

Tilburg University

Personality, health behaviors and quality of life among colorectal cancer survivors

Husson, O.; Denollet, J.; Ezendam, N.P.M.; Mols, F.

Published in:

Journal of Psychosocial Oncology

DOI:

[10.1080/07347332.2016.1226227](https://doi.org/10.1080/07347332.2016.1226227)

Publication date:

2017

Document Version

Publisher's PDF, also known as Version of record

[Link to publication in Tilburg University Research Portal](#)

Citation for published version (APA):

Husson, O., Denollet, J., Ezendam, N. P. M., & Mols, F. (2017). Personality, health behaviors and quality of life among colorectal cancer survivors: Results from the PROFILES registry. *Journal of Psychosocial Oncology*, 35(1), 61-76. <https://doi.org/10.1080/07347332.2016.1226227>

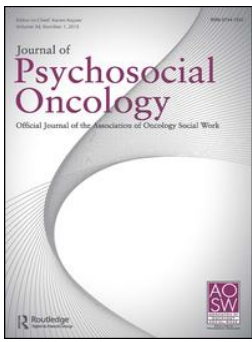
General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.



Personality, health behaviors, and quality of life among colorectal cancer survivors: Results from the PROFILES registry

Olga Husson, Johan Denollet, Nicole P. M. Ezendam & Floortje Mols

To cite this article: Olga Husson, Johan Denollet, Nicole P. M. Ezendam & Floortje Mols (2017) Personality, health behaviors, and quality of life among colorectal cancer survivors: Results from the PROFILES registry, Journal of Psychosocial Oncology, 35:1, 61-76, DOI: 10.1080/07347332.2016.1226227

To link to this article: <https://doi.org/10.1080/07347332.2016.1226227>



© 2017 The Author(s). Published with license by Taylor & Francis Group, LLC © Olga Husson, Johan Denollet, Nicole P. M. Ezendam, and Floortje Mols.



Accepted author version posted online: 17 Oct 2016.
Published online: 27 Oct 2016.



Submit your article to this journal [↗](#)



Article views: 519



View related articles [↗](#)



View Crossmark data [↗](#)



Citing articles: 1 View citing articles [↗](#)

ARTICLE

 OPEN ACCESS

Personality, health behaviors, and quality of life among colorectal cancer survivors: Results from the PROFILES registry

Olga Husson, PhD^a, Johan Denollet, PhD^b, Nicole P. M. Ezendam, PhD^{b,c}, and Floortje Mols, PhD^{b,c}

^aDepartment of Medical Psychology, Radboud University Medical Center, Nijmegen, The Netherlands; ^bDepartment of Medical and Clinical Psychology, CoRPS-Center of Research on Psychology in Somatic Diseases, Tilburg University, Tilburg, The Netherlands; ^cComprehensive Cancer Centre the Netherlands, Eindhoven Cancer Registry, Eindhoven, The Netherlands

ABSTRACT



Purpose: There is a paucity of research looking into the relationship between personality and health behaviors among cancer survivors. The aim of this study was to investigate whether Type D personality and its two constituent components, negative affectivity (NA) and social inhibition (SI), are associated with health behaviors, quality of life (QoL), and mental distress among colorectal cancer (CRC) survivors. *Methods:* A population-based study was conducted among 2,620 CRC patients diagnosed between 2000 and 2009, who completed measures of personality (DS14), health behaviors, QoL (EORTC QLQ-C30), and mental distress (hospital anxiety and depression scale). *Results:* Personality was not associated with body mass index or smoking. Those scoring high on NA (with or without SI) were more often nondrinkers and less physically active compared to those scoring high on neither or only SI. Personality (high scores NA) and health behaviors (inactivity) were independently associated with poor QoL and mental distress. *Conclusions:* CRC survivors with high scores on NA are at risk of being inactive and have worse health outcomes.

KEYWORDS

colorectal cancer; distress; health behaviors; quality of life; Type D personality

Introduction

With the ongoing improvements in early detection and treatment along with the aging of population, the number of colorectal cancer (CRC) survivors is rapidly increasing in the Western world. In the Netherlands, there were about 77,000 CRC survivors in 2009 and expected to increase to 121,000 in 2020 (Dutch Cancer Society, 2011). CRC has increasingly been referred to as a chronic disease since the majority (53%) of the patients survive relatively long term (>10 years after

CONTACT Olga Husson, PhD  olga.husson@radboudumc.nl  Department of Medical Psychology, Radboud University Medical Center, PO Box 9101, 6500 HB Nijmegen, The Netherlands.

© 2017 Olga Husson, Johan Denollet, Nicole P. M. Ezendam, and Floortje Mols. Published with license by Taylor & Francis Group, LLC. This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

diagnosis) (Dutch Cancer Registry, 2012). Many of those CRC survivors face continuing physical and psychosocial problems due to cancer and its treatment, which could negatively impact health-related quality of life (HRQoL) (Denlinger & Barsevick, 2009).

Health behaviors like engaging in regular physical activity, increased fruit and vegetable intake, moderate alcohol consumption, not smoking, and maintaining a healthy weight have been shown to play an important role in CRC prevention, mortality, survival, and recurrence (Je, Jeon, Giovannucci, & Meyerhardt, 2013; Johnson et al., 2013; Simons, et al., 2013; Vrieling & Kampman, 2010). In addition, studies have shown higher overall HRQoL and less fatigue, pain, insomnia, and mental distress among CRC survivors who are physically more active, have a high vegetable and fruit intake, and who do not smoke (Blanchard, Courneya, & Stein, 2008; Buffart et al., 2012; Grimmert, Bridgewater, Steptoe, & Wardle, 2011; Lynch, Cerin, Owen, Hawkes, & Aitken, 2008). Given these favorable HRQoL outcomes of health behaviors among CRC survivors, it is important to gain an insight into the predictors of health behaviors.

Several studies relate personality to health behaviors (Anton & Miller, 2005; De Moor, Beem, Stubbe, Boomsma, & De Geus, 2006; Malouff, Thorsteinsson, Rooke, & Schutte, 2007; McWilliams & Asmundson, 2001; Munafo, Zettler, & Clark, 2007; Rhodes, Courneya, & Jones, 2004; Shankar, McMunn, Banks, & Steptoe, 2011; Valtonen et al., 2009). Most studies focused on the five-factor model of personality and reported neuroticism, extraversion, and conscientiousness as reliable correlates of health behavior. For example, persons with negative emotion personality traits such as anxiety (McWilliams & Asmundson, 2001), anger and hostility (Anton & Miller, 2005), loneliness (Shankar et al., 2011), and hopelessness (Valtonen et al., 2009) may be less likely to engage in physical activity compared to those with lower scores on these traits. In addition, high scores on activity (Rhodes et al., 2004) and sensation seeking (de Moor et al., 2006), as facets of extraversion, were positively correlated to physical activity. Both increased extraversion and increased neuroticism were associated with an increased likelihood of being a smoker rather than a nonsmoker (Munafo et al., 2007). A meta-analysis showed that alcohol consumption was associated with low conscientiousness, low agreeableness, and high neuroticism (Malouff et al., 2007).

