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Physical activity and annual medical outlay in U.S. colorectal, breast and prostate cancer survivors

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ABSTRACT

Multiple chronic conditions in cancer survivors are highly prevalent and may increase health care costs for both patients and the health care system. Studies of cancer survivors reveal positive effects of physical activity (PA) on reducing risk of cancer recurrence, other chronic conditions, and secondary cancer. Few nationally representative studies have examined how physical activity levels have affected survivors' annual economic burden in the United States.

Leisure-time physical activity data from the National Health Interview Survey was linked to health care expenditure data from the Medical Expenditure Panel Survey data (2008–2012). We calculated per-person annual total medical expenditures for identified colorectal, breast, and prostate cancer survivors. We conducted multivariable analyses controlled for survival years and other sociodemographic variables. Generalized linear models were performed to measure correlation between medical expenditure and PA level using STATA 14. All analyses considered the complex survey design and were conducted in 2017.

Of 1015 cancer survivors sampled, 30% (n = 305) adhered to physical activity recommendation, while the other 70% (n = 710) did not. Multivariable-adjusted expenditure in adherence group was $9108.8 (95% CI 7410.9–10,806.7) versus 12,899.1 (95% CI 11,450.2–14,348) in non-adherence group. Stratified analyses revealed cancer survivors who adhered to their PA recommendation saved $4686.1 (1–5 years' survival time) and $2874.5 (11 or more years' survival time) on average for total health care expenditure, respectively.

Analyses of the national representative sample revealed that the economic burden of survivors from the three most prevalent cancers is substantial. Increasing survivor's PA to guidelines may reduce U.S. health care expenditure.

1. Introduction

Cancer survivors, both those undergoing active treatment and those who have lived with the diagnosis in the long term, are a steadily-growing segment of the US population (Rim et al., 2016). There are approximately 15.5 million cancer survivors in the United States, with the number projected to exceed 20 million by 2026 (Miller et al., 2016). The economic burden of cancer survivorship in the United States is substantial (Guy et al., 2015). Every seven in ten survivors suffer from multiple chronic conditions (MCCs), such as cardiovascular disease, diabetes, and obesity (Edwards et al., 2014). These conditions (Rim et al., 2016; Giovannucci et al., 2010) can complicate health care delivery (i.e., cancer treatment) and create practical concerns about survivorship care (Rim et al., 2016; Ward et al., 2014). The presence of MCCs may also increase health care costs for patients and, more broadly, for the health care system (Rim et al., 2016; Edwards et al., 2014).

The MCCs and competing causes of death are believed to stem from cancer treatment, genetic predisposition, and/or common lifestyle factors (Demark-Wahnefried and Jones, 2008). Healthy lifestyle behaviors like physical activity (PA) hold promise for reducing the risk of comorbidities, such as cardiovascular disease (Hewitt et al., 2003; Oeffinger and Hudson, 2004), diabetes (Earle et al., 2003), and obesity (Chelbowski et al., 2002), and could prevent cancer recurrence and cancer-specific mortality (Carmack Taylor et al., 2006; Parry et al., 2011; Blackburn and Wang, 2007; Demark-Wahnefried et al., 2005), and improve quality of life (Irwin et al., 2008; McNeely et al., 2006). Most of the evidence supporting the potential benefits of physical

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activity in cancer survivors comes from people diagnosed with breast, prostate, or colorectal cancer (Schmid and Leitzmann, 2014), the three most prevalent types of cancers. These cancers, to some degree, appear to have similar comorbidities associated with physical activity levels. For instance, in the United States, patients with breast and prostate cancer had a prevalence of 30–32% for comorbidity, and colorectal cancer had a prevalence of 41% (Edwards et al., 2014).

Estimating the economic burden of cancer among patients with comorbidities has become increasingly important for physicians, employers, policy makers, health care systems, and for society at large. To our best knowledge, few nationally-representative studies have examined how physical activity levels affect survivors' annual economic burden in the United States, particularly among survivors of prostate, colorectal, and breast cancers. Given the fact that more people are surviving to older ages with MCCs, it is critical to explore how public health prevention strategies, such as promoting physical activity, might affect survivors' medical costs, in the context of recent transformations that embed prevention in the broader health care delivery system. Such research can provide decision makers in both public and private sectors with evidence in the hope of implementing fundamental changes, thus altering the way in which we deliver health care.

To date, the majority of studies with detailed information on economic burden (i.e., from surveillance, epidemiology, and end results (SEER)-Medicare databases) were conducted exclusively among Medicare beneficiaries aged 65 years and older (Mariotto et al., 2011; Yabroff et al., 2011; Yabroff et al., 2008). The Medical Expenditure Panel Survey (MEPS), conducted by the Agency for Healthcare Research and Quality (AHRQ), is a nationally representative survey of the civilian non-institutionalized population of all ages in the US. MEPS is also the only national data source that measures Americans' use of, and payment for, medical care and health insurance. It provides comprehensive information about all types of health insurance, in cancer survivors of all ages. More importantly, MEPS contains socioeconomic variables, including education and income level, which are highly correlated to individual health behavior patterns but not available in clinically and insurance-based datasets like SEER-Medicare.

