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Original Contribution

Death and Chronic Disease Risk Associated With Poor Life Satisfaction: A Population-Based Cohort Study

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Life satisfaction is increasingly recognized as an important determinant of health; however, prospective population-based studies on this topic are limited. We estimated the risk of chronic disease and death according to life satisfaction among a population-based cohort in Ontario, Canada ($n = 73{,}904$). The cohort included 3 pooled cycles of the Canadian Community Health Survey (2003–2008) linked to 6 years of follow-up (to 2015), using population-based health databases and validated disease-specific registries. The databases capture incident and prevalent cases of diabetes, cancer, chronic obstructive pulmonary disease, heart disease, and death. Multivariable Cox proportional hazard models were used to estimate hazards of incident chronic disease and death, and were adjusted for sociodemographic, behavioral, and clinical confounders, including age, sex, comorbidity, mood disorder, smoking, alcohol consumption, physical activity, body mass index, immigrant status, education, and income. In the fully adjusted models, risk of both death and incident chronic disease was highest for those most dissatisfied with life (for mortality, hazard ratio = 1.59, 95% confidence interval: 1.15, 2.19; for chronic disease, hazard ratio = 1.70, 95% confidence interval: 1.16, 2.51). In this population-based cohort, poor life satisfaction was an independent risk factor for incident chronic disease and death, supporting the idea that interventions and programs that improve life satisfaction will affect population health.

chronic disease; life satisfaction; mortality

Abbreviations: ADG, Aggregated Diagnosis Group; CCHS, Canadian Community Health Survey; CHD, coronary heart disease; CI, confidence interval; COPD, chronic obstructive pulmonary disease; OHIP, Ontario Health Insurance Plan.

Life satisfaction, a dimension of quality of life encompassing physical, mental, and social well-being, is increasingly being recognized as a meaningful determinant of health (1). Life satisfaction is part of the broader construct of psychological well-being, which also includes domains such as positive emotion, optimism, and purpose (2). Self-reported measures of life satisfaction have been shown to be stable and reliable over time (3, 4). Poor life satisfaction has been linked repeatedly to undesirable health outcomes, including elevated risk of chronic disease (2, 5, 6) and death (7–9). This association is observed less consistently after adjusting for key predictors of incident chronic disease, including lifestyle and comorbidity (10).

These findings suggest that life satisfaction may influence chronic disease and death outcomes independently of traditional risk factors. However, in observational studies to date, the focus either has been on selected populations (e.g., women or older adults) or not explicitly on capturing life satisfaction before the chronic disease incidence or death, and the study designs were varied in their control for confounding variables, particularly variables accounting for health status. Consequently, in these studies, researchers had limited ability to assess a comprehensive range of health outcomes prospectively, independent of behavioral and sociodemographic risk factors. Using a large, representative, population-based cohort offers greater opportunity to appropriately assess the direct impact of life satisfaction on chronic disease and death risk, and can provide important evidence to inform prevention efforts.

The objective for this study was to determine the association between life satisfaction and chronic disease and death in a population-based prospective cohort, using validated disease outcomes for key burdensome chronic diseases (namely, diabetes, coronary heart disease (CHD), chronic obstructive respiratory disease (COPD), and cancer) and population vital statistics for death. In our analyses, we leveraged powerful linkages between survey

responses and administrative health data, which allowed us to prospectively follow-up chronic disease and mortality outcomes for up to 6 years after life satisfaction was assessed. Multilinked data were used to establish whether the association persisted after adjustment for age and sex, comorbidity measured using health records, mood disorder, health-relevant behaviors (i.e., smoking, alcohol consumption, and physical activity), and immigrant status.