In recent years, Type D (distressed) personality has become an important research topic in the field of medical psychology (O'Dell, Masters, Spielmann, & Maisto, 2011). Type D personality has been described as the tendency to experience a high joint occurrence of negative affectivity (NA) and social inhibition (SI) (Denollet, 2005). People who score high on NA have the tendency to experience negative emotions, while people who score high on SI have the tendency not to express these emotions, because of fear of rejection or disapproval by others (Denollet, 2005). NA is positively correlated with neuroticism ($r = 0.68$) and SI is negatively correlated with extraversion ($r = -0.59$) (Denollet, 2005). Type D personality, the combination of the two personality traits NA and SI, possibly leads

to poor health behaviors. Healthy individuals and people with a cardiac condition with a Type D personality are found to be less likely to be physically active, are more often smokers, and have poor dietary habits (Borkoles, Polman, & Levy, 2010; Gilmour & Williams, 2012; Mommersteeg, Kupper, & Denollet, 2010; Williams et al., 2008).

Up to now, no studies have focused on the role of the personality traits NA and SI and their combined effect (Type D personality) on the health behaviors of cancer survivors. However, research shows that having a Type D personality among cancer survivors is associated with having more comorbid conditions (Mols, Oerlemans, Denollet, Roukema, & van de Poll-Franse, 2012) and lower HRQoL, more disease-specific complaints, and higher levels of mental distress (Mols, Thong, van de Poll-Franse, Roukema, & Denollet, 2012). It could be hypothesized that the association between Type D personality and HRQoL is partly explained by poorer health behaviors of those survivors. Therefore, the aims of the present study were to explore whether Type D personality and its two constituent components—NA and SI—are associated with health behaviors among CRC survivors and specifically, whether or not Type D personality and health behaviors are independently associated with HRQoL and mental distress or have (partly) overlapping variances.

Methods

Setting and participants

This study is a population-based survey among CRC survivors registered within the Eindhoven Cancer Registry (ECR) of the Comprehensive Cancer Centre South. The ECR compiles data of all individuals newly diagnosed with cancer in the southern part of the Netherlands, an area with ten hospitals serving 2.3 million inhabitants (Janssen-Heijnen, Louwman, Van de Poll-Franse, & Coebergh, 2005). All individuals diagnosed with CRC between 2000 and 2009 as registered in the ECR were eligible for participation ($N = 6,446$). We excluded patients who participated in another CRC study ($N = 2,388$), died before our study ($N = 327$), had cognitive impairment, or were too ill at the time of the study (medical records and advice from the attending specialist $N = 63$), or the tumor was not staged ($N = 83$). This study was approved by the certified Medical Ethics Committee of the Maxima Medical Centre in Veldhoven.

Data collection

This study was conducted in December 2010 within patient-reported outcomes following initial treatment and long term evaluation of survivorship (PROFILES) (van de Poll-Franse et al., 2011). PROFILES is a registry for the study of the physical and psychosocial impacts of cancer and its treatment on a dynamic, growing population-based cohort of both short and long-term cancer survivors. PROFILES

contains a large web-based component and is linked directly to clinical data from the ECR. Details of the PROFILES data collection method have been previously described (van de Poll-Franse et al., 2011).

Study measures

Sociodemographic and clinical characteristics

Survivors' sociodemographic and clinical characteristics at the time of cancer diagnosis (e.g., sex, date of birth, and cancer diagnosis, tumor stage, primary treatment) were available from the ECR. Self-reported comorbidity at the time of survey was assessed with the Self-administered Comorbidity Questionnaire (Sangha, Stucki, Liang, Fossel, & Katz, 2003). Self-designed questions on marital status, educational level, and current occupation were added to the questionnaire.

Type D personality

Type D personality was measured with the self-administered 14-item Type D personality scale (DS14) (Denollet, 2005). Items are scored on a five-point response scale ranging from 0 (false) to 4 (true). Seven of these items refer to "NA" or the tendency to experience negative emotions in general (feelings of dysphoria, anxiety, and irritability). The remaining seven items refer to the patient's level of "SI" or the tendency to inhibit the expression of emotions in social relationships (discomfort in social interactions, lack of social poise, and the tendency to avoid confrontation in social interaction leading to nonexpression). At the intermediate level, NA/SI is assessed as continuous dimensions, and Type D refers to the combination of these traits at a superordinate level. Patients were categorized as having a Type D personality using a standardized previously established cutoff score of ≥ 10 on both the NA and SI subscales (Denollet, 2005); using the item response theory shows that the DS14 has the highest information around this point (Emons, Meijer, & Denollet, 2007). The DS14 is a valid and reliable scale with Cronbach's alpha of 0.87/0.88 in our study sample and a test-retest reliability over a 3-month period of $r = 0.72/0.82$ for the two subscales, respectively (Denollet, 2005).

Health behaviors

Physical activity was assessed with questions derived from the validated European Prospective Investigation into Cancer Physical Activity Questionnaire (Pols et al., 1997). Participants were asked how much time they spend on the following activities (average number of hours per week, in the last summer and winter separately): walking, bicycling, gardening, housekeeping, and sports. Six separate sports could be specified. The mean number of hours of physical activity per week in summer and winter was computed. To include an estimate of intensity, metabolic equivalent of task (MET) values (MET value: 1 MET = 4.184 kJ/kg body weight/h) were assigned to each activity, according to the compendium of physical activities (Ainsworth et al., 2000). Total physical activity (PA) was

calculated by summing hours per week of all activities. The duration of moderate to vigorous physical activity (MVPA) was assessed as time (h/wk) spent on walking, bicycling, gardening, and sports (≥ 3 MET), excluding housekeeping and light intensity sports (< 3 MET) (Buffart et al., 2012). MVPA was dichotomized according to whether meeting the Dutch PA guideline of 150 min/wk or not (Nederlandse Norm Gezond Bewegen, 2013).

