 35] Moreover, the proportion of the Yangzhong population had dietary habits of consumption of pickled, fried and hot food were greater than the levels in Huaian (22.7%, 7.1%, and 10.9%),[36] as well as in Nanbu (28.63%, 1.95%, and 6.11%),[19] both of these region mentioned above are high-risk areas of UDTC in China.

The co-prevalence of risk factors for chronic diseases is widespread.[19] Several previous studies reported the coprevalence of chronic diseases in the Chinese population. For example, among 49 247 Chinese aged 15–69 years from the 2007 China Chronic Disease and Risk Factor Surveillance, the prevalence of having zero, one, two and at least three chronic disease risk factors were 9.1%, 33.9%, 32.4% and 24.6%, respectively.[37] Also, other regional studies have examined the coprevalence of some specific chronic diseases in residents. Hong *et al*[23] reported that 30.1% and 35.2% of the Nanjing population presented one and at least two cardiovascular diseases (CVD) risk factors. Conversely, a much higher rate of CVD risk factors coprevalence was noticed by Ni *et al* in Shenzhen city.[24]

In our present study, it was observed that 0.1%, 1.3%, 6.4%, 22.6% and 69.7% of participants had zero, one, two, three and at least four modified UDTC risk factors, respectively, among residents aged 40–69 years. The modified UDTC risk factors coprevalence was prevalent considerably in Yangzhong city. Different estimates of the risk factors coprevalence for UDTC were found in the literature. He *et al*[19] showed that among residents aged 40–69 years in UDTC high-risk areas, 33.08%, 35.99%, 16.76% and 11.93% of participants had one, two, three and at least four OC risk factors, respectively. In another case–control study of 2 266 Chinese adults, 32.5% and 41.1% of the participants presented three and four or more risk factors, respectively, for OC or SC.[18] Compared with these two studies mentioned above,[18 19] a much higher coprevalence of risk factors was noticed in our present study. The variations could change likely due to the difference in diagnostic criteria, the number and kind of risk factors included in the research and the participants' age group. Overall, there are some other national, and worldwide studies on the coprevalence of some common or specific chronic diseases risk factors. Still, the study on modifiable UDTC risk factors is limited.

The factors associated with modifiable UDTC risk factors coprevalence included gender, age, marriage status, education, annual family income and household size. We found the prevalence of modifiable UDTC risk factors coprevalence was lower in women compared with men, which was consistent with findings from other settings.[19 23 37] The possible reason could be Chinese men are less aware of self-protect for chronic diseases and have worse health-seeking behaviour, and may also attend more social occasions, tend to consume more tobacco/cigarette high-salt, high-fat and high-calorie food compared with women.[23 31]

In addition, this study revealed that the prevalence of modifiable UDTC risk factors coprevalence was increased with age, which was consistent with previous studies.[19 23 24 37] Studies showed that in Nanbu, China, the coprevalence of OC risk factors increased with age may attribute to the lower level of awareness, practice and willingness for health among the elder.[19] Meanwhile, it is also shown in table 5 that being over 65 protects against having more than four risk factors. A possible reason for this difference is as follows: with the ageing of the body and the deterioration of organ function, an elder individual possesses a higher risk of health disorder and has a greater demand for medical care. As a result, this creates more opportunities to get diagnosed with some health screening, including UDTC. Correspondingly, the elderly have more chance to get a healthy education from physicians than the younger.[38] Our study also showed that single participants had more prevalence of modifiable UDTC risk factors coprevalence compared with participants who were currently married, following a previous study.[19] A possible explanation is that being a single older resident comes with its own economic and emotional challenges, contributing to the unhealthy habit of lifestyle and diet.[39 40]

Our study demonstrated that the level of socioeconomic status (SES, education, annual family income) was positively associated with modifiable UDTC risk factors coprevalence, which was inconsistent with other reports.[19 23 37] Residents with a higher level of SES are more aware of control and prevention of chronic disease and have better health-seeking behaviour compared with those with a lower level of SES.[19 23 41] Moreover, the poor or lower education participants may have relatively more inaccessibility and unaffordability to medical services.[38] This paradox may be due to most of the participants enrolled in our study were from rural areas, and their SES was generally low. However, it may also imply that the higher income may contribute to unhealthy lifestyles,[42] and knowledge alone may not be sufficient to change unhealthy lifestyles. Therefore, the level of education and income are two essential SES factors for modifiable UDTC risk factors coprevalence.