METHODS

Data sources

Participants were pooled from 3 cycles of the Canadian Community Health Survey (CCHS): cycle 2.1 (2003–2004), cycle 3.1 (2005–2006), and cycle 4.1 (2007–2008). Each participant was linked deterministically (i.e., via exact matching) and individually to population-based health administrative databases for Ontario, Canada. Deterministic linkage refers to an all-or-nothing linkage approach, wherein records are matched on the basis of an exact match of unique identifying information. This approach is superior in contrast to probabilistic linkage, where exact matches may not be found (11). The CCHS is a cross-sectional survey administered by Statistics Canada and is representative of 98% of the Canadian population aged 12 years or older living in private dwellings; response rates are greater than 75%. The CCHS gathers up-to-date, cross-sectional data about the distribution of health determinants and outcomes, as well as health care use, across Canada (11). CCHS data are representative at national and provincial levels; detailed survey methodology is available elsewhere (12).

This study received ethics approval from the University of Toronto Research Ethics Board (protocol reference no. 32666). Of survey respondents, 84% consented to have their responses linked to the data from Ontario's single-payer health insurance program, the Ontario Health Insurance Plan (OHIP), which contains all the data to capture that are relevant to chronic disease diagnosis. Our study cohort was restricted to CCHS respondents who consented to have their data linked, reported on life satisfaction, were eligible for OHIP throughout the follow-up period, and were aged 18 years or older as of the CCHS interview date. All survey respondents were also linked to Ontario's population registry, the Registered Persons Database, which captures core demographic (i.e., age, sex) and death information for all OHIP-eligible residents.

The analytic sample included adults who reported on life satisfaction, were eligible for OHIP throughout the study period, and did not have a prevalent chronic disease at baseline. Because OHIP eligibility requires residency in Ontario, Canada, our sample was effectively limited to Ontario CCHS respondents. Overall, 101,719 individuals were successfully linked across the 3 combined survey cycles. After removing duplicate records ($n = 532$) and excluding people younger than 18 years of age ($n = 9{,}633$), those missing life satisfaction data ($n = 1{,}723$), and those without complete OHIP eligibility ($n = 121$), there were 89,710 individuals included, of whom 73,904 had no prevalent chronic disease (i.e., diabetes, CHD, or COPD) at baseline. The creation of our analytic sample is described in Web Figure 1 (available at https://academic.oup.com/aje).

Variable definitions

Exposure. Information about participants' life satisfaction was captured using the question "How satisfied are you with your life in general?" with response options of "very satisfied," "satisfied," "neither satisfied nor dissatisfied," "dissatisfied" or "very dissatisfied." Very dissatisfied and dissatisfied were pooled, resulting in a 4-level life satisfaction variable as the main independent variable. Self-report has been shown to be a reliable and valid measure of life satisfaction in population survey data (13, 14). Furthermore, single-item measures of life satisfaction perform highly similarly to equivalent multidimensional measures (15).

Outcome. Information on chronic conditions was captured using validated derived chronic disease case–detection algorithms for diabetes, myocardial infarction, congestive heart failure, and COPD (16–19). Incident myocardial infarction and congestive heart failure cases were grouped together as CHD in the analysis. Cancer data were captured from the Ontario Cancer Registry (20). Information on deaths was captured using the Registered Persons' Database and Vital Statistics data.

Other covariates. Interview questions were used to capture baseline sociodemographic and behavioral covariates, body mass index, and mood disorder diagnoses. Sociodemographic characteristics captured included age, sex, household income quintile, household educational attainment, and immigrant status. Health-relevant behaviors included smoking, alcohol consumption, and physical activity level. Mood disorder diagnosis was based on participant self-report of a physician-diagnosed mood disorder, such as depression, bipolar disorder, mania, or dysthymia. Comorbidity at baseline was captured using Aggregated Diagnosis Group (ADG) scores (21) based on data from administrative health records. ADG clusters are broad diagnostic categories that can be derived from clinical diagnoses recorded in administrative health records. Examples of ADG groups include Asthma (ADG 6); Chronic Medical: Unstable, such as anemia or cystic fibrosis (ADG 11); and Signs/Symptoms: Minor, such as headache or limb pain (ADG 28) (21, 22). ADG scores, which measure the number of ADGs a patient has a diagnosis in, have been validated for use in Ontario and are reliable for morbidity adjustment (22, 23).

