Detecting effects of holidays and seasonality on female breast cancer incidence using central cancer registry data

Qiao Wang, MA1,2; Chester L. Schmaltz, PhD1,3; Jeannette Jackson-Thompson, PhD, MSPH1,4; Yilin Yoshida, PhD, MPH1,5; Dongchu Sun, PhD2

1 Missouri Cancer Registry and Research Center (MCR-ARC); 2 University of Missouri-Columbia (MU), College of Arts & Sciences, Department of Statistics; 3 MU School of Medicine, Department of Health Management & Informatics; 4 MU Informatics Institute, Columbia, Missouri

1. BACKGROUND
- Effects of holidays and seasonality have been widely studied in fields such as economics and neuroscience.
- Few efforts have been made to perform time series analysis on the cancer registry data.

2. OBJECTIVE
Apply time series analysis techniques to daily and monthly incidence of invasive female breast cancer (FBC) to quantify holiday effects and seasonality.

3. DATA OVERVIEW
- We used Missouri Cancer Registry data. It included complete data (YY/MM/DD) on incident cases of invasive FBC from 1996 to 2015 in Missouri (N=84,792 cases).
- Daily incidence data included 7,305 days and 1,114 days had zero counts (See Figure 1).
- Monthly incidence data had 20 subseries (years) and 240 months in total (See Figure 1).

4. METHODS

4.1 Monthly Incidence Data
- The trend decomposition procedure based on Locally Weighted Scatterplot Smoothing (LOWESS) was used to obtain the structure of trend and seasonality.
- A seasonal trend decomposition procedure based on Locally Weighted Scatterplot Smoothing (LOWESS) was used to obtain the structure of trend and seasonality.

4.2 Daily Incidence Data
- Zero-inflated Poisson regression model with lagged variables was used to adjust for excess zero counts in the data. Covariates included a linear trend, holiday effects, weekend effects and seasonality.

5. RESULTS (CONTINUED)

5.1 Monthly Incidence Data
- The main goal was to decompose the daily incidence into trend, seasonality and irregular (white noise), which we expected to be random. A seasonal trend decomposition procedure based on Locally Weighted Scatterplot Smoothing (LOWESS) was used to obtain the structure of trend and seasonality.

5.2 Daily Incidence Data
- Six out of ten holidays had a significant influence on the incidence based on AIC and p-value (< 10^-5). Incidence of invasive FBC on holidays was lower than non-holidays. Among holidays, Christmas Day, Independence Day and Thanksgiving Day had the lowest incidence (See Figure 3).
- Weekends had a great negative effect on the incidence of invasive FBC. The incidence ratio of weekend to weekday was 0.1022 with CI [0.0954, 0.1095]. The probability to get a zero incidence on the weekend was 37.4% with CI [37.07%, 37.76%].
- Seasonality of one week, two weeks, one month and one year were detected. We also noticed that seasonality was relatively small compared with holiday effects.
- On average, we expected 0.04% more incidence per year.

5.3 Results continued
- Incidence data gave us more power to study the long term seasonality.
- More advanced techniques are required to improve the interpretability of the seasonality component and solve the identification problem that arose by the complex seasonality in the daily time series.

6. CONCLUSIONS
- Both daily and monthly incidence data indicated seasonality.
- Holidays and weekends had a great negative impact on the incidence of invasive FBC.

7. DISCUSSIONS
- Daily data had the advantage of study holidays effects and short term seasonality such as different weekly effects and weekend effects.
- The long term seasonality such as annual effects and different monthly effects could be easily masked by short term seasonalities. In this case, monthly incidence data gave us more power to study the long term seasonality.
- More advanced techniques are required to improve the interpretability of the seasonality component and solve the identification problem that arose by the complex seasonality in the daily time series.

Acknowledgement: MCR-ARC core activities are supported in part by a cooperative agreement between the Centers for Disease Control and Prevention (CDC) and the Missouri Department of Health and Senior Services (DHSS) (NU58DP006299-01/02) and a Surveillance Contract between DHSS and the University of Missouri.

We would like to thank the MCR-ARC Quality Assurance staff, and the staff of facilities throughout Missouri and other states’ central cancer registries for their dedication and desire for continuous quality improvement and submitting their reportable cases to MCR-ARC.

Contact: Qiao Wang (qwxv2@mail.missouri.edu).