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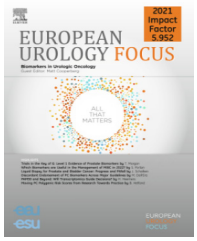

Bladder Cancer

Lifestyle Factors in Patients with Bladder Cancer: A Contemporary Picture of Tobacco Smoking, Electronic Cigarette Use, Body Mass Index, and Levels of Physical Activity

James W.F. Catto[a,b,c,†,*], *Zoe Rogers*[d,e,†,*], *Amy Downing*[d,e], *Samantha J. Mason*[f], *Ibrahim Jubber*[a,b,c], *Sarah Bottomley*[a,b], *Mark Conner*[g], *Kate Absolom*[d,e,‡], *Adam Glaser*[d,e,h,‡]

[a] *Academic Urology Unit, University of Sheffield, Sheffield, UK;* [b] *Department of Urology, Sheffield Teaching Hospitals NHS Trust, Sheffield, UK;* [c] *Department of Urology, Sheffield Teaching Hospitals NHS Foundation Trust, Sheffield, UK;* [d] *Leeds Institute of Medical Research, University of Leeds, Leeds, UK;* [e] *Leeds Institute for Data Analytics, University of Leeds, Leeds, UK;* [f] *School of Human and Health Sciences, University of Huddersfield, Huddersfield, UK;* [g] *School of Psychology, University of Leeds, Leeds, UK;* [h] *Leeds Teaching Hospitals NHS Trust, Leeds, UK*

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Abstract

Background: Little is known about contemporary lifestyle choices in patients with bladder cancer (BC). These choices include carcinogenic risk factors and could affect fitness to receive treatments.
Objective: To evaluate the contemporary lifestyle choices in BC patients.
Design, setting, and participants: Self-reported surveys from participants diagnosed with BC in the previous 10 yr captured smoking patterns, e-cigarette use, physical activity using the GODIN Leisure-Time Exercise Questionnaire, long-term conditions (LTCs), relationship status, sociodemographics, and body mass index (BMI; height and weight).
Outcome measurements and statistical analysis: Findings were compared with the general population and men with prostate cancer.
Results and limitations: Completed surveys were received from 2092 participants. Most respondents were ex-smokers (61% vs 10% current vs 29% never). The use of e-cigarettes was uncommon (9%) and at lower rates than the age-equivalent general population. Passive smoke exposure was frequent (48%). Most participants (68%) were "insufficiently active" using the GODIN criteria and less physically active than the age-equivalent general population. Most respondents (44%) were classified as overweight (BMI 25–29.99) or obese (22%, BMI >30). Lifestyle factors varied with age, sex, socioeconomic deprivation, and LTCs. Younger participants were less likely to smoke ($p < 0.001$), more likely to have used e-cigarettes ($p < 0.001$), but more likely to have had passive smoke exposure ($p = 0.008$). Those from less affluent areas were more likely to smoke ($p < 0.001$), have used e-cigarettes ($p < 0.001$), and have had passive smoke exposure ($p = 0.02$). Females were less likely to be smokers ($p < 0.001$) but more likely to have been exposed to passive smoke ($p < 0.001$).

† These authors shared first authorship.
‡ These authors shared senior authorship.
* Corresponding authors. Academic Urology Unit, G Floor, The Medical School, University of Sheffield, Sheffield, UK. Tel. +44 114 226 1229 (J. Catto); Leeds Institute of Medical Research and Leeds Institute for Data Analytics, University of Leeds, Leeds, UK (Z. Rogers).
E-mail addresses: j.catto@sheffield.ac.uk (J.W.F. Catto), z.a.rogers@leeds.ac.uk (Z. Rogers).

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Conclusions: Persons affected by BC often have smoking exposures and high BMI, and are insufficiently active. Rates of e-cigarette use were lower than in the general population. Efforts to improve quality of life in this cohort should include wider advocation of smoking cessation, perhaps including the use of e-cigarettes, and programmes to increase exercise and reduce BMI.

Patient summary: We looked at the lifestyle choices, such as smoking, e-cigarette use, physical activity levels, and obesity, of patients following a bladder cancer diagnosis. We conclude that this population would benefit from healthy lifestyle interventions.