Current smoking status was assessed by the question “Do you smoke?” Response options included “No,” “No, but I used to,” and “Yes.” Alcohol consumption in the last 12 months was categorized as nondrinker, moderate drinker (>1 and <14 glasses for women per week; >1 and <21 glasses for men), and heavy drinker (Grimmett et al., 2011). Body mass index (BMI) was calculated with self-reported height and weight and classified as (1) underweight, (2) normal (18.5–24.9), (3) overweight (25–29.9), and (4) obese (≥ 30).

Health-related quality of life

The EORTC QLQ-C30 (Version 3.0) was used to assess HRQoL (Niezgoda & Pater, 1993). It contains five functional scales on physical, role, cognitive, emotional, and social functioning, a global health status/QoL scale, three symptom scales, and six single items. Each item is scored from (1) *not at all* to (4) *very much*, except for the global QoL scale, which ranges from (1) *very poor* to (7) *excellent*. Cronbach’s alpha ranged from 0.52 to 0.89. Scores were linearly transformed to a 0–100 scale; a higher score on the functional scales and global QoL means better functioning and QoL. Clinical relevance was determined following evidence-based guidelines for EORTC QLQ-C30 scores (Cocks et al., 2011).

Mental distress

Mental distress was assessed with the Hospital Anxiety and Depression Scale (HADS), with seven items each for assessing both anxiety and depression (Zigmond & Snaith, 1983). A meta-analysis showed that the Cronbach’s alpha of the anxiety scale varied from 0.68 to 0.93 (mean 0.83) and the depression scale from 0.67 to 0.90 (mean 0.82) (Bjelland, Dahl, Haug, & Neckelmann, 2002). Clinically meaningful differences were determined with Norman’s “rule of thumb,” whereby a difference of ~ 0.5 SD indicates a threshold of discriminant change in scores of a chronic illness (Norman, Sloan, & Wyrwich, 2003).

Statistical analyses

ECR data on sociodemographic and clinical characteristics enabled us to compare the group of respondents, nonrespondents, and patients with unverifiable addresses, using analyses of variance for continuous and chi-square analyses for categorical variables. Similar statistics were applied to analyze differences in sociodemographic and clinical characteristics, health behaviors and HRQoL,

and mental distress between patients with (1) Type D personality (NA+/SI+), (2) SI only (NA-/SI+), (3) NA only (NA+/SI-), and (4) the reference group (NA-/SI-).

Hierarchical linear regression models were constructed to assess a unique variance in HRQoL and mental distress (dependent variables) explained by personality and health behaviors separately and total variance (entering personality and health behavior together in the model). Overlapping variances are determined by the difference in the sum of unique variance explained by personality and health behaviors and total variance. The variables were entered to the model as follows: confounders (age, time since diagnosis, sex, number of comorbid conditions, marital status, educational level, disease stage, and treatment) (step 1); confounders + personality (step 2); confounders + health behaviors (step 3); confounders + personality + health behaviors (step 4). Partial mediation will be indicated if the relationship between personality and HRQoL is significant in step 2, and smaller, but still significant in step 4 when health behaviors are added. Full mediation will be indicated when the relationship between personality and HRQoL is significant in step 2, and not significant in step 4 when health behaviors are added (Baron & Kenny, 1986). The Sobel test will be conducted to provide statistical evidence for mediation, using the unstandardized regression coefficients and standard errors for the relationships between the independent variable and mediator, and between the mediator and the dependent variable (Baron & Kenny, 1986). Missing data at random were treated as another category when dummy variables were created to ensure complete case analyses.

All statistical analyses were performed using SPSS version 19.0 (Statistical Package for Social Sciences, Chicago, IL, USA) and p values <0.05 were considered statistically significant.

Results

Respondents and nonrespondents

Seventy-three percent of the 3,585 cancer survivors returned a questionnaire ($N = 2,620$). For 240 patients, the number of missing items was too high and those patients were therefore excluded from analyses. Compared to respondents, nonrespondents ($N = 624$) were statistically significantly older, more often female, more often diagnosed Stage II disease, and they were more often treated with surgery only. Those with unverifiable addresses ($N = 341$) had a longer time since diagnosis compared to respondents.

Type D, sociodemographic, and clinical characteristics

In total, 21% ($N = 490$) of the respondents could be classified as having a Type D personality, 11% ($N = 256$) scored above the cutoff for NA only

Table 1. Demographic and clinical characteristics of respondents stratified by personality.

	Reference group			Type D personality	p Value
	NA-/SI- n = 1,238 (52.0%)	NA-/SI+ n = 386 (16.6%)	NA+/SI- n = 256 (10.8%)	NA+/SI+ n = 490 (20.6%)	
Sociodemographic characteristics					
Age at diagnosis–mean (SD)	63.5 (9.6)	62.9 (9.7)	63.1 (10.6)	63.9 (9.9)	0.47
Age at time of survey–mean (SD)	69.1 (9.3)	68.7 (9.6)	68.6 (10.1)	69.4 (9.6)	0.62
Sex					
Male	696 (56.2)	247 (62.4)	137 (53.3)	252 (51.4)	0.01
Female	542 (43.8)	149 (37.6)	119 (46.5)	238 (48.6)	
Marital status					
Married	976 (79.3)	312 (79.8)	190 (75.1)	352 (72.3)	0.02
Single/divorced	95 (7.7)	38 (9.7)	25 (9.9)	50 (10.3)	
Widow/widower	160 (13.0)	41 (10.5)	38 (15.0)	85 (17.5)	
Educational level [†]					
Low	218 (17.8)	71 (18.0)	58 (22.8)	109 (22.7)	0.02
Medium	759 (61.8)	228 (57.9)	149 (58.7)	295 (61.3)	
High	251 (20.4)	95 (24.1)	47 (18.5)	77 (16.0)	
Current occupation status					
Not employed/retired	1023 (84.0)	308 (79.0)	213 (83.9)	414 (85.5)	0.06
Employed	195 (16.0)	82 (21.0)	41 (16.1)	70 (14.5)	
Clinical characteristics					
Years since diagnosis (mean)	5.0 (2.8)	5.3 (2.8)	4.9 (2.6)	5.0 (2.7)	0.37
Cancer stage					
1	369 (29.8)	129 (32.6)	71 (27.7)	130 (26.5)	0.30
2	452 (36.5)	124 (31.1)	87 (34.0)	191 (39.0)	
3	338 (27.3)	120 (30.3)	74 (28.9)	131 (26.7)	
4	51 (4.1)	14 (3.5)	18 (7.0)	24 (4.9)	
Unknown	28 (2.3)	9 (2.3)	6 (2.3)	14 (2.9)	
Primary treatment					
SU only	594 (48.1)	178 (45.1)	115 (45.3)	241 (49.5)	0.23
SU + RT	280 (22.7)	95 (24.1)	51 (20.1)	107 (22.0)	
SU + CT	248 (20.1)	93 (23.5)	67 (26.4)	92 (18.9)	
SU + RT + CT	107 (8.7)	26 (6.6)	17 (6.7)	43 (8.8)	
CT only	5 (0.4)	3 (0.8)	3 (1.2)	3 (0.6)	
RT only	0 (0)	0 (0)	1 (0.4)	1 (0.2)	
Comorbidity ⁺⁺					
None	407 (32.9)	142 (35.9)	50 (19.5)	102 (20.8)	<0.01
1	352 (28.4)	114 (28.8)	68 (26.6)	136 (27.8)	
2 ⁺	479 (38.7)	140 (35.4)	138 (53.9)	252 (51.4)	

