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Relationship between Cancer Incidence and Health Behaviors from Ecological Study in Korea

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The aim of this ecological study was to examine the correlation between cancer incidence and health behaviors such as smoking, alcohol consumption, and obesity, and investigated whether there were differences in this correlation between metropolitan areas and other regions. Data on health behaviors exposure/prevalence and cancer incidence rates for 227 administrative districts (cities and counties) were obtained. The average exposure proportion measured annually from 2008 to 2011 in the Korea Community Health Survey data and the age-standardized cancer incidence data from 2014 to 2018, obtained through the cancer registry data, were downloaded from the Statistics Korea website. To examine the relationship between smoking, alcohol consumption, obesity exposure rate (prevalence), and cancer incidence, a correlation analysis was conducted, and Pearson's correlation coefficient was calculated. The correlation coefficient between male smoking and male cancer incidence rate across 227 districts was 0.259. This significance was more pronounced in large metropolitan areas, where the correlation coefficient was 0.631 in the 73 districts belonging to these areas. In large metropolitan areas, the correlation coefficient between alcohol consumption rate and cancer incidence rate was 0.390. In the correlation analysis between obesity prevalence and cancer incidence rate, no correlation was found in large metropolitan areas, while in areas outside of large cities, the correlation coefficient was –0.295, indicating a significant negative correlation. This ecological study demonstrated that the relationship between cancer incidence and health behaviors differed between large metropolitan areas and areas outside of large cities.

Key Words Neoplasms, Health behavior, Ecological study

INTRODUCTION

Cancer is a major factor in premature death and is the second leading cause of death worldwide, following cardiovascular disease [1]. Although there are differences between types of cancer, health behaviors such as smoking, alcohol consumption, and obesity are known to be major risk factors for the development of cancer [2]. Health behaviors such as smoking, alcohol consumption, and obesity are modifiable lifestyle habits, however, the relationship between these behaviors and cancer incidence, as well as the population attributable risk, varies across different populations. According to previous studies, the population attributable risk percentage of smoking for cancer in male was reported to be approximately 15% to 33%, alcohol consumption 2% to 12%, and obesity 0.1% to 5% [3]. In females, the population attributable risk percentage of smoking for cancer was reported to be approximately 8% to 15%, alcohol consumption 0.2% to 6%, and obesity 0.8% to 11% [3].

There are typically regional disparities in the exposure rates to cancer risk factors and the incidence rates of cancer [4]. Recent studies have shown that regional disparities in cancer incidence in Korea were not observed at the national level, but were identified at the municipal level [5].

This study conducted an ecological analysis based on the administrative districts of South Korea to examine the correlation between cancer incidence and lifestyle factors, and investigated whether there were differences in this correlation between metropolitan areas and other regions.

MATERIALS AND METHODS

Acquiring information on health behaviors and cancer incidence by district

Data on lifestyle exposure/prevalence and cancer incidence rates for 227 administrative districts (cities and counties)

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were obtained. The proportion of smoking, alcohol consumption, and obesity at the district (si-gun-gu) level were obtained from the Korea Community Health Survey. The Community Health Survey is a survey conducted in South Korea to assess the health status and lifestyle habits of residents at the city, county, and district level [6]. The survey targets adult residents aged 19 and older in the region, with samples randomly selected and the survey conducted using a standardized questionnaire through an interview-based method. The survey includes items on health status, lifestyle habits, health behaviors, and social factors. The definition of smoking rate refers to the proportion of males who currently smoke, out of those who have smoked at least 100 cigarettes (5 packs) in their lifetime. The definition of the alcohol consumption rate refers to the proportion of people who have consumed alcohol at least once a month in the past year. The definition of obesity prevalence refers to the proportion of people with a body mass index (BMI) of 25 or higher, calculated from self-reported height and weight.

In South Korea, cancer incidence data are collected through the National Cancer Registration Program. This program began in 1999 and provides essential data on cancer incidence rates, prevalence, mortality rates, and other factors, which are used to develop cancer prevention and management policies [7].

The health behaviors data for each region, derived from the Community Health Survey, and the cancer incidence data for each region, obtained from the National Cancer Registration Program, were downloaded from the Statistics Korea website (www.kosis.kr).

Statistical analysis

The exposure proportion was calculated as the average of the standardized values measured annually from 2008 to 2011 over a four-year period. The cancer incidence rate was based on the standardized incidence rate from 2014 to 2018. To examine the relationship between smoking, alcohol consumption, obesity exposure rate (prevalence), and cancer incidence, a correlation analysis was conducted, and Pearson's correlation coefficient was calculated. Additionally, correlation analysis was performed by stratifying the data into metropolitan cities (Seoul, Busan, Incheon, Daegu, Daejeon, Gwangju, Ulsan) and non-metropolitan areas, and the correlation coefficients were presented. Statistical significance was based on a *P*-value of less than 0.05.