1. Introduction

Bladder cancer (BC) is a common and expensive malignancy to manage [1,2]. Most tumours arise following exposure to exogenous agents, which may be occupational [3,4], iatrogenic (radiation or pharmaceutical), environmental, or lifestyle related in nature. Of lifestyle factors, most is known about tobacco smoking [5]. Longitudinal studies suggest that around half of BCs arise following exposure to tobacco cigarettes [6] in a dose-dependent manner [7]. The Global Burden of Disease reported that 36.8% (28.5–44.0%) of disability-adjusted life years due to BC were attributable to smoking [8]. Patterns of smoking are changing in many societies, reflecting government policies, public health awareness, and availability of alternative products [9,10]. Of these, the use of electronic cigarettes (e-cigarettes) is increasing in many countries [11]. A recent national survey reported that 8.5% of US adults had tried and 2.4% were currently using e-cigarettes [12]. The rates of e-cigarette use were highest in men and those who had recently stopped smoking (49.3%) as compared with current smokers (38.2%). Prospective clinical trials have supported the use of e-cigarettes for smoking cessation when compared with other forms of nicotine replacement [13].

Little is known about diet, obesity, and exercise and BC [14,15]. A meta-analysis suggested a slight increase in the relative risk of BC with rising body mass index (BMI) in a dose-dependent manner (1.07 and 1.10 for preobese and obese types, respectively), although the data were heterogeneous [16]. A single–centre report found no association between BMI and recurrence or survival after cystectomy [17]. A meta-analysis of 15 studies reporting physical exercise in BC patients found modest reductions (summary relative risk = 0.85-fold that of the general population) in cancer risk in the physically active groups [18]. However, a cross-sectional survey reported low levels of exercise in many BC patients [19] and a recent randomised controlled trial reported average daily step counts of around 6500/d (with 13% walking ≥10 000 steps per day) in patients prior to cystectomy [20]. In addition to contributing to disease biology, lifestyle choices may affect an individual's fitness for particular treatments. For example, many patients with BC have competing smoking-related comorbidities that limit their fitness for radical surgery [20,21].

Given the role of lifestyle factors in the aetiology of BC, changing patterns of smoking, and the limited understanding of exercise patterns and BMI within BC populations, we undertook a survey of these factors within a contemporary cohort in England. We compared our findings with those from matching general populations and a comparable survey of men with prostate cancer.

2. Patients and methods

2.1. Study design and setting

Lifestyle information was collected within a *cross-sectional* (single survey between 1 and 10 yr after a diagnosis of BC; year of diagnosis ranged from 2007 to 2016) and a *longitudinal* (with four surveys collected over the 1st year of treatment, starting from as close to diagnosis as possible; year of diagnosis ranged from 2019 to 2020) patient-reported outcome measure survey. A full summary of study methods and survey development are provided in previous Life and Bladder Cancer protocol and research publications [22,23]. Here, we report respondents to the cross-sectional and longitudinal (first of four data collection times, within 3 mo of diagnosis of BC) cohorts. Eligible participants were aged ≥18 yr after a diagnosis of BC in National Health Service (NHS) hospitals in Yorkshire and Humber, North Derbyshire, or South Tees regions (approximately 10% of the English population). Individuals for the cross-sectional cohort were identified through the National Disease Registration Service (NDRS; formerly NCRAS) [24] and excluded if younger than 18 yr of age, serving a custodial sentence (in His Majesty's Prison Service), or had registered objection to participating in research (type 2/National Patient data opt-out with NHS Digital) [25]. Individuals for the longitudinal cohort were recruited by research nurses working in participating centres. For both cohorts, patient-reported outcome measure surveys were mailed out to eligible participants. This activity was coordinated by an approved independent survey provider (Quality Health Ltd., Chesterfield, UK; now a part of IQVIA).

2.2. Questionnaire content

Surveys captured self-reported information on participant's age, ethnicity, height, and weight, presence of long-term conditions (LTCs), relationship status, employment status, and treatment(s) received for BC. Sex- and area-based socioeconomic deprivation status (Index of Multiple Deprivation) was obtained from the NDRS [24]. The income domain quintile of the Index of Multiple Deprivation 2015 (1–least deprived to 5—most deprived) was obtained for each participant in the cross-sectional cohort, and the 2019 version of the same measure was used for the longitudinal cohort.