CT, chemotherapy; NA, negative affectivity; RT, radiotherapy; SI, social inhibition; SU, surgery

[†]Education: low (no or primary school); medium (lower general secondary education or vocational training); high (pre-university education, high vocational training, university).

⁺⁺Adapted self-administered comorbidity questionnaire (Sangha et al., 2003).

(NA+/SI-), and 17% (N = 386) for SI only (NA-/SI+) (Table 1). Patients with high scores on NA only or with a Type D personality more often reported two or more comorbid conditions, more often had a lower educational level, and were married less often compared to the reference group (NA-/SI-). Patients with SI only were more often male compared to the other three groups.

Table 2. Lifestyle factors and HRQoL stratified by personality.

	Reference group			Type D personality	Overall <i>p</i> value
	NA−/SI− <i>n</i> = 1,238 (52.0%)	NA−/SI+ <i>n</i> = 386 (16.6%)	NA+/SI− <i>n</i> = 256 (10.8%)	NA+/SI+ <i>n</i> = 490 (20.6%)	
BMI					
< 18.4 (underweight)	16 (1.3)	1 (0.3)	5 (2.0)	10 (2.1)	0.18
18.5–24.9 (normal)	419 (34.2)	133 (34.1)	73 (29.1)	164 (34.0)	
25–29.9 (overweight)	581 (47.4)	195 (50.0)	117 (46.6)	228 (47.2)	
> 30 (obese)	209 (17.1)	61 (15.6)	56 (22.3)	81 (16.8)	
Smoking					
Current	128 (10.3)	45 (11.4)	32 (12.5)	67 (13.7)	0.38
Ex-smoker	701 (56.6)	234 (59.1)	139 (54.3)	139 (54.3)	
Never smoker	409 (33.0)	117 (29.5)	85 (33.2)	161 (32.9)	
Alcohol use					
Nondrinker	351 (28.4)	98 (24.7)	98 (38.3)	176 (35.9)	<0.01
Moderate drinker	827 (66.8)	279 (70.5)	143 (55.9)	292 (59.6)	
Heavy drinker [†]	60 (4.8)	19 (4.8)	15 (5.9)	22 (4.5)	
Physical activity (mean)					
Walking, h/wk	4.8 (4.2)	4.7 (4.4)	4.5 (4.3)	4.0 (3.9)	<0.01
Cycling, h/wk	3.5 (4.2)	3.6 (4.3)	3.0 (4.0)	3.1 (4.1)	0.04
Gardening, h/wk	1.8 (2.5)	2.1 (2.7)	1.8 (2.5)	1.5 (2.3)	0.01
Housekeeping, h/wk	7.7 (8.4)	7.6 (8.9)	8.3 (8.8)	7.3 (8.3)	0.48
Sports, h/wk [‡]	4.6 (3.9)	4.8 (4.1)	5.2 (4.2)	4.4 (4.1)	0.47
Total physical activity, h/wk	19.5 (13.1)	19.6 (15.2)	19.4 (14.1)	17.2 (13.5)	<0.01
Moderate to vigorous physical activity, h/wk	11.7 (8.8)	11.9 (9.7)	10.9 (9.5)	9.8 (8.7)	<0.01
Moderate to vigorous physical activity (%)					
Not	69 (5.6)	14 (3.5)	26 (10.2)	42 (8.6)	<0.01
Low (<2.5 h/wk)	97 (7.9)	35 (8.8)	25 (9.8)	62 (12.7)	
Moderate (2.5–15 h/wk)	715 (57.9)	239 (60.4)	137 (53.7)	283 (57.9)	
High (> 15 h/wk)	354 (28.7)	108 (27.3)	67 (26.3)	102 (20.9)	
EORTC QLQ-C30 functioning scales					
Global health	81.8 (16.4)	80.7 (16.3)	67.0 (22.5)	67.4 (20.1)	<0.01
Physical functioning	83.3 (19.0)	83.4 (17.8)	72.7 (22.2)	74.2 (22.6)	<0.01
Role functioning	84.3 (24.9)	84.6 (24.0)	69.5 (31.2)	70.6 (30.1)	<0.01
Cognitive functioning	89.6 (15.6)	87.5 (17.5)	75.8 (25.5)	76.0 (24.4)	<0.01
Emotional functioning	92.9 (12.3)	92.0 (13.2)	70.9 (22.1)	71.2 (30.1)	<0.01
Social functioning	91.2 (17.7)	91.4 (16.2)	77.1 (27.2)	76.0 (28.0)	<0.01
HADS subscale scores					
Anxiety	3.1 (2.8)	3.4 (2.7)	7.6 (3.9)	7.9 (3.8)	<0.01
Depression	2.9 (2.7)	3.6 (2.9)	6.6 (3.8)	7.4 (4.3)	<0.01

NA, negative affectivity; SI, social inhibition; HRQoL, health-related quality of life; HADS, hospital anxiety and depression scale

[†]Moderate alcohol intake: >1 and <14 units for women, >1 and <21 units for men.

[‡]For patients who indicated to sport.

Type D personality and health behaviors

No significant differences were found between the four personality groups on BMI and smoking behavior (Table 2). Patients scoring high on NA only or patients with a Type D personality were more often nondrinkers (38 and 36%, respectively) compared to the reference group or patients scoring high on SI only (28 and 25%, respectively; $p < 0.01$). Patients with a Type D personality spent fewer hours per week on walking, cycling, and gardening activities, resulting in a lower total number of hours spent on physical activity per week compared to the other three

groups ($p < 0.05$). The total number of hours per week spent on MVPA was also lower for patients with a Type D personality compared to the other three groups. In addition, cancer patients with high scores on NA only or a Type D personality (20 and 21%, respectively) were less likely to meet the national guidelines for healthy physical activity, compared to patients with SI only or the reference group (12 and 13%, respectively; $p < 0.01$).