Statistical analyses

Cox proportional hazards models were run to estimate the hazards associated with baseline life satisfaction on risk of separate chronic disease endpoints (i.e., diabetes, cancer, COPD, CHD) developing and death. Time was defined as the interval between interview date and an event (i.e., incident chronic disease or death) or censoring. Censoring took place 6 years after the interview date; at the study endpoint of March 31, 2015; or, for chronic disease models only, in case of death.

Three models were run to study the association and compare the impact of confounder adjustment. The first model was adjusted for age, sex, and survey cycle. Second, a minimally adjusted model included age, sex, survey cycle, ADG comorbidity score, household income quintile, and immigrant status. Finally, a fully adjusted model was fit that included the terms in the minimally adjusted model plus mood disorder diagnosis, smoking, alcohol consumption, physical activity level, body mass

Table 1. Baseline Characteristics (Weighted) of Pooled Study Participants With No Chronic Conditions at Baseline According to Life Satisfaction, Surveyed From 2003 to 2007 and Followed to 2015 (n = 73,904), Canadian Community Health Survey Ontario, Canada

Characteristic	Life Satisfaction			
	Very Satisfied or Satisfied, % (n = 67,366)[a]	Neither Satisfied or Dissatisfied, % (n = 4,105)[a]	Dissatisfied, % (n = 2,017)[a]	Very Dissatisfied, % (n = 416)[a]
Sex				
Male	48.4	46.6	50.3	43.8
Female	51.6	53.4	49.7	56.2
Age group, years				
<40	45.2	50.4	37.5	33.9
40–49	23.2	21.0	31.1	26.9
50–59	15.9	15.8	19.6	24.2
60–69	9.1	7.5	7.6	6.3
70–79	4.8	3.8	2.9	5.2
≥80	1.8	1.5	1.3	3.5
Immigrant				
No	69.1	62.9	60.6	64.1
Yes	30.6	36.9	38.9	35.7
Highest education level in household				
No postsecondary	79.0	75.1	71.2	66.1
Postsecondary	5.8	7.5	8.0	10.3
Household income quintile				
1 (lowest)	13.0	24.7	31.5	37.7
2	16.5	20.5	17.7	17.9
3	18.2	17.8	14.5	14.2
4	21.8	14.3	15.4	10.5
5 (highest)	22.3	13.6	12.3	9.8
ADG comorbidity score[b,c]	2.92 (0.05)	3.79 (0.24)	5.06 (0.37)	6.80 (0.64)
Smoking status				
Current smoker	22.4	32.6	38.8	40.5
Former smoker	21.6	17.6	19.5	18.6
Nonsmoker	55.8	49.7	41.4	40.9
Alcohol consumption				
Current nondrinker	17.4	21.0	24.7	28.6
Occasional drinker	15.9	20.2	22.6	28.4
Regular drinker	58.8	50.4	42.4	34.6
Occasional binge drinker	7.6	8.1	9.6	8.1
Physical activity status				
Active	26.1	18.1	17.4	17.7
Moderate	25.6	22.1	18.7	15.1
Inactive	48.3	59.7	63.8	67.1
Body mass index[d]				
Underweight (<18.5)	2.7	4.1	3.9	4.9
Normal weight (18.5–24.9)	47.2	47.1	43.2	39.9
Overweight (25.0–29.9)	33.3	29.4	31.2	31.0
Moderately obese (30.0–34.9)	10.4	9.7	11.9	16.7
Very/severely obese (≥35.0)	6.5	9.6	9.8	7.6

Table continues

Table 1. Continued

Characteristic	Life Satisfaction			
	Very Satisfied or Satisfied, % (n = 67,366)[a]	Neither Satisfied or Dissatisfied, % (n = 4,105)[a]	Dissatisfied, % (n = 2,017)[a]	Very Dissatisfied, % (n = 416)[a]
Mood disorder	4.9	16.2	34.7	41.8
Average annual health care costs, CAD[b]	1,798.64 (24.35)	2,272.85 (136.53)	3,579.23 (325.12)	5,720.66 (1,067.73)

Abbreviations: ADG, Aggregated Diagnosis Group; BMI, body mass index; CAD, Canadian dollars.