The following factors were collected (Supplementary material):

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1. Physical activity: The Godin Leisure-Time Exercise Questionnaire (GLTEQ) asks participants to report the number of times they have engaged in light, moderate, and vigorous activity in a typical week [26]. Scores are classified into active, moderately active, or inactive/sedentary.
2. Tobacco smoking use was captured using six options ranging from "current smoking of >20 cigarettes/eight pipe bowls of tobacco/more than ten cigars a day" to "I have never smoked tobacco".
3. E-cigarette use was captured using four options ranging from "I currently use e-cigarettes and I used them before my diagnosis" to "I have never used e-cigarettes".
4. Passive smoke exposure used five options from "I have never breathed in the second-hand smoke" to "I have breathed in the second-hand smoke of someone I live or lived with for over 10 yr" (Supplementary material).
5. Height and weight were self-reported and converted into BMI. Participants were classified into underweight (<18.5), normal (18.5–24.99), overweight (25–29.99), and obese (≥30).
6. Relationship status was captured using one question that presented seven options: "married", "in a civil partnership", "separated", "divorced/dissolved civil partnership", "widowed/surviving partner from civil partnership", "single (never married/never in civil partnership)", or "other".

2.3. Comparisons with other populations

We obtained data from 3826 men (of 9073; 42% response) in England surveyed within the Life After Prostate Cancer Diagnosis (LAPCD) study (Anna Gavin and Adam Glaser, unpublished data; https://www.lifeafterprostatecancerdiagnosis.com). We compared our findings with the following general population data: rates of smoking in Yorkshire collected in 2019 [27]; reported rates of e-cigarette use, smoking, and BMI in England collected in 2019 [28]; reported exposure to others' smoke and exercise levels in England collected in 2017 and 2018, respectively [29,30]; and relationship status in England collected in 2019 [31]. All general population data were restricted to adults aged ≥55 yr to align with our BC cohort.

2.4. Statistical analysis

Age was categorised: <65, 65–74, 75–84, and ≥85 yr; numbers of self-reported LTCs were grouped: none, one, two, three, or four or more; and BC was categorised into non–muscle-invasive BC (NMIBC; Tis, Ta, or T1), muscle-invasive BC (MIBC; T2+), and unknown (missing stage data). Categorical outcomes were analysed using a chi-square test and Fisher's exact test where variables had frequencies of <10. Frequencies of <5 were suppressed, and adjacent percentages were suppressed if ≤2%. Comparisons with the Health Survey for England data were carried out using the published percentages and weighted bases within each age category over 55 yr (55–64, 65–74, and 75+ yr) and combining the calculated frequencies. Missing data were excluded from the analysis. A statistical analysis was performed using STATA (version 17.0 for Windows; Stata Corp., College Station, TX, USA).

3. Results

3.1. Participants

Surveys were received from 2092 participants (1796 from cross-sectional [55% response rate] and 296 from longitudinal [85% response rate] cohort; Table 1). Most participants were aged 65–84 yr (n = 1551, 74%) and were male (n = 1610, 77%), and 49% belonged to the two most affluent social quintiles. Most participants (75%) had one or more LTCs, of which the commonest were hypertension (39%), heart conditions (22%), and arthritis (25%; data not shown). The number of participants (54%) with NMIBC (Tis, Ta, or T1) was slightly more than that with MIBC (T2+). Of respondents, 95% (n = 1991) were White and 1% non-White (n = 20, of whom n = 11 reported their ethnicity as Asian/Asian British and n = 6 as Black/African/Caribbean/Black British).

Table 1 – Population characteristics of cross-sectional (n = 1796) and longitudinal (n = 296) cohorts

	All patients (n = 2092)	
	N	%
Age (yr)		
<65	252	12
65–74	707	34
75–84	844	40
85+	289	14
Sex		
Male	1610	77
Female	482	23
Ethnicity		
White	1991	95
Non-White	20	1
Missing	81	4
Social Deprivation Index [a]		
1 (affluent)	485	23
2	538	26
3	429	20
4	312	15
5 (deprived)	327	16
Number of long-term conditions		
0	517	25
1	637	31
2	445	21
3	281	13
4+	212	10
Type of bladder cancer		
NMIBC	1129	54
MIBC	924	44
Missing	39	2

IMD = Index of Multiple Deprivation; MIBC = muscle-invasive bladder cancer; NMIBC = non–muscle-invasive bladder cancer.
[a] N = 1 patient IMD income quintile missing.