It is, however, important to note that participants who have more than six family members had a lower prevalence of modifiable UDTC risk factors coprevalence compared with those who have less than three ones. Changes in household size are bound to affect the adjustment of the family diet. As the household size increase, it is more likely to increase dietary diversity (eg, fruits, vegetables and milk) every day.[43] Besides, the affection, information and economic support among family members will also increase significantly, which can adjust and correct the unhealthy lifestyle of individuals.[44 45]

Our study explored the prevalence and influencing factors of modifiable UDTC risk factors coprevalence in the UDTC high-risk area, Yangzhong City, based on the community-based project for UDTC screening with a large sample size. Additionally, the physical measurement and the data collection implemented by trained interviewers strictly according to standard protocol and instrument increase the validity of our results. In order to reduce the prevalence and coprevalence rate of UTDC risk factors, the screening teams should focus on individuals with coprevalence of risk factors in screening and improve their unhealthy lifestyles continually through a range of methods such as post-screening health education, personalised interventions and disease follow-up. The social impact of screening should be expanded to improve the compliance of high-risk groups, thereby increasing the output of screening health benefits. Meanwhile, the government should also help high-risk groups (especially the older and male groups) to improve their health literacy and awareness of UTDC prevention through diversified education, motivation and publicity methods, such as health education, health talks and mass media campaigns. By guiding the culture of smoking, drinking and other food culture, promote high-cultural groups to transform their cognitive and economic advantages into advantages in UTDC prevention and healthcare, and effectively change unhealthy habits. Besides, the government should focus on single and residents with small household size in the high-risk groups in the

process of health education and the development of prevention strategies. The findings may also provide the reference for departments in charge of the prevention and control of UDTC in Yangzhong city, Jiangsu province and relevant departments in other UDTC high-risk areas (eg, Linzhou, Feicheng, Yanting).

There were also several possible limitations to our study. First, a cross-section study cannot exam the causality or temporal relationship between the coprevalence of modifiable UDTC risk factors and its influencing factors. Second, the modifiable UDTC risk factors included in our study were self-reported by participants, which may contribute to recall and reporting bias, except BMI. Our study results were from Yangzhong city only, and cannot be generalised to the other high-risk areas and the whole of southeast China. Additionally, the study response rate was relatively low, particularly among males, which may affect the results' representativeness. Finally, our study only focused on the eight modifiable UDTC risk factors, but there are far more than eight risk factors for UDTC. Hence, further studies are needed.

CONCLUSION

In summary, this cross-sectional study shows that the prevalence and coprevalence of modifiable UDTC risk factors are high among participants in Yangzhong city. Our analyses indicate that men, younger adults, single adults and participants with higher SES or smaller household size are susceptible to modifiable UDTC risk factors coprevalence. Policies to prevent UDTC have already been developed in the strategic plan and operational plan, however, the accuracy and validity of implementing the undertaken policies are still insufficient. Consequently, extra attention is required to pay to these high-risk groups during the progress of screening. Relative departments also need to make effective public health programmes targeting modifiable UDTC risk factors that aim to decrease UDTC risk factors coprevalence in high-risk groups from high-risk areas of UDTC.

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Correction notice The affiliation for co-author Gang Shao has been corrected.