[a] Weighted using bootstrap weights provided by Statistics Canada; sampling weights were used to produce population estimates.

[b] Values are expressed as mean (standard error).

[c] A weighted score based on an individual's ADGs. Austin's weighted ADG score has been described and validated elsewhere (39).

[d] Weight (kg)/height (m^2).

index, and household educational attainment. The proportional hazard assumption was checked and verified for all models.

Bootstrap sampling weights provided by Statistics Canada were applied, using balanced repeated replication, to all analyses to account for the complex survey design of the CCHS (24). All analyses, including descriptive statistics, were based on the weighted cohort, which is representative of the Ontario adult population.

We conducted a sensitivity analysis to further limit the potential influence of reverse causation. We estimated lagged models, excluding cases occurring within 2 years of the interview date, to capture any baseline disease that may have influenced reporting of life satisfaction but was not captured in the diagnostic cohorts. We also estimated models for the age strata younger than 60 years and 60 years or older to assess whether the associations between life satisfaction and chronic disease and death differed by age. All statistical analyses were performed using SAS, version 9.4 (SAS Institute, Inc., Cary, North Carolina).

RESULTS

Cohort characteristics at baseline are shown in Table 1. The cohort had a mean follow-up time of 2,041 days (5.6 years) for chronic disease (minimum of 0 days, maximum of 2,190 days (6 years)) and 2,129 days (5.8 years) for death (minimum of 18 days, maximum of 2,190 days (6 years)).

Most respondents (n = 67,366, 91%) reported being satisfied or very satisfied with their life at baseline. Those who reported being very dissatisfied with life had a higher mean ADG comorbidity score when compared with very satisfied or satisfied respondents, indicating a greater burden of overall morbidity (6.80 vs. 2.92) (Table 1). Very dissatisfied respondents were also more likely to belong to the lowest income quintile (37.7% vs. 13.0%) and more likely to report current smoking (40.5% vs. 22.4%) and physical inactivity (67.1% vs. 48.3%) than very satisfied or satisfied respondents (Table 1).

Among those with no prevalent chronic conditions of interest at baseline, poor life satisfaction at baseline was associated with increased risk of a chronic disease endpoint of diabetes, cancer, CHD, or COPD. In the age-sex-cycle adjusted model, the hazard ratio for any chronic disease endpoint was 2.49 for individuals who reported being very dissatisfied at baseline, compared to those who reported being satisfied or very satisfied (95% confidence interval (CI): 1.69, 3.67) (Table 2). Mortality risk also increased with increasing levels of dissatisfaction (Figure 1). In the equivalent age-sex-cycle adjusted model for mortality, those who reported being very dissatisfied at baseline experienced 2.51 times the risk of death of those who were satisfied or very satisfied at baseline (95% CI: 1.81, 3.47) (Table 3). In models adjusted for age, sex, and survey cycle for chronic disease endpoints and death, a dose-response effect was seen for increasing levels of life dissatisfaction, with the highest risk of incident chronic disease and death observed among individuals who were very dissatisfied with their lives at baseline (Tables 2 and 3). Compared with the very satisfied or satisfied group, statistically significant hazards were observed in the model adjusted for age, sex, and survey cycle for all other life-satisfaction groups, for both chronic disease and death (Tables 2 and 3).