Type D personality and health-related quality of life/mental distress

Significant main effects for personality were evident for all HRQoL and mental distress subscales (all $p_s < 0.01$; Table 2). Post hoc pairwise comparisons revealed that patients scoring high on NA only or having a Type D personality had statistically significant and clinically relevant (small–medium) lower scores on all functioning scales of the EORTC QLQ-C30 compared to the reference group (Table 2).

In multivariate linear regression analyses, Type D personality, high scores on NA only, and MVPA were significantly associated with HRQoL and mental distress when corrected for covariates (Table 3). A significant negative association between smoking behavior and HRQoL was found (except for social functioning). The effects of Type D personality slightly diminished when health behaviors were added to the model (model 4). The overlapping variances between personality and health behaviors ranged from 2.5% for physical functioning to 0.7% for cognitive functioning. Statistical evidence for partial mediation of physical activity into the relationship between personality and HRQoL and mental distress was indicated by the Sobel test (all $p < 0.01$), only for patients with a Type D personality. No statistical evidence for mediation of the other health behaviors was found.

Discussion

This population-based study showed that CRC patients with Type D personality or high scores on NA were less likely to meet the physical activity guidelines and to drink alcohol compared to those scoring high on neither or only SI. No differences between the four personality groups were found with respect to BMI and smoking behavior. High scores on NA (with or without SI), physical activity, and smoking behavior were independently associated with HRQoL and mental distress; however, the effect of Type D personality slightly diminished when health behaviors were added to the model.

With respect to physical activity, our results are partly in agreement with previous research, which found Type D personality (Borkoles et al., 2010; Gilmour & Williams, 2012; Mommersteeg et al., 2010; Williams et al., 2008) and both neuroticism and introversion (Courneya & Helsten, 1998) to be related to less active behavior. Our results indicate that NA was more prominent in explaining physical activity behavior than SI. The exercise barriers (lack of motivation/desire, lack of energy, and embarrassment in a fitness evaluation) associated with neuroticism (Courneya & Helsten, 1998) may therefore be stronger determinants of physical activity behavior than the social barriers experienced by introvert persons.

Table 3. Standardized betas of hierarchical multiple linear regression analyses evaluating the association of personality and health behaviors with health-related quality of life, anxiety, and depression scales.

	Global health status	Physical functioning	Role functioning	Cognitive functioning	Emotional functioning	Social functioning	HADS-depression	HADS-anxiety
Model 1: confounders [†]								
<i>R</i> ²	0.10	0.17	0.08	0.04	0.07	0.06	0.08	0.06
Model 2: confounders + personality								
Personality								
Reference group	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
SI only	−0.03	−0.02	−0.01	−0.04*	−0.03	−0.01	0.07**	0.04*
NA only	−0.21**	−0.13**	−0.15**	−0.20**	−0.33**	−0.17**	0.28**	0.35**
Type D	−0.27**	−0.14**	−0.18**	−0.26**	−0.43**	−0.26**	0.47**	0.50**
personality								
<i>R</i> ²	0.19	0.19	0.12	0.12	0.31	0.14	0.31	0.35
Model 3: confounders + health behaviors								
Smoking								
Non or ex-smoker	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Current smoker	−0.06**	−0.09**	−0.05*	−0.04*	−0.06**	−0.04	0.06**	0.02
Alcohol use								
Non or moderate drinker	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Intensive drinker	0.07**	0.07**	0.07**	0.01	0.04	0.04	−0.09**	−0.05*
Moderate to vigorous physical activity								
Not meeting guidelines	−0.17**	−0.32**	−0.22**	−0.09**	0.11**	−0.15**	0.16**	0.09**
Meeting guidelines	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
BMI								
Normal	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Overweight	−0.02	0.06**	−0.01	−0.01	−0.03	−0.03	0.02	0.03
<i>R</i> ²	0.14	0.29	0.13	0.05	0.09	0.09	0.12	0.07
Model 4: confounders + personality + health behaviors								
Personality								
Reference group	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
SI only	−0.04*	−0.02	−0.01	−0.04*	−0.03	−0.01	0.07**	0.05*
NA only	−0.20**	−0.11**	−0.14**	−0.20**	−0.33**	−0.17**	0.28**	0.35**
Type D	−0.26**	−0.12**	−0.16**	−0.25**	−0.43**	−0.25**	0.46**	0.49**
personality								
Smoking								
Non or ex-smoker	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Current smoker	−0.05**	−0.08**	−0.05*	−0.04*	−0.05*	−0.03	0.06**	0.01
Alcohol use								
Non or moderate drinker	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Intensive drinker	0.05*	0.06**	0.06**	−0.01	0.02	0.02	−0.07**	−0.02
Moderate to vigorous physical activity								
Not meeting guidelines	−0.16**	−0.31**	−0.21**	−0.07**	−0.08**	−0.13**	0.12**	0.06**
Meeting guidelines	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
BMI								
Normal	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Overweight	−0.02	0.05**	−0.01	−0.01	−0.04	−0.04*	0.02	0.03
<i>R</i> ²	0.22	0.30	0.17	0.12	0.32	0.16	0.34	0.36

SI, social inhibition; NA, negative affectivity; BMI, body mass index; Ref, reference category; HADS, hospital anxiety and depression scale.

[†]Confounders include age, time since diagnosis, sex, number of comorbid conditions, marital/partner status, educational level, disease stage, treatment.

p* < 0.05; *p* < 0.01

With respect to alcohol and smoking behavior, the results of previous studies are inconsistent. In accordance with our findings, a study among a large community sample in the Netherlands found no differences between Type Ds and non-Type Ds in their smoking behavior, and Type Ds were found to be less likely to consume alcohol (Mommersteeg et al., 2010), while other studies among healthy participants and cardiac patients did find an association between Type D personality and more smoking behavior (Einvik et al., 2011; Gilmour & Williams, 2012; Svansdottir et al., 2012). In addition, other studies found both increased extraversion and neuroticism to be associated with an increased likelihood of being a smoker rather than a nonsmoker (Munafo et al., 2007), while high neuroticism, low conscientiousness, and low agreeableness were associated with more alcohol consumption (Malouff et al., 2007). It could be that more substance use (e.g., alcohol consumption, smoking) is a strong correlation with other personality characteristics including novelty seeking, harm avoidance, or an antisocial personality rather than Type D personality.