RESULTS

In the correlation analysis between male smoking rate and male cancer incidence rate across 227 districts, the correlation coefficient was 0.259, which was statistically significant (Fig. 1). This significance was more pronounced in large

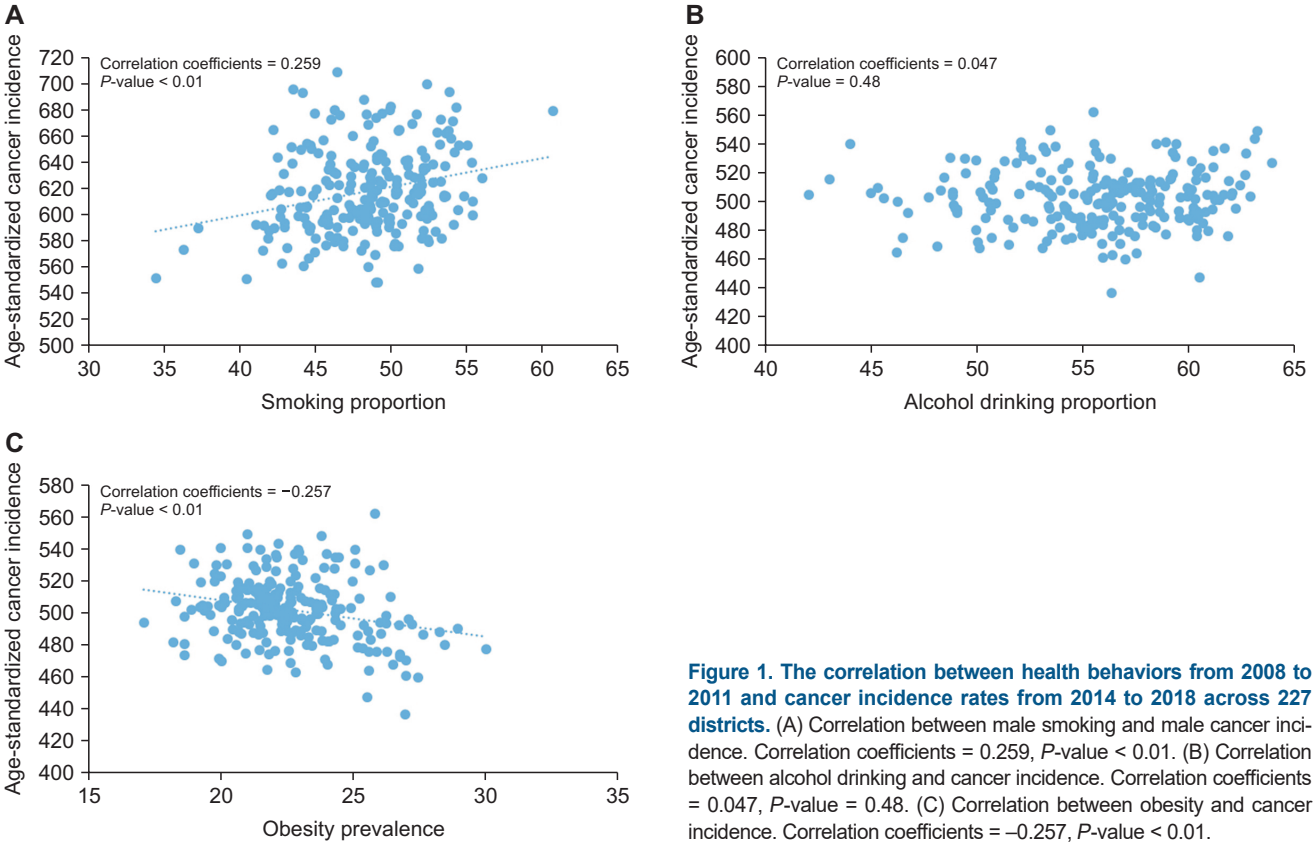

Figure 1. The correlation between health behaviors from 2008 to 2011 and cancer incidence rates from 2014 to 2018 across 227 districts. (A) Correlation between male smoking and male cancer incidence. Correlation coefficients = 0.259, *P*-value < 0.01. (B) Correlation between alcohol drinking and cancer incidence. Correlation coefficients = 0.047, *P*-value = 0.48. (C) Correlation between obesity and cancer incidence. Correlation coefficients = –0.257, *P*-value < 0.01.

metropolitan areas, where the correlation coefficient between male smoking rate and male cancer incidence rate was 0.631 in the 73 districts belonging to these areas (Fig. 2).