The observed associations were attenuated by multivariable adjustment for ADG comorbidity score, household income quintile, and immigrant status (minimally adjusted models), and for smoking, alcohol consumption, physical activity level, household educational attainment, and body mass index (fully adjusted models) (Tables 2 and 3). The hazard ratio for incident chronic disease for the very dissatisfied group compared with the very satisfied or satisfied group was 1.70 in the fully adjusted model (95% confidence interval (CI): 1.16, 2.51), compared with hazard ratios of 2.49 (95% CI: 1.69, 3.67) in the model adjusted for age, sex, and survey cycle and 2.14 (95% CI: 1.46, 3.15) in the minimally adjusted model (Table 2). A similar pattern was observed for the same group in the death model, for which the hazard ratio estimate was 1.54 (95% CI: 1.10, 2.16) in the fully adjusted model, compared with hazard ratios of 2.51 (95% CI: 1.81, 3.47) and 1.81 (95% CI: 1.30, 2.50) in the model adjusted for age, sex, and survey cycle and the minimally adjusted model, respectively (Table 3). Despite the attenuation of effect size, the dose response seen in the model adjusted for age, sex, and survey cycle was still observed. For each model, both chronic disease and death risks were highest among individuals who reported being very dissatisfied at baseline and were lowest among those who reported being very satisfied or satisfied (Tables 2 and 3).

Table 2. Multivariable Adjusted Hazard Models for Life Satisfaction and of Any Incident Chronic Disease for Pooled Participants Surveyed From 2003 to 2007 and Followed to 2015 (n = 73,904), Canadian Community Health Survey, Ontario, Canada

Life Satisfaction	No.[a]	Adjusted for Age, Sex, and Survey Cycle		Minimally Adjusted[b]		Fully Adjusted[c]	
		HR	95% CI	HR	95% CI	HR	95% CI
Very satisfied or satisfied	67,366	1.00	Referent	1.00	Referent	1.00	Referent
Neither satisfied nor dissatisfied	4,105	1.17	0.99, 1.38	1.07	0.90, 1.25	0.96	0.83, 1.13
Dissatisfied	2,017	1.62	1.37, 1.92	1.42	1.19, 1.69	1.19	1.00, 1.43
Very dissatisfied	416	2.49	1.69, 3.67	2.14	1.46, 3.15	1.70	1.16, 2.51
2-sided P for trend		<0.0001		<0.0001		0.0014	

Abbreviations: CI, confidence interval; HR, hazard ratio.
[a] Unweighted.
[b] Minimally adjusted model includes age, sex, survey cycle, adjusted diagnostic groups comorbidity score, household income quintile, and immigrant status.
[c] Fully adjusted model includes age, sex, survey cycle, adjusted diagnostic groups comorbidity score, household income quintile, household educational attainment, immigrant status, mood disorder, smoking, alcohol consumption, physical activity level, and body mass index.

When the fully adjusted model was fit for specific chronic conditions, the strongest association between life satisfaction and chronic disease was observed for COPD (Table 4). Individuals who reported being very dissatisfied at baseline experienced a 76% higher risk of having COPD than those who were very satisfied or satisfied at baseline (hazard ratio = 1.76, 95% CI: 0.90, 3.43). The trend in COPD risk was statistically significant across all levels of baseline life satisfaction (Table 4). The trend across life satisfaction groups was also significant for diabetes and CHD risk, though the effect-size estimates for chronic disease risk in the very dissatisfied group were smaller than observed with COPD (for diabetes, hazard ratio = 1.27, 95% CI: 0.82, 1.97; for CHD, hazard ratio = 1.65, 95% CI: 0.73, 3.75). The weakest association was seen in cancer outcomes, which did not differ significantly by baseline life-satisfaction groups (Table 4). In all cases, including for cancer, a dose-response pattern was observed wherein hazard ratio estimates increased with each increasing level of life dissatisfaction (Table 4). Additional disease-specific results from the model adjusted for age, sex, and survey cycle and the minimally adjusted model are shown in Web Table 1.