Consistent with previous research, both personality and health behaviors were independently associated with health outcomes (Anton & Miller, 2005; Blanchard et al., 2008; Buffart et al., 2012; De Moor et al., 2006; Grimmett et al., 2011; Malouff et al., 2007; McWilliams & Asmundson, 2001; Munafo et al., 2007; Rhodes et al., 2004; Shankar et al., 2011; Valtonen et al., 2009). A small part of the variances of personality and health behaviors overlapped, suggesting that maladaptive health behavior could only partly act as a (behavioral) mechanism to explain the link between personality and health outcomes. This behavioral mechanism could act through negative illness perceptions of Type D cancer patients' experience (Mols, Denollet, Kaptein, Reemst, & Thong, 2012). Individuals scoring high on neuroticism, which is highly correlated with NA, might be more prone to somatic awareness, monitoring of fear of disease recurrence, and more negative illness perceptions. They will therefore possibly associate physical activity with worsening of their disease and stay inactive. A recent study among coronary artery disease patients showed that patients with a Type D personality had a decreased motivation for activity (Bunevicius et al., 2014) and will probably remain inactive. In addition, Type D cancer survivors perceive to have received less information from their health-care provider compared to nonType Ds (Husson, Denollet, Oerlemans, & Mols, 2013), and the importance of maintaining a healthy lifestyle might therefore not be clear to those survivors. However, only a small part of the explained variances of NA and health behaviors overlapped, indicating that other mechanisms may play a more important role in explaining the relation between NA and health outcomes. The joint presence of NA and SI showed the strongest association with mental distress in the present study; it could therefore be hypothesized that mental distress acts as a mediating mechanism in the relation between personality and HRQoL. Those patients with the NA component might assess their HRQoL more negatively compared to those who lack the NA component. Besides this, Type D personality has previously been associated with depression, anxiety,

loneliness, inadequate social support, and stressful life events (Bjelland et al., 2002; Michal, Wiltink, Grande, Beutel, & Braehler, 2011; Mols & Denollet, 2010; Statistiek). People high on NA are quite likely to discuss their own thoughts, feelings, and behaviors with other people, while patients with a Type D personality may feel a similar need to express themselves, but they are held back by social evaluation concerns (SI component) which may add to their overall distress levels.

Our study suggests that there are important individual differences in the way people manage their health. NA and SI do not cover all personality dimensions relevant to health, but their combination (Type D personality) may help to identify those individuals who are at increased risk of suboptimal health behaviors and emotional distress. While health-care professionals may be aware of the consequences of NA, they may be less aware of the repercussions of its combination with SI. When health-care professionals may sense that something in the doctor-patient communication is not quite right, there is a brief screening tool available, the DS14, to measure NA and SI (Denollet, 2005). Although Type D personality has been shown to be a quite stable construct (Martens, Kupper, Pedersen, Aquarius, & Denollet, 2007), there are opportunities for interventions to reduce the negative symptoms and behaviors associated with Type D personality. For example, research has indicated that Type D personality is associated with maladaptive coping (Polman, Borkoles, & Nicholls, 2010). As such, coping interventions may help cancer survivors with Type D personality to better deal with problems. These interventions could in particular target the appraisal process through cognitive restructuring, development of emotion-focused coping skills to downregulate their emotional state while reducing maladaptive avoidance coping strategies. As health behaviors represent a potential mechanism to explain the negative effect of Type D personality on health outcomes, this represents a potential avenue for intervention as Type D individuals may benefit from intensive exposure to behavior change techniques (Williams, Abbott, & Kerr, 2015). In general, as a recent study showed that CRC survivors were significantly more likely to report lack of physical activity, fair/poor health, and other chronic health conditions compared with persons without a cancer diagnosis (Rohan, Townsend, Fairley, & Stewart, 2015), targeted interventions, such as self-management, to address these health issues should be considered for the whole CRC survivor group with poor health behaviors.

This study has some limitations that should be considered when interpreting the results. Although information was present regarding demographic and clinical characteristics of the respondents and nonrespondents, it remains unknown why nonrespondents declined to participate. Second, the cross-sectional design of this study limits the determination of causal associations between the study variables. The relationship between HRQoL and health behaviors can be bidirectional, since a healthy lifestyle can lead to a better physical and mental functioning; however, decreased HRQoL can also be a barrier to perform healthy behavior. Our finding that the effect of Type D personality diminished by adding health behaviors to the model is an indication that Type D personality and health behaviors partly share

the same mechanism or share the same confounder(s). Another limitation is the use of self-report questionnaires to assess health behaviors, which is susceptible to recall and social desirability bias. This may have led to an underestimation or overestimation of healthy behaviors. In addition, our study sample is relatively healthy with respect to physical activity; potentially indicating survivorship bias as unhealthy lifestyles are related to mortality among CRC survivors. This means that the survivors who participated in this study may be more physically active because the inactive survivors died sooner after their diagnosis. It would be interesting for future research to confirm our results in other countries where people have a less active lifestyle and among younger or other cancer survivor populations. Furthermore, the DS14 is not validated among cancer patients; however, the Cronbach's alphas were high in this study. Finally, we did not have information about dietary habits, drug consumption, and social environment, which are also important determinants of health for CRC survivors.

In conclusion, CRC survivors with high scores on NA (with or without SI) are at risk to be less physically active, have worse HRQoL, and higher levels of mental distress as compared to those scoring high on neither or only SI. Only a small part of the association between personality and HRQoL could be explained by maladaptive health behavior, therefore other mechanisms to explain this relation need to be explored. Individuals scoring high on NA might benefit from a more patient-tailored care approach, where health-care practitioners are sensitive to patients' tendency to experience negative emotions and evaluate their illness and behavior negatively. Strategies for tailored long-term management and support for patients on the basis of a more individualized approach, as a function of stable differences in coping with chronic medical conditions, should be developed and evaluated.

Acknowledgments

Olga Husson, Johan Denollet, Nicole Ezendam, and Floortje Mols conformed to the Helsinki Declaration concerning human rights and informed consent and followed correct procedures concerning treatment of humans and animals in research.

References

- Ainsworth, B. E., Haskell, W. L., Whitt, M. C., Irwin, M. L., Swartz, A. M., Strath, S. J., ... Leon, A. S. (2000). Compendium of physical activities: An update of activity codes and MET intensities. *Medicine & Science in Sports & Exercise*, 32(9 Suppl), S498-S504.
- Anton, S. D., & Miller, P. M. (2005). Do negative emotions predict alcohol consumption, saturated fat intake, and physical activity in older adults? *Behavior Modification*, 29(4), 677-688.
- Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51, 1173-1182.
- Bjelland, I., Dahl, A. A., Haug, T. T., & Neckelmann, D. (2002). The validity of the hospital anxiety and depression scale. An updated literature review. *Journal of Psychosomatic Research*, 52(2), 69-77.

