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Diet quality is associated with reduced incidence of cancer and self-reported chronic disease: Observations from Alberta's Tomorrow Project

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ABSTRACT

The objective of this study was to assess diet quality using the Healthy Eating Index-2005 Canada (HEI-2005-Canada) and its association with risk of cancer and chronic disease in a sample of Alberta's Tomorrow Project (ATP) participants. Food frequency questionnaires completed by 25,169 participants (38% men; mean age 50.3 (9.2)) enrolled between 2000 and 2008 were used to calculate HEI-2005-Canada scores. Data from a subset of participants (n = 10,735) who reported no chronic disease at enrollment were used to investigate the association between HEI-2005-Canada score and development of self-reported chronic disease at follow-up (2008). Participants were divided into HEI-2005-Canada score quartiles. Cox proportional hazards models were used to estimate hazard ratios (HR) and 95% confidence intervals (CI) for cancer and chronic disease incidence. In this cohort, mean HEI-2005-Canada scores for men and women were 50.9 and 55.5 (maximum range 0–100), respectively. In men, higher HEI-2005-Canada score (Q4 vs. Q1) was associated with lower cancer risk (HR (95% CI) 0.63 (0.49–0.83)) over the course of follow-up (mean (SD) = 10.4 (2.3) years); the same was not observed in women. In contrast, higher overall HEI-2005-Canada score (Q4 vs. Q1) was associated with lower risk of self-reported chronic disease (0.85 (0.75–0.97)) in both men and women over follow-up (4.2 (2.3) years). In conclusion, in this cohort better diet quality was associated with a lower risk of cancer in men and lower risk of chronic disease in both sexes. Future studies with longer follow-up and repeated measures of diet may be helpful to elucidate sex-specific associations between dietary quality and disease outcomes.

1. Introduction

In 1981, a seminal report authored by Doll & Peto estimated that up to 35% of cancer deaths in the United States may be attributed to suboptimal diet. While the authors believed the estimate to be plausible, they noted that more research was needed to verify its reliability (Doll and Peto, 1981). In the subsequent decades, much work has been done to explore associations between diet and risk of cancer and chronic disease. Several comprehensive reports have synthesized the resulting evidence pertaining to diet and risk of cancer (World Cancer Research Fund and American Institute for Cancer Research, 2007) and chronic disease (World Health Organization, 2003), and translated the findings into guidelines for individuals and populations (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2005; Van Horn et al., 2016; American Diabetes Association, 2016). However, despite the vast amount of research investigating the effects of foods and nutrients on cancer and chronic disease risk, it has been noted recently that the evidence base for more precisely estimating proportions of cancer cases or cancer deaths associated with diet remains relatively weak (Blot and Tarone, 2015). Similarly, evidence for the attributable risk of diet for chronic diseases suggests that accuracy could be improved; for example, the risk of cardiovascular disease attributable to diet ranges from 9 to 37% (Georgousopoulou et al., 2014), while a Cochrane review concluded there is a lack of high-quality data for the prevention of type 2 diabetes by diet (Nield et al., 2008).

One major challenge in bolstering the evidence-base lies in characterizing diets reported by participants enrolled in large epidemiologic studies (Illner et al., 2010). In the past, many studies assessed intakes of specific nutrients or foods and explored associations with cancer and chronic disease risk. However, given that 'diet' refers to a complex

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and chronic exposure to a wide variety of foods and nutrients, there has been a burgeoning interest in studying overall dietary patterns in relation to cancer or chronic disease risk (Hu, 2002; Russell et al., 2013; Mayne et al., 2016).

Several methods have been developed to derive dietary patterns – some are data-driven (e.g. cluster (Devlin et al., 2012); principal components (van Dam, 2005)), while others are comprised of numerical indexes based on adherence to national dietary guidelines (Cespedes and Hu, 2015). Index-based approaches are growing in popularity because they are relatively easy to apply, and relate to existing guidelines. On the other hand, such approaches may be subject to limitations caused by an incomplete understanding of how diet is associated with disease risk, coupled with some uncertainty regarding the appropriateness of cut-offs used to differentiate between "good" and "poor" diets (Hu, 2002; Alkerwi, 2014; Wirt and Collins, 2008).

Regardless, index-based approaches have become increasingly used in large cohorts in the U.S. to explore associations between dietary patterns and risk of cancer and chronic diseases. One of the more commonly used approaches is the Healthy Eating Index (HEI), which is based on the recommendations from the Dietary Guidelines for Americans (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2005; Bowman et al., 1998) and adapted accordingly as the guidelines have evolved (Guenther et al., 2013). The U.S. Dietary Patterns Methods Project (DPMP) (Harmon et al., 2015; Reedy et al., 2014; George et al., 2014; Liese et al., 2015) and others (Ye et al., 2013; Mertens et al., 2015) have consistently demonstrated that higher HEI scores are associated with lower risk of all-cause mortality and improved health outcomes. More recently, work from the Women's Health Initiative reported that higher HEI scores were associated with lower risk of colorectal cancer (Vargas et al., 2016).

In Canada, Garriguet (2009) adapted the HEI-2005 to align with Canada's Food Guide (Katamay et al., 2007) recommendations, using the number of servings of food groups to calculate a score for each component, instead of the recommended intake per 1000 cal used in the U.S. version (Guenther et al., 2007, 2008). The HEI-2005-Canada score has been used in several cross-sectional studies where higher scores have been positively associated with higher educational attainment, not smoking, greater physical activity and a lower BMI (Garriguet, 2009; Sundararajan et al., 2014; Yang et al., 2014). However, to the best of our knowledge, few Canadian studies have explored associations between diet quality assessed using HEI-2005-Canada and risk of subsequent adverse health outcomes such as cancer and chronic disease.