3.2. Response rates

Question completion rates varied from relationship status (96%, n = 2013) to exercise levels (76%, n = 1594; Supplementary Table 1). Almost all respondents completed questions regarding smoking (n = 1971 [94%]), e-cigarettes (n = 1833 [88%]), and passive smoke inhalation (n = 1784 [85%]; Table 2). BMI could be calculated for 1873 (90%) participants.

3.3. Lifestyle factors

Most respondents were ex-smokers (1211, 61%), with 10% (n = 194) currently smoking and 29% having never smoked (n = 566). The use of e-cigarettes was uncommon (n = 165, 9%; Table 2). Few ex-smokers had ever used e-cigarettes (8%; Supplementary Table 2). Of them, half (n = 47, 50%) had started since their BC diagnosis, 14 (15%) had used them before their diagnosis, and 33 (35%) no longer used

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Table 2 – Smoking status by demographic/clinical features for cross-sectional (*n* = 1684) and longitudinal (*n* = 287) T1 cohorts

	Smoking (*n* = 1971)								E-cigarettes (*n* = 1833)						Passive smoking (*n* = 1784)							
	Current tobacco smoker		Ex-tobacco smoker		Never smoked tobacco		Did not answer	*p* value	Ever used e-cigarettes		Never used e-cigarettes		Did not answer	*p* value	Passive smoke exposure		No passive exposure		Did not answer		*p* value	
Age (yr)																						
<65	37	15%	114	47%	92	38%	9		40	18%	187	82%	25		131	57%	98	43%	23			
65–74	84	12%	433	64%	164	24%	26		73	11%	568	89%	66		312	50%	311	50%	84			
75–84	67	9%	501	64%	213	27%	63		45	6%	686	94%	113		317	45%	390	55%	137			
85+	6	2%	163	61%	97	36%	23	<0.001	7	3%	227	97%	55	<0.001	103	46%	122	54%	64		0.008	
Sex																						
Male	147	10%	995	65%	378	25%	90		125	9%	1310	91%	175		624	45%	761	55%	225			
Female	47	10%	216	48%	188	42%	31	<0.001	40	10%	358	90%	84	0.41	238	60%	161	40%	83		<0.001	
Social Deprivation Index [a]																						
1 (affluent)	26	6%	269	58%	166	36%	24		32	7%	414	93%	39		194	45%	241	55%	50			
2	42	8%	302	59%	165	32%	29		34	7%	431	93%	73		227	49%	235	51%	76			
3	29	7%	260	65%	114	28%	26		21	6%	357	94%	51		159	44%	202	56%	68			
4	39	13%	191	66%	60	21%	22		36	14%	229	86%	47		135	52%	124	48%	53			
5 (deprived)	58	19%	188	61%	61	20%	20	<0.001	42	15%	237	85%	48	<0.001	147	55%	119	45%	61		0.02	
Number of long-term conditions																						
0	44	9%	273	56%	169	35%	31		43	10%	405	90%	69		204	46%	239	54%	74			
1	62	10%	368	61%	170	28%	37		55	10%	508	90%	74		264	49%	279	51%	94			
2	37	9%	264	63%	120	29%	24		26	7%	365	93%	54		173	46%	202	54%	70			
3	29	11%	173	65%	65	24%	14		20	8%	232	92%	29		118	48%	129	52%	34			
4+	22	11%	133	68%	42	21%	15	0.03	21	12%	158	88%	33	0.27	103	59%	73	41%	36		0.06	
Type of bladder cancer																						
NMIBC	100	9%	658	62%	308	29%	63		87	9%	908	91%	134		478	50%	481	50%	170			
MIBC	89	10%	532	61%	248	29%	55	0.82	74–77	9%	732	91%	116	0.63	372	47%	421	53%	131		0.22	
Missing	5	14%	21	58%	10	28%	3		<5	7%	28	93%	9		12	38%	20	63%	7			
Total	194	10%	1211	61%	566	29%	121		165	9%	1668	91%	259		862	48%	922	52%	308			

IMD = Index of Multiple Deprivation; MIBC = muscle-invasive bladder cancer; NMIBC = non–muscle-invasive bladder cancer.
[a] N = 1 patient IMD income quintile missing

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Table 3 – Comparison with healthy adults over 55 yr of age and LAPCD patients