- Blanchard, C. M., Courneya, K. S., & Stein, K. (2008). Cancer survivors' adherence to lifestyle behavior recommendations and associations with health-related quality of life: Results from the American Cancer Society's SCS-II. *Journal of Clinical Oncology*, 26(13), 2198–2204. doi:26/13/2198
- Borkoles, E., Polman, R., & Levy, A. (2010). Type-D personality and body image in men: The role of exercise status. *Body Image*, 7(1), 39–45. doi:S1740-1445(09)00106-5
- Buffart, L. M., Thong, M. S., Schep, G., Chinapaw, M. J., Brug, J., & van de Poll-Franse, L. V. (2012). Self-reported physical activity: Its correlates and relationship with health-related quality of life in a large cohort of colorectal cancer survivors. *PLoS One*, 7(5), e36164. doi:10.1371/journal.pone.0036164
- Bunevicius, A., Brozaitiene, J., Staniute, M., Gelziniene, V., Duonelien, I., Pop, V. J. M., ... Denollet, J. (2014). Decreased physical effort, fatigue, and mental distress in patients with coronary artery disease: Importance of personality-related differences. *International Journal of Behavioral Medicine*, 21(2), 240–247. doi:10.1007/s12529-013-9299-9
- Cocks, K., King, M. T., Velikova, G., Martyn St-James, M., Fayers, P. M., & Brown, J. M. (2011). Evidence-based guidelines for determination of sample size and interpretation of the European Organisation for the Research and Treatment of Cancer Quality of Life Questionnaire Core 30. *Journal of Clinical Oncology*, 29(1), 89–96.
- Courneya, K. S., & Helsten, L. A. M. (1998). Personality correlates of exercise behavior, motives, barriers and preferences: An application of the five-factor model. *Personality and Individual Differences*, 24(5), 625–633.
- De Moor, M. H., Beem, A. L., Stubbe, J. H., Boomsma, D. I., & De Geus, E. J. (2006). Regular exercise, anxiety, depression and personality: A population-based study. *Preventive Medicine*, 42(4), 273–279.
- Denlinger, C. S., & Barsevick, A. M. (2009). The challenges of colorectal cancer survivorship. *Journal of National Comprehensive Cancer Network*, 7(8), 883–893 (quiz 894).
- Denollet, J. (2005). DS14: Standard assessment of negative affectivity, social inhibition, and type D personality. *Psychosomatic Medicine*, 67(1), 89–97. doi:67/1/89
- Dutch Cancer Registry. (2012). Cijfers over kanker. Retrieved from <http://www.cijfersoverkanker.nl>
- Dutch Cancer Society. (2011). *Kanker in Nederland tot 2020: Trends en prognoses*. Amsterdam, the Netherlands: Dutch Cancer Society.
- Einvik, G., Dammen, T., Hrubos-Strom, H., Namtvedt, S. K., Randby, A., Kristiansen, H. A., ... Omland, T. (2011). Prevalence of cardiovascular risk factors and concentration of C-reactive protein in type D personality persons without cardiovascular disease. *European Journal of Cardiovascular Prevention & Rehabilitation*, 18(3), 504–509. doi:1741826710389383
- Emons, W. H., Meijer, R. R., & Denollet, J. (2007). Negative affectivity and social inhibition in cardiovascular disease: Evaluating type-D personality and its assessment using item response theory. *Journal of Psychosomatic Research*, 63(1), 27–39. doi:S0022-3999(07)00134-1
- Gilmour, J., & Williams, L. (2012). Type D personality is associated with maladaptive health-related behaviours. *Journal of Health Psychology*, 17(4), 471–478.
- Grimmett, C., Bridgewater, J., Steptoe, A., & Wardle, J. (2011). Lifestyle and quality of life in colorectal cancer survivors. *Quality of Life Research*, 20(8), 1237–1245. doi:10.1007/s11136-011-9855-1
- Husson, O., Denollet, J., Oerlemans, S., & Mols, F. (2013). Satisfaction with information provision in cancer patients and the moderating effect of type D personality. *Psychooncology*, 22(9), 2124–2132. doi:10.1002/pon.3267
- Janssen-Heijnen, M. L. G., Louwman, W. J., Van de Poll-Franse, L. V., & Coebergh, J. W. W. (2005). *Results of 50 years cancer registry in the South of the Netherlands: 1955–2004 (in Dutch)*. Eindhoven: Eindhoven Cancer Registry.