Thus, the objectives of this study were three-fold: 1) to describe the dietary quality of Alberta's Tomorrow Project (ATP) participants using the HEI-2005-Canada scoring system, and to determine the association of this score with subsequent development of 2) cancer and 3) self-reported chronic disease.

2. Methods

2.1. Study population

ATP is a longitudinal cohort initiated in 2000 in the province of Alberta, Canada to facilitate studies of the etiology of cancer and chronic disease. Recruitment, enrollment and data collection methods for the cohort are described in detail elsewhere (Bryant et al., 2006; Robson et al., 2016). Ethical approval for the current study was granted by the Health Research Ethics Board of Alberta Cancer Committee (ID: 14-0203). The present analysis focused on participants aged 35–69 recruited between 2000 and 2008 who completed a Health and Lifestyle Questionnaire (HLQ), Canadian Diet History Questionnaire (C-DHQI) (Csizmadi et al., 2007) (described in detail below) and Past-Year Total Physical Activity Questionnaire (PYTPAQ) (Friedenreich et al., 2006) at enrollment. The HLQ collected information on socio-demographic characteristics, family health history, and self-reported chronic disease. The validated PYTPAQ assessed moderate and vigorous intensity recreational physical activity over the past year (Friedenreich et al., 2006). We only assessed moderate to vigorous levels of recreational activity due to the association of this domain of physical activity with reduced all-

Table 1
Total and component Healthy Eating Index (HEI) 2005 Canada scores of Alberta's Tomorrow Project participants at enrollment.

	All participants (n = 25,169)							
	Q1 (20.5–<47.5)		Q2 (47.5–<54.3)		Q3 (54.3–<60.5)		Q4 (60.5–82.9)	
HEI-2005-Canada total score[a] (mean (SD))	41.4 (4.8)		51.1 (1.9)		57.2 (1.7)		65.4 (3.8)	
HEI-2005-Canada components[b]	Mean score (SD)	Equivalent servings/amount[c]	Mean score (SD)	Equivalent servings/amount[c]	Mean score (SD)	Equivalent servings/amount[c]	Mean score (SD)	Equivalent servings/amount[c]
Total fruit and vegetable servings (10)	4.9 (1.9)	3.6 (1.6)	7.4 (1.9)	5.8 (2.4)	8.8 (1.5)	7.6 (3.1)	9.5 (1.0)	9.5 (4.2)
Whole fruit servings (5)	2.6 (1.5)	0.9 (0.7)	4.0 (1.3)	1.7 (1.1)	4.7 (0.8)	2.5 (1.5)	4.9 (0.4)	3.5 (2.1)
Dark green and orange vegetable servings (5)	2.9 (1.4)	1.0 (0.8)	4.0 (1.2)	1.7 (1.3)	4.5 (0.9)	2.2 (1.5)	4.7 (0.7)	2.8 (1.8)
Total grain servings (5)	2.5 (1.1)	3.6 (1.9)	3.2 (1.2)	4.5 (2.2)	3.5 (1.1)	5.0 (2.4)	3.8 (1.1)	5.4 (2.6)
Whole grain servings (5)	1.1 (0.8)	0.8 (0.6)	1.6 (1.0)	1.1 (0.7)	2.0 (1.1)	1.3 (0.8)	2.5 (1.2)	1.7 (0.9)
Milk and alternative servings (10)	4.3 (2.8)	1.1 (1.0)	5.5 (3.0)	1.5 (1.3)	6.1 (3.0)	1.8 (1.3)	7.5 (2.8)	2.3 (1.4)
Meat and alternative (grams) (10)	3.0 (1.2)	57.3 (27.2)	3.9 (1.4)	71.3 (30.0)	4.5 (1.6)	78.4 (32.7)	5.2 (1.7)	86.9 (33.9)
Unsaturated fat (grams) (10)	7.9 (2.2)	35.5 (18.9)	8.8 (1.8)	42.4 (21.1)	9.0 (1.7)	43.5 (22.1)	9.1 (1.6)	40.0 (19.7)
Saturated fat (%energy) (10)	4.3 (3.3)	12.4 (3.0)	5.6 (3.0)	11.3 (2.6)	6.8 (2.5)	10.3 (2.3)	8.3 (1.6)	8.9 (1.9)
Sodium (grams) (10)	7.4 (2.8)	2.3 (1.1)	6.0 (3.2)	2.9 (1.2)	5.5 (3.2)	3.1 (1.3)	5.2 (2.9)	3.3 (1.3)
Other food[d] (20)	0.5 (1.2)	46.3 (8.6)	1.0 (1.8)	42.4 (7.8)	1.9 (2.4)	38.7 (7.2)	4.6 (3.1)	32.5 (6.4)
Discretionary fat %		28.5 (6.7)		26.9 (6.1)		24.9 (5.5)		21.2 (4.7)
Alcohol[e] %		5.7 (9.1)		4.7 (7.4)		3.7 (5.9)		2.2 (3.6)
Beer and wine %		1.1 (2.3)		0.9 (1.8)		0.6 (1.3)		0.4 (0.8)
Added sugar %		12.2 (7.6)		10.9 (6.0)		10.1 (5.1)		9.1 (3.7)

[a] Maximum score is out of 100 points.
[b] Maximum score listed in parenthesis.
[c] Corresponding number of standard servings (as per Canada's Food Guide) represented by the mean score (SD).
[d] Other foods is the percentage of total caloric intake from discretionary fats, alcohol and added sugars.
[e] Energy from alcohol includes calories from ethanol (grams) as well as carbohydrates in wine and/or beer.