The purpose of this study is three fold: (1) to examine the prevalence of MCCs and physical activity adherence; (2) to examine the association between MCCs and annual health care costs; and (3) to examine how physical activity adherence affects an individual's annual total economic burden, among a nationally representative sample of prostate, colorectal, and breast cancer survivors in the United States. In particular, we examined the independent effects of physical activity adherence on total health care expenditures, and stratified by lengths of survival.

2. Methods

2.1. Study design and data source

We measured the association between annual health care expenditures and individual adherence to physical activity recommendations among cancer patients, by pooling cross-sectional data from the 2008–2012 MEPS (Cohen et al., 2009) and its corresponding National Health Interview Survey (NHIS) data (National Center for Health Statistics, 2017). Since MEPS respondents are from a subsample of NHIS with a shared unique identifier, we were able to link two datasets using the linkage files provided by the National Center for Health Statistics Data Center. The linked NHIS/MEPS data (Quality AfHRa, 2017) allowed us to access multiple variables for the same respondents from both data sources. The MEPS is an ongoing annual survey maintained by the Agency for Healthcare Research and Quality. It collects detailed information on demographics, socioeconomic status, health conditions, health service utilization and costs from a nationally representative sample of non-institutionalized civilian Americans, as well as their medical providers and employers. The linkage to NHIS further provided data on respondents' minutes of moderate and vigorous physical activities. This study included adult patients aged 18 and older, who were diagnosed with any of the three most prevalent types of cancers: prostate, colorectal, and breast cancer. Our original sample size was 1092, and listwise deletion resulted in a final analytical sample of 1015 cancer survivors.

2.2. Measures

2.2.1. Health care expenditures

Our outcome of interests was annual total health care expenditure derived from MEPS. Total health care expenditures are the sum of all direct actual third-party (private insurance, Medicare, Medicaid, Veterans Administration, other federal sources) payments made to the providers for various types of services rendered, plus the out-of-pocket spending by the individual or family during the calendar year. These services included inpatient and outpatient care, emergency department visits, prescriptions, home health care, durable medical equipment, dental care, and eye care.

2.2.2. Physical activity level

The primary independent variable indicated whether respondents adhere to physical activity recommendations. In the NHIS, participants were asked about weekly frequency and average duration of leisure-time physical activities of at least 10 min duration including 1) vigorous-intensity activities (i.e., heavy sweating or large increases in breathing or heart rate) and 2) moderate-intensity activities (i.e., light sweating or slight to moderate increases in breathing or heart rate). We first calculated total minutes per week of vigorous or moderate activity, then categorized participants into two levels of physical activity using the Centers for Disease Control and Prevention (CDC) guidelines (US Department of Health and Human Services, 2008): 1) adherence to physical activity guidelines (total minutes equal to 150 or more of moderate-intensity physical activity per week or total minutes equal to 75 min or more of vigorous-intensity physical activity per week); 2) non-adherence including insufficiently active, or inactive.

2.2.3. Covariates

We also controlled for demographic characteristics, socioeconomic status, and health conditions in multivariable analyses, including age in year, race/ethnicity (Hispanic, non-Hispanic white, non-Hispanic Black, and Non-Hispanic other), education attainment (less than high school, high school, and college and above), income level ($\geq$125% vs. $<$ 125% Federal Poverty Level), insurance status (uninsured vs. insured), cancer type (breast cancer, colon cancer, and prostate cancer), chronic conditions and cancer survival time (0–5, 6–10, 11 years and above). If one patient was diagnosed with two or more types of cancer, we used the most recent one to define survival time. The respondents were asked whether they had been told by a doctor or other health professional that they had any of the following common chronic conditions, including hypertension, cardiovascular disease, stroke, diabetes, emphysema, asthma, and arthritis. We also defined overweight or obesity with their self-reported body mass index (BMI) being $>$ 25 kg/m^2 (National Heart L, and Blood Institute, 1998). All the respondents were further categorized into three groups by their number of conditions, including 0, 1, 2 and above. For the purpose of the analyses, we categorized numbers of chronic conditions into three groups: none, one, and two and above.

2.3. Statistical analysis

Data was obtained in 2017. We first performed univariate analyses to describe the distributions of annual health care expenditure, demographic characteristics, socioeconomic status, and health conditions by physical activity adherence. We used a Pearson χ^2 test to examine whether expenditure and other covariates varied significantly between