Sensitivity analysis

The results of our lagged-model sensitivity analysis are listed in Table 5. Excluding cases with chronic disease diagnoses received not more than 2 years after survey response date led to a slight attenuation (<10%) of hazard ratio estimates for CHD, COPD, and any incident chronic disease compared with the primary models (Table 5; for comparison see Tables 2 and 4). However, we observed no notable changes in these models relative to the overall pattern, direction, or statistical significance of the observed associations (Table 5). In the age-stratified sensitivity analysis (<60 years vs. ≥60 years), risk for chronic disease and death was consistently associated in the fully adjusted models with being very dissatisfied. For those younger than 60 years, the adjusted hazard ratios for chronic disease and death were, respectively, 1.78 (95% CI: 1.02, 3.11) and 2.21 (95% CI: 1.19, 4.08). For those age 60 years or older, the respective hazard ratios for chronic disease and death were 2.10 (95% CI: 1.23, 3.57) and 1.39 (95% CI: 0.95, 2.03).

DISCUSSION

In this large, population-based cohort study, we demonstrate that poor life satisfaction is associated with increased development of multiple chronic diseases and risk for death. Risk of both death and chronic disease increased for each progressive level of self-reported life dissatisfaction and was highest among individuals who reported being very dissatisfied with their lives at baseline. After adjustment for several demographic, socioeconomic, and behavioral traits, the association between life satisfaction and studied health outcomes was attenuated but not eliminated. When the fully adjusted model was implemented for specific chronic disease outcomes (i.e., diabetes, CHD, COPD, and cancer), significant associations with life satisfaction were seen for diabetes, CHD, and COPD, but not for cancer.

These findings demonstrate that poor life satisfaction is associated with elevated risk of incident chronic disease and

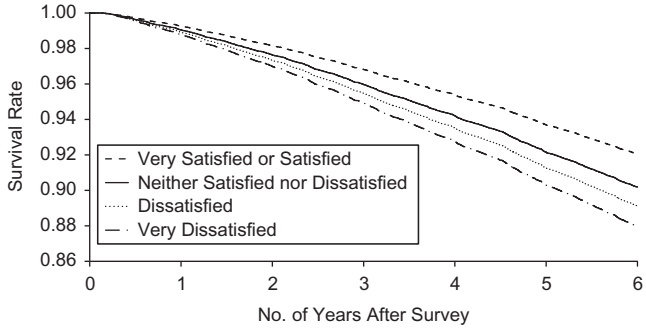

Figure 1. Adjusted survival curves according to baseline life satisfaction among a cohort of 73,904 pooled Canadian Community Health Survey participants surveyed from 2003 to 2007 and followed to 2015 (Ontario, Canada).

Table 3. Multivariable Adjusted Hazard Models for Life Satisfaction and Risk of Death for Pooled Participants Surveyed From 2003 to 2007 and Followed to 2015 (n = 73,904), Canadian Community Health Survey, Ontario, Canada

Life Satisfaction	No.[a]	Adjusted for Sex, Age, and Survey Cycle		Minimally Adjusted[b]		Fully Adjusted[c]	
		HR	95% CI	HR	95% CI	HR	95% CI
Very satisfied or satisfied	67,366	1.00	Referent	1.00	Referent	1.00	Referent
Neither satisfied nor dissatisfied	4,105	1.36	1.15, 1.61	1.21	1.02, 1.43	1.05	0.88, 1.25
Dissatisfied	2,017	1.91	1.56, 2.35	1.50	1.22, 1.85	1.26	1.00, 1.58
Very dissatisfied	416	2.51	1.81, 3.47	1.81	1.30, 2.50	1.54	1.10, 2.16
2-sided P for trend		<0.0001		0.0002		0.0038	

Abbreviations: CI, confidence interval; HR, hazard ratio.
[a] Unweighted.
[b] Minimally adjusted model includes age, sex, survey cycle, adjusted diagnostic groups comorbidity score, household income quintile, and immigrant status.
[c] Fully adjusted model includes age, sex, survey cycle, adjusted diagnostic groups comorbidity score, household income quintile, household educational attainment, immigrant status, mood disorder, smoking, alcohol consumption, physical activity level, and body mass index.