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REFERENCES

1 World Health Organization. World health statistics 2018: monitoring health for the SDGs, sustainable development goals, 2018. Available: https://www.who.int/gho/publications/world_health_statistics/2018/en/
2 Bray F, Ferlay J, Soerjomataram I, *et al*. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin* 2018;68:394–424.
3 Zheng RS, Sun KX, Zhang SW. [Report of cancer epidemiology in China, 2015]. *Zhonghua Zhong Liu Za Zhi* 2019;41:19–28.
4 Chen W, Zheng R, Baade PD, *et al*. Cancer statistics in China, 2015. *CA Cancer J Clin* 2016;66:115–32.
5 Ajani JA, Bentrem DJ, Besh S, *et al*. Gastric cancer, version 2.2013: featured updates to the NCCN guidelines. *J Natl Compr Canc Netw* 2013;11:531–46.
6 Ciocirlan M, Lapalus MG, Hervieu V, *et al*. Endoscopic mucosal resection for squamous premalignant and early malignant lesions of the esophagus. *Endoscopy* 2007;39:24–9.
7 Ma D, Yang F, Liao Z. Expert opinion on early screening and endoscopic diagnosis and treatment esophageal cancer in China (2014, Beijing). *China Prac Med* 2015;4:320–37.
8 Chen R, Ma S, Guan C, *et al*. The National cohort of esophageal Cancer-Prospective cohort study of esophageal cancer and precancerous lesions based on high-risk population in China (NCEC-HRP): study protocol. *BMJ Open* 2019;9:e027360.
9 Salaspuro M. Interrelationship between alcohol, smoking, acetaldehyde and cancer. *Novartis Found Symp* 2007;285:80–9.
10 Somi MH, Mousavi SM, Naghashi S, *et al*. Is there any relationship between food habits in the last two decades and gastric cancer in North-Western Iran? *Asian Pac J Cancer Prev* 2015;16:283–90.
11 Navarro Silvera SA, Mayne ST, Risch HA, *et al*. Principal component analysis of dietary and lifestyle patterns in relation to risk of subtypes of esophageal and gastric cancer. *Ann Epidemiol* 2011;21:543–50.
12 Andrici J, Eslick GD. Hot food and beverage consumption and the risk of esophageal cancer: a meta-analysis. *Am J Prev Med* 2015;49:952–60.
13 Gupta B, Kumar N, Johnson NW. Relationship of lifetime exposure to tobacco, alcohol and second hand tobacco smoke with upper aero-digestive tract cancers in India: a case-control study with a life-course perspective. *Asian Pac J Cancer Prev* 2017;18:347–56.
14 Chen WQ, Zuo TT. [Initial effect achievement of battles on upper digestive tract cancer in China]. *Zhonghua Yu Fang Yi Xue Za Zhi* 2017;51:378–80.
15 Luan DC, SJ L, Li H. Change trends in health behaviors among residents in Liaoning province,1991-2006. *Chin J Public Health* 2013;29:1509–11.