- Je, Y., Jeon, J. Y., Giovannucci, E. L., & Meyerhardt, J. A. (2013). Association between physical activity and mortality in colorectal cancer: A meta-analysis of prospective cohort studies. *International Journal of Cancer* doi: 10.1002/ijc.28208
- Johnson, C. M., Wei, C., Ensor, J. E., Smolenski, D. J., Amos, C. I., Levin, B., & Berry, D. A. (2013). Meta-analyses of colorectal cancer risk factors. *Cancer Causes Control*, 24(6), 1207–1222. doi:10.1007/s10552-013-0201-5
- Lynch, B. M., Cerin, E., Owen, N., Hawkes, A. L., & Aitken, J. F. (2008). Prospective relationships of physical activity with quality of life among colorectal cancer survivors. *Journal of Clinical Oncology*, 26(27), 4480–4487. doi:26/27/4480
- Malouff, J. M., Thorsteinsson, E. B., Rooke, S. E., & Schutte, N. S. (2007). Alcohol involvement and the five-factor model of personality: A meta-analysis. *Journal of Drug Education*, 37(3), 277–294.
- Martens, E. J., Kupper, N., Pedersen, S. S., Aquarius, A. E., & Denollet, J. (2007). Type-D personality is a stable taxonomy in post-MI patients over an 18-month period. *Journal of Psychosomatic Research*, 63(5), 545–550. doi:10.1016/j.jpsychores.2007.06.005
- McWilliams, L. A., & Asmundson, G. J. G. (2001). Is there a negative association between anxiety sensitivity and arousal-increasing substances and activities? *Anxiety Disorders*, 15, 161–170.
- Michal, M., Wiltink, J., Grande, G., Beutel, M. E., & Brahler, E. (2011). Type D personality is independently associated with major psychosocial stressors and increased health care utilization in the general population. *Journal of Affective Disorders*, 134(1–3), 396–403. doi:S0165-0327(11)00279-5
- Mols, F., & Denollet, J. (2010). Type D personality in the general population: A systematic review of health status, mechanisms of disease, and work-related problems. *Health and Quality of Life Outcomes*, 8, 9. doi:10.1186/1477-7525-8-9
- Mols, F., Denollet, J., Kaptein, A. A., Reemst, P. H., & Thong, M. S. (2012). The association between type D personality and illness perceptions in colorectal cancer survivors: A study from the population-based PROFILES registry. *Journal of Psychosomatic Research*, 73(3), 232–239. doi:S0022-3999(12)00184-5
- Mols, F., Oerlemans, S., Denollet, J., Roukema, J. A., & van de Poll-Franse, L. V. (2012). Type D personality is associated with increased comorbidity burden and health care utilization among 3080 cancer survivors. *General Hospital Psychiatry*, 34(4), 352–359. doi:S0163-8343(12)00029-1
- Mols, F., Thong, M. S., van de Poll-Franse, L. V., Roukema, J. A., & Denollet, J. (2012). Type D (distressed) personality is associated with poor quality of life and mental health among 3080 cancer survivors. *Journal of Affective Disorders*, 136(1–2), 26–34. doi:S0165-0327(11)00520-9
- Mommersteeg, P. M., Kupper, N., & Denollet, J. (2010). Type D personality is associated with increased metabolic syndrome prevalence and an unhealthy lifestyle in a cross-sectional Dutch community sample. *BMC Public Health*, 10, 714. doi:1471-2458-10-714
- Munafo, M. R., Zettler, J. I., & Clark, T. G. (2007). Personality and smoking status: A meta-analysis. *Nicotine & Tobacco Research*, 9(3), 405–413. doi:772842142
- Nederlandse Norm Gezond Bewegen. (2013) Retrieved from <http://www.sportzorg.nl/bibliotheek/nederlandse-norm-gezond-bewegen-nngb/>. Accessed 21 March 2014.
- Niezgoda, H. E., & Pater, J. L. (1993). A validation study of the domains of the core EORTC quality of life questionnaire. *Quality of Life Research*, 2(5), 319–325.
- Norman, G. R., Sloan, J. A., & Wyrwich, K. W. (2003). Interpretation of changes in health-related quality of life: The remarkable universality of half a standard deviation. *Medical Care*, 41(5), 582–592. doi:10.1097/01.MLR.0000062554.74615.4C

- O'Dell, K. R., Masters, K. S., Spielmans, G. I., & Maisto, S. A. (2011). Does type-D personality predict outcomes among patients with cardiovascular disease? A meta-analytic review. *Journal of Psychosomatic Research*, 71(4), 199–206. doi:10.1016/j.jpsychores.2011.01.009
- Polman, R., Borkoles, E., & Nicholls, A. R. (2010). Type D personality, stress, and symptoms of burnout: The influence of avoidance coping and social support. *British Journal of Health Psychology*, 15(Pt 3), 681–696. doi:10.1348/135910709X479069
- Pols, M. A., Peeters, P. H., Ocke, M. C., Slimani, N., Bueno-de-Mesquita, H. B., & Collette, H. J. (1997). Estimation of reproducibility and relative validity of the questions included in the EPIC Physical Activity Questionnaire. *International Journal of Epidemiology*, 26(Suppl 1), S181–S189.
- Rohan, E. A., Townsend, J. S., Fairley, T. L., & Stewart, S. L. (2015). Health behaviors and quality of life among colorectal cancer survivors. *Journal of National Comprehensive Cancer Network*, 13(3), 297–302.
- Rhodes, R. E., Courneya, K. S., & Jones, L. W. (2004). Personality and social cognitive influences on exercise behavior: Adding the activity trait to the theory of planned behavior. *Psychology of Sport and Exercise*, 5(3), 243–254.
- Sangha, O., Stucki, G., Liang, M. H., Fossel, A. H., & Katz, J. N. (2003). The Self-Administered Comorbidity Questionnaire: A new method to assess comorbidity for clinical and health services research. *Arthritis & Rheumatism*, 49(2), 156–163. doi:10.1002/art.10993
- Shankar, A., McMunn, A., Banks, J., & Steptoe, A. (2011). Loneliness, social isolation, and behavioral and biological health indicators in older adults. *Health Psychology*, 30(4), 377–385.
- Simons, C. C., Hughes, L. A., van Engeland, M., Goldbohm, R. A., van den Brandt, P. A., & Weijenberg, M. P. (2013). Physical activity, occupational sitting time, and colorectal cancer risk in the Netherlands cohort study. *American Journal of Epidemiology*, 177(6), 514–530. doi:kws280
- Svansdottir, E., Karlsson, H. D., Gudnason, T., Olason, D. T., Thorgilsson, H., Sigtryggsdottir, U., ... Denollet, J. (2012). Validity of type D personality in Iceland: Association with disease severity and risk markers in cardiac patients. *Journal of Behavioral Medicine*, 35(2), 155–166. doi:10.1007/s10865-011-9337-5
- Valtonen, M., Laaksonen, D. E., Laukkanen, J., Tolmunen, T., Rauramaa, R., Viinamaki, H., Kauhanen, J., Lakka, T., & Niskanen, L. (2009). Leisure-time physical activity, cardiorespiratory fitness and feelings of hopelessness in men. *BMC Public Health*, 9, 204.
- van de Poll-Franse, L. V., Horevoorts, N., Eenbergen, M. V., Denollet, J., Roukema, J. A., Aaronson, N. K., ... Mols, F. (2011). The patient reported outcomes following initial treatment and long term evaluation of survivorship registry: Scope, rationale and design of an infrastructure for the study of physical and psychosocial outcomes in cancer survivorship cohorts. *European Journal of Cancer*, 47(14), 2188–2194. doi:S0959-8049(11)00313-3
- Vrieling, A., & Kampman, E. (2010). The role of body mass index, physical activity, and diet in colorectal cancer recurrence and survival: A review of the literature. *American Journal of Clinical Nutrition*, 92(3), 471–490. doi:92/3/471
- Williams, L., Abbott, C., & Kerr, R. (2015). Health behaviour mediates the relationship between type D personality and subjective health in the general population. *Journal of Health Psychology*. doi: 10.1177/1359105315571977
- Williams, L., O'Connor, R. C., Howard, S., Hughes, B. M., Johnston, D. W., Hay, J. L., ... O'Carroll, R. E. (2008). Type-D personality mechanisms of effect: The role of health-related behavior and social support. *Journal of Psychosomatic Research*, 64(1), 63–69. doi:S0022-3999(07)00242-5
- Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica*, 67(6), 361–370.