In the correlation analysis between alcohol consumption rate and cancer incidence rate, the correlation coefficient was 0.047, showing no statistical significance (Fig. 1). However, in large metropolitan areas, the correlation coefficient was 0.390, indicating a significant positive correlation, while in areas outside of large cities, the correlation coefficient was –0.204, showing a significant negative correlation (Fig. 2).

In the correlation analysis between obesity prevalence and cancer incidence rate, the correlation coefficient was –0.257, showing a statistically significant negative correlation (Fig. 1). However, no correlation was found in large metropolitan

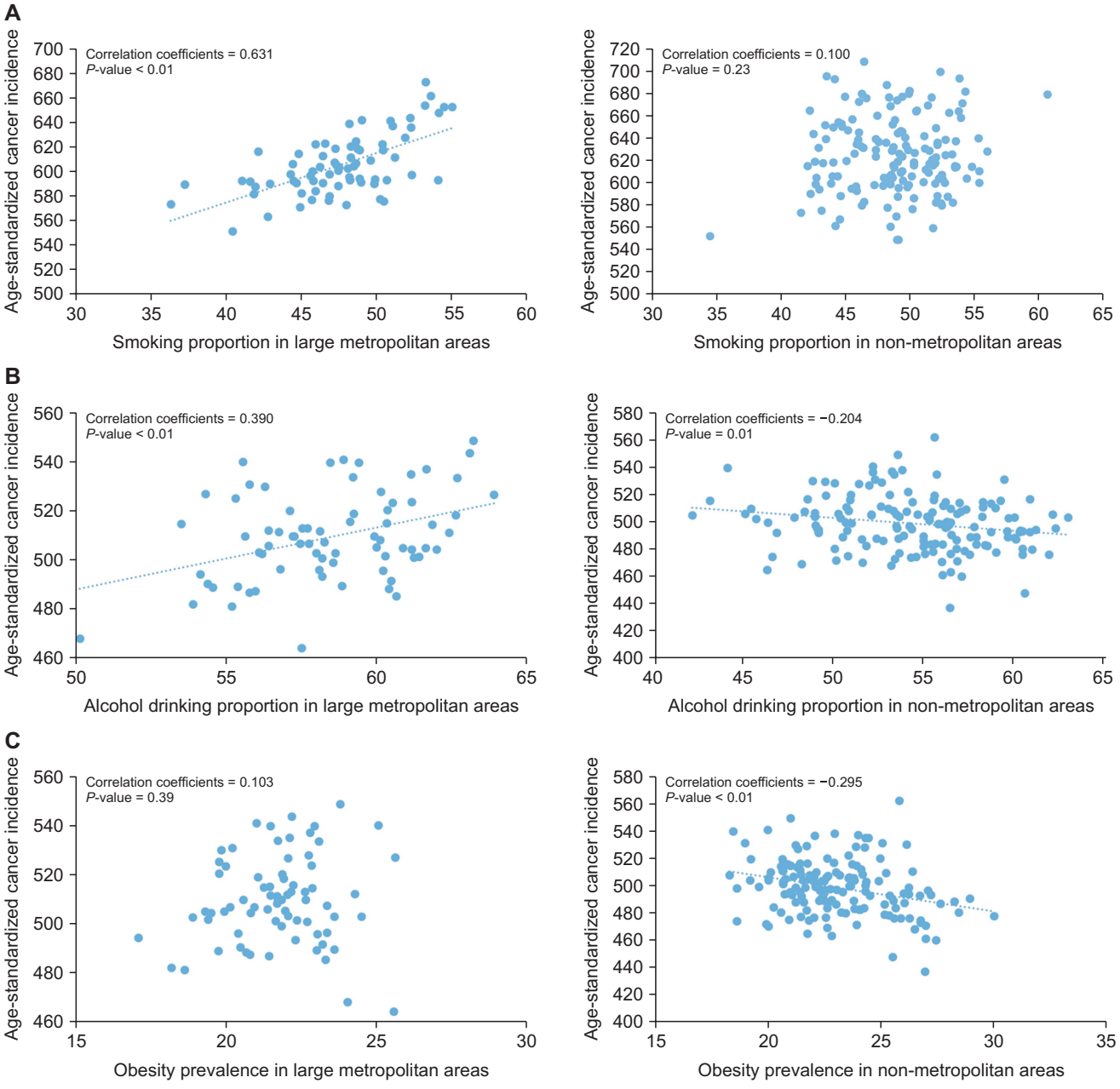

Figure 2. The correlation between health behaviors from 2008 to 2011 and cancer incidence rates from 2014 to 2018 in large metropolitan areas and other areas. (A) Correlation between male smoking and male cancer incidence in large metropolitan areas and non-metropolitan areas. Correlation coefficients = 0.631, *P*-value < 0.01 (left); Correlation coefficients = 0.100, *P*-value = 0.23 (right). (B) Correlation between alcohol drinking and cancer incidence in large metropolitan areas and non-metropolitan areas. Correlation coefficients = 0.390, *P*-value < 0.01 (left); Correlation coefficients = –0.204, *P*-value = 0.01 (right). (C) Correlation between obesity and cancer incidence in large metropolitan areas and non-metropolitan areas. Correlation coefficients = 0.103, *P*-value = 0.39 (left); Correlation coefficients = –0.295, *P*-value < 0.01 (right).

areas, while in areas outside of large cities, the correlation coefficient was –0.295, indicating a significant negative correlation (Fig. 2).

DISCUSSION

The results of this ecological study showed a significant positive correlation between smoking rate and cancer incidence, and a significant negative correlation between obesity prevalence and cancer incidence. Additionally, in metropolitan cities, smoking rate and alcohol consumption rate showed a significant positive correlation with cancer incidence. In medium-sized cities and rural areas, alcohol consumption rate and obesity prevalence showed a significant negative correlation with cancer incidence.

Cigarettes and tobacco smoke contain at least 70 carcinogenic substances, including polycyclic aromatic hydrocarbons, phenolic compounds, and nitrosamines, which smokers are exposed to [8]. Smoking increases the risk of lung cancer by up to 9 fold, laryngeal cancer by 7 fold, and bladder cancer by approximately 3 fold. It also significantly increases the risk of oral, esophageal, stomach, colorectal, ovarian, cervical, pancreatic, nasopharyngeal, kidney, and breast cancers [9]. This ecological study also showed a significant correlation between smoking and cancer incidence, with a particularly strong correlation in large metropolitan areas.