16 McCormack VA, Boffetta P. Today's lifestyles, tomorrow's cancers: trends in lifestyle risk factors for cancer in low- and middle-income countries. *Ann Oncol* 2011;22:2349–57.
17 Li FX, Robson PJ, Chen Y, *et al*. Prevalence, trend, and sociodemographic association of five modifiable lifestyle risk factors for cancer in Alberta and Canada. *Cancer Causes Control* 2009;20:395–407.
18 XP G, Wang YC, Zhi HK. Risk factors of esophageal and stomach cancer and their clustering in Dafeng municipality：a case-control study. *Chin J Public Health* 2016;32:1406–9.
19 He Q, Jing YH, Huang HR. Prevalence and clustering of esophageal cancer-related risk factors among rural residents in Nanbu County, Sichuan Province. *Chin H Cancer Prev Treat* 2019;26:1675–80.
20 Tong HY, Zhang MM, Zhang HY. Analysis on the epidemiology trend and disease burden of esophagus cancer in Yangzhong from 2004 to 2015. *Modern Prev Med* 2016;43:3665-68,3687.In Chinese.
21 Tong HY, Zhang MM, Sun LP. Quantitative study on death caused by main chronic diseases in Yangzhong City. *Jiangsu J Prev Med* 2017;28:502–4.
22 DONG ZW. *China's cancer screening and early diagnosis and treatment technology program*. Beijing: People's medical publishing house, 2009.
23 Hong X, Ye Q, He J, *et al*. Prevalence and clustering of cardiovascular risk factors: a cross-sectional survey among Nanjing adults in China. *BMJ Open* 2018;8:e020530.
24 Ni W, Weng R, Yuan X, *et al*. Clustering of cardiovascular disease biological risk factors among older adults in Shenzhen City, China: a cross-sectional study. *BMJ Open* 2019;9:e024336.
25 Chen C, Lu FC, Department of Disease Control Ministry of Health, PR China. The guidelines for prevention and control of overweight and obesity in Chinese adults. *Biomed Environ Sci* 2004;17 Suppl:1–36 https://pubmed.ncbi.nlm.nih.gov/15807475/
26 Howitt C, Hambleton IR, Rose AMC, *et al*. Social distribution of diabetes, hypertension and related risk factors in Barbados: a cross-sectional study. *BMJ Open* 2015;5:e008869.
27 Chinese nutrition society. *Dietary guidelines for Chinese residents*. Beijing: People's medical publishing house, 2016.
28 Cureau FV, Duarte P, dos Santos DL, *et al*. Clustering of risk factors for noncommunicable diseases in Brazilian adolescents: prevalence and correlates. *J Phys Act Health* 2014;11:942–9.
29 Xu F, Yin X-M, Zhang M, *et al*. Family average income and body mass index above the healthy weight range among urban and rural residents in regional Mainland China. *Public Health Nutr* 2005;8:47–51.
30 National Commission of Health Bureau of disease control and Prevention. Report on China national nutrition and chronic disease survey. People's Medical Publishing House Beijing; 2015: 33–50.
31 Wang R, Zhang P, Gao C, *et al*. Prevalence of overweight and obesity and some associated factors among adult residents of northeast China: a cross-sectional study. *BMJ Open* 2016;6:e010828.
32 Howitt C, Hambleton IR, Rose AMC, *et al*. Social distribution of diabetes, hypertension and related risk factors in Barbados: a cross-sectional study. *BMJ Open* 2015;5:e008869.
33 Millwood IY, Walters RG, Mei XW, *et al*. Conventional and genetic evidence on alcohol and vascular disease aetiology: a prospective study of 500 000 men and women in China. *Lancet* 2019;393:1831–42.
34 Msambichaka B, Eze IC, Abdul R, *et al*. Insufficient fruit and vegetable intake in a low- and middle-income setting: a population-based survey in semi-urban Tanzania. *Nutrients* 2018;10:222.
35 Guo YL, Tan XD, Liu XZ. Fruit and vegetable intake of adults and its influencing factors in some cities of Hubei Province. *J of Pub health and Prev Med* 2016;27:82–5.
36 Wen JB, Sun ZM, Miao DD. Influencing factors about early cancer of upper-digestive tract among high-risk population in Huai'an City of Jiangsu Province. *China cancer* 2019;28:749–56.
37 Li Y, Zhang M, Jiang Y, *et al*. Co-variations and clustering of chronic disease behavioral risk factors in China: China chronic disease and risk factor surveillance, 2007. *PLoS One* 2012;7:e33881.
38 Ahmed S, Tariqujjaman M, Rahman MA, *et al*. Inequalities in the prevalence of undiagnosed hypertension among Bangladeshi adults: evidence from a nationwide survey. *Int J Equity Health* 2019;18:33.
39 Floud S, Balkwill A, Canoy D, *et al*. Marital status and ischemic heart disease incidence and mortality in women: a large prospective study. *BMC Med* 2014;12:42.
40 Cao Z, Wang R, Cheng Y, *et al*. Adherence to a healthy lifestyle counteracts the negative effects of risk factors on all-cause mortality in the oldest-old. *Aging* 2019;11:7605–19.
41 Prom-Wormley EC, Clifford JS, Bourdon JL, *et al*. Developing community-based health education strategies with family history: assessing the association between community resident family history and interest in health education. *Soc Sci Med* 2021;271:112160.
42 Yang F, Qian D, Liu X, *et al*. Socioeconomic disparities in prevalence, awareness, treatment, and control of hypertension over the life course in China. *Int J Equity Health* 2017;16:100.
43 Workicho A, Belachew T, Feyissa GT, *et al*. Household dietary diversity and animal source food consumption in Ethiopia: evidence from the 2011 welfare monitoring survey. *BMC Public Health* 2016;16:1192.
44 Bot SD, Mackenbach JD, Nijpels G, *et al*. Association between social network characteristics and lifestyle behaviours in adults at risk of diabetes and cardiovascular disease. *PLoS One* 2016;11:e0165041.
45 Verheijden MW, Bakx JC, van Weel C, *et al*. Role of social support in lifestyle-focused weight management interventions. *Eur J Clin Nutr* 2005;59 Suppl 1:S179–86.