death, independent of sociodemographic, health, and behavioral risk factors traditionally conceived as being predictive of health outcomes. Importantly, our findings are also independent of diagnosed mood disorders, providing strong evidence that life satisfaction, and not merely the absence of psychological distress, can have meaningful implications for future chronic disease risk. Because life satisfaction was measured at baseline with up to 6 years of follow-up for chronic disease and death outcomes, and given that baseline comorbidity was accounted for, it is unlikely that the observed association can be explained by reverse causation. The potential influence of reverse causation is further limited by the findings of our sensitivity analysis, which excluded from models incident cases occurring within2 years after interview. These lagged models showed no meaningful differences in the direction or statistical significance of all observed associations and only a slight attenuation of effect size. The results of our work, in concordance with findings from other settings, suggest subjective well-being may directly affect individual health outcomes (7).

The attenuation of the hazards after adjustment suggests that the association between life satisfaction and risk for chronic disease and death may be confounded by lifestyle-related risk factors. It may be that individuals who are most dissatisfied with their life may also engage in unhealthy lifestyle habits, which contribute to their chronic disease risk. This is consistent with research in the literature hypothesizing that the association between life satisfaction and death is mediated by changes in lifestyle factors (e.g., physical activity, smoking, or diet) (10). For instance, negative affect has been correlated with unhealthy behaviors, including initiation and maintenance of smoking (25). These results support the need for analyses to be conducted to understand the nature of the association between life satisfaction and health behaviors and the mechanisms by which they may influence chronic disease and death risk.

Biological mechanisms by which life satisfaction affects chronic disease risk have been proposed in the literature. These proposed mechanisms broadly implicate systemic biological processes. Greater life satisfaction can be linked to restorative processes, such as elevated serum antioxidant levels (26). Simultaneously, life satisfaction may be protective against deteriorative processes and indicators, including dysregulated cortisol output

Table 4. Fully Adjusted[a] Hazard Models for Life Satisfaction and of Specific Chronic Disease for Pooled Participants Surveyed From 2003 to 2007 and Followed to 2015 (n = 73,904), Canadian Community Health Survey, Ontario, Canada

Life Satisfaction	No.[b]	Risk of Diabetes		Risk of Coronary Heart Disease		Risk of COPD		Risk of Cancer	
		HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Very satisfied or satisfied	67,366	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
Neither satisfied nor dissatisfied	4,105	0.98	0.78, 1.22	1.26	0.96, 1.67	1.02	0.77, 1.34	0.91	0.73, 1.12
Dissatisfied	2,017	1.10	0.86, 1.39	1.46	1.12, 1.92	1.46	1.07, 1.98	0.95	0.72, 1.25
Very dissatisfied	416	1.27	0.82, 1.97	1.65	0.73, 3.75	1.76	0.90, 3.43	1.19	0.75, 1.89
2-sided P for trend		0.025		0.001		0.0005		0.82	

Abbreviations: CI, confidence interval; COPD, chronic obstructive pulmonary disease; HR, hazard ratio.
[a] Fully adjusted model includes age, sex, survey cycle, adjusted diagnostic groups comorbidity score, household income quintile, household educational attainment, immigrant status, mood disorder, smoking, alcohol consumption, physical activity level, and body mass index.
[b] Unweighted.

Table 5. Fully Adjusted[a] Hazard Models for Life Satisfaction and of Specific Chronic Disease for Pooled Participants Surveyed From 2003 to 2007 and Followed to 2015, Excluding Cases Occurring Within 2 Years of Interview Date (n = 73,904), Canadian Community Health Survey, Ontario, Canada