Ethanol, the main component of alcohol, is oxidized to produce acetaldehyde, which is a major carcinogenic factor [10]. The more alcohol is consumed, the higher the risk of cancer. Even small amounts, such as one or two drinks per day, can increase the risk of certain cancers, including liver, colorectal, and breast cancer [11]. In this study, the results for large metropolitan areas and non-metropolitan areas were reversed. In epidemiological studies, individuals with healthy lifestyles may be more likely to abstain from alcohol, while those with existing health conditions might quit drinking, leading to a potential “healthy worker effect,” where healthier individuals tend to drink more. This dual effect could explain why the results differed between large metropolitan areas and non-metropolitan areas.

Obesity is known to contribute to cancer development by triggering inflammatory responses in adipocytes, increasing insulin resistance, and disrupting hormone secretion [12]. Obesity and overweight are associated with the development of cancers such as colorectal cancer, esophageal cancer, kidney cancer, postmenopausal breast cancer, and endometrial cancer [13,14]. In this study, a negative correlation between obesity and cancer incidence was observed. U-shaped relationship is seen between obesity and chronic disease [15,16]; however, in our study, the underweight group was not differentiated, the BMI threshold for defining obesity was set lower at 25 (which differs from Western standards), and cancer types and sex were not classified, which could be potential reasons for this finding.

This study has several limitations, so there are points to be cautious about when interpreting the results. First, this study is an ecological study, so the results obtained at the group level cannot be applied to individuals. Second, individuals who already have a disease may experience lifestyle changes such as quitting smoking, abstaining from alcohol, and controlling their weight. Third, the small population in medium-sized cities and rural areas may result in unstable values for the exposure rate and cancer incidence rate used in the analysis. Fourth, stratified analysis between males and females should be conducted; however, due to limitations in the data, stratified analysis by sex was not possible. Fifth, since risk factors differ by cancer type, it is necessary to analyze cancer incidence by cancer type. However, at the municipal level, the number of cancer cases for each type is small, which prevented analysis by cancer type.

In conclusion, the present ecological study demonstrate that the relationship between cancer incidence and health behaviors differ between large metropolitan areas and areas outside of large cities. It is necessary to confirm these findings in future large-scale cohort studies that focus on individuals.

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CONFLICTS OF INTEREST

No potential conflicts of interest were disclosed.

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