Life Satisfaction	No.[b]	Risk of Diabetes		Risk of Coronary Heart Disease		Risk of COPD		Risk of Cancer		Risk of Any Incident Chronic Disease		Risk of Death	
		HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Very satisfied or satisfied	67,366	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
Neither satisfied nor dissatisfied	4,105	1.02	0.78, 1.33	1.35	0.99, 1.85	1.06	0.77, 1.47	0.84	0.65, 1.08	0.99	0.82, 1.21	1.00	0.83, 1.20
Dissatisfied	2,017	1.26	0.93, 1.69	1.46	1.06, 2.01	1.56	1.08, 2.25	1.08	0.80, 1.46	1.34	1.07, 1.69	1.28	1.00, 1.64
Very dissatisfied	416	1.47	0.84, 2.55	1.49	0.44, 5.07	1.63	0.89, 2.98	1.22	0.70, 2.14	1.81	1.06, 3.10	1.61	1.12, 2.31
2-sided P for trend		0.014		0.0047		0.0002		0.71		0.0049		0.0099	

Abbreviations: CI, confidence interval; COPD, chronic obstructive pulmonary disease; HR, hazard ratio.

[a] Fully adjusted model includes age, sex, survey cycle, adjusted diagnostic groups comorbidity score, household income quintile, household educational attainment, immigrant status, mood disorder, smoking, alcohol consumption, physical activity level, and body mass index.

[b] Unweighted.

(27), neuroendocrine pathways, and inflammation (28). In the proposed pathway, individuals with positive life satisfaction experience greater expression of health-protective processes and less activity of deleterious biological pathways (4), reducing their risk of chronic disease and death (26). The physiological mechanism connecting life satisfaction and morbidity is best described in the literature for diseases of the cardiovascular system (2). This connection is consistent with the significant associations observed in our analyses between life satisfaction and CHD. Our results suggest that diabetes and COPD outcomes are also strongly linked to life satisfaction.

We did not observe a significant association between life satisfaction and cancer after adjusting for sociodemographic and behavioral covariates, which is inconsistent with other findings (29, 30). However, few studies have been published regarding the association between incident cancer and psychological well-being, which is conceptually distinct from the absence of psychological distress (31). This is an area that warrants more investigation. In the literature on psychological distress and cancer outcomes, the findings are mixed. Null associations between psychological distress traits and incident cancer have been shown in several prospective cohort analyses (32–34). However, site-specific analyses revealed positive associations between psychological distress and pancreatic and prostate cancers (35, 36), and null or negative associations with breast and smoking-related cancers (32, 34, 35, 37). These findings suggest that the association between psychological distress and cancer outcomes may be heterogeneous and dependent on cancer site. It is possible that site-specific analyses of the association between psychological distress and life satisfaction would reveal the same heterogeneity.

Potential limitations of this study include the use of baseline survey data to capture health behavior information, with no ability to capture or account for changes in these behaviors over the study period. For consistency, survival was modelled for 6 years after death for all individuals participating in the CCHS. It is possible that behavioral patterns may have changed during the follow-up time, with implications for chronic disease and death risk. Also, we used a single-item measure of life satisfaction, which is not as comprehensive as a multidimensional scale. Although single-item scales have been shown to perform similarly to multidimensional scales, their scope is somewhat limited (15).

The study findings also may have been affected by reverse causation if survey respondents had prevalent chronic disease at baseline that was not captured by the existing disease cohorts. In this case, self-reported life satisfaction at baseline may have been negatively affected by the symptoms of undiagnosed disease. The disease cohorts have been validated and effectively identify population cohorts with diagnosed disease, which, in a single-payer system, likely represents the majority of symptomatic cases (16, 18, 19, 38). In addition, results from our sensitivity analysis using lagged models did not meaningfully differ from those of our primary analysis, further limiting the risk of reverse causation being the explanation.

This study joins a growing body of evidence characterizing life satisfaction as an important risk factor for future disease and death. By using a large, representative, and population-based cohort and integrating data for a wide variety of disease risk factors, its findings lend compelling support to the idea

that life satisfaction can affect chronic disease and death risk independently of traditional physiological pathways and independently of psychological distress. This research supports the need for more upstream interventions and social programs that will ensure all can have an opportunity for maximum life satisfaction. Additional research that elucidates the specific mechanism by which this association takes place can be used to refine where best to intervene and protect individuals and improve population health.

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