	Life and bladder cancer (n=2,092)		England (HSE/ONS)	*p* value	Yorkshire (ONS)	*p* value	Life after prostate cancer diagnosis (*n* = 3826)		*p* value
	n	%	%		%		*n*	%	
BMI [a]									
Underweight (<18.5)	646	34	27		NK		1163	33	
Normal (18.5–24.99)									
Overweight (25–29.99)	816	44	40				1714	48	
Obese (30+)	411	22	33	<0.001			665	19	0.001
Did not answer	219						284		
Smoking status [b,c]									
Never	566	29	54		53		1718	46	
Ex-smoker	1211	61	35		37		1759	47	
Current	194*	10	11	<0.001	10	<0.001	253	7	<0.001
Did not answer	121						96		
E-cigarette use [d]									
Never	1668	91	88		NK		3319	96	
Ex	73	4	8				69	2	
Current	92*	5	4	<0.001			55	2	<0.001
Did not answer	259						383		
Passive smoking [e]									
Never	922	52	84		NK		NK		
Ever	862*	48	16						
Did not answer	308								
GODIN activity levels [f]									
Insufficiently active (low benefit)	1083	68	35		NK		1893	55	
Moderately active (some benefit)	147	9	65				490	14	
Active (substantial benefit)	364	23					1042	30	<0.001
Did not answer	498	24					401		
Relationship Status [g]									
Married/civil partnership	1392	69	72		NK		2939	78	
Separated/divorced	172	9	15				281	7	
Widowed/surviving partner	349	17	13				360	10	
Single	76	4	NK				139	4	<0.001
Other	24	1					63	2	
Not known	79						44		

APS = Annual Population Survey; BMI = body mass index; HSE = Health Survey for England; IPAQ = International Physical Activity Questionnaire used by Health Survey England; LABC = Life and Bladder Cancer; LAPCD = Life After Prostate Cancer Diagnosis; NK = not known; ONS = Office for National Statistics.
[a] HSE 2019 BMI for all adults 55+ yr in England (*n* = 2485; weighted bases) and LAPCD BMI compared with LABC. [b] HSE 2019 smoking status for all adults 55+ yr in England (*n* = 3054; weighted bases) and LAPCD smoking status compared with LABC.
[c] ONS APS 2019 smoking status for all adults 55+ yr in Yorkshire and Humber (*n* = 1 606 277; weighted counts) compared with LABC.
[d] HSE 2019 e-cigarette use for all adults 55+ yr in England (*n* = 3056; weighted bases) and LAPCD e-cigarette use compared with LABC.
[e] HSE 2017 self-reported passive smoke exposure (location unknown) for all adults 55+ yr in England (*n* = 2963; weighted bases).
[f] HSE 2018 physical activity (IPAQ) for all adults 55+ yr in England (*n* = 2484; weighted bases). LAPCD Godin activity levels compared with LABC
[g] ONS 2019 marital status/living arrangements (no separated category) for all adults 55+ yr in England. LAPCD relationship status compared with LABC

e-cigarettes or tobacco. Current smokers were more likely to have ever used e-cigarettes (42%), with 35% having used them since their diagnosis (Supplementary Table 2). Passive smoke exposure was common (reported in 48% of respondents; Table 2). Passive smoke exposure differed with respect to tobacco smoking history, with 63% of current smokers, 49% of ex-smokers, and 43% of never tobacco smokers reporting some level of exposure ($p < 0.001$, Supplementary Table 2). Conversely, of those reporting passive smoke exposure, 97 were current smokers (11%), 534 were ex-smokers (63%), and 221 were never smokers (26%). Most respondents (Table 3) were classified as overweight (44%, BMI 25–29.99) or obese (22%, BMI >30), 68% were scored as "insufficiently active" using the GODIN criteria, and most were married or living in a civil partnership (69%; Table 3).

3.4. Comparison with other populations

BC participants were less likely to be obese (22%) than the age-matched (≥55 yr) general population (eg, 33% across England; Table 3) [28], but were similar to men with prostate cancer (19% obese). Respondents with BC had greater exposure to cigarettes (29% never smokers) than men with prostate cancer (46% never smokers) and the general population (54% never smokers across England; 53% never smokers across Yorkshire) [27,28]. BC participants were more likely to be ex-smokers (61% ex-smokers) than the general population (35% ex-smokers across England; 37% ex-smokers across Yorkshire) [27,28]. The use of e-cigarettes was more common in respondents with BC (9%) than in men with prostate cancer (4%) but less than in the general population (12% in England) [28]. Physical activity levels were lower in the BC cohort (68% insufficiently active) than in the prostate cancer patients (55%) and the general population (35%) [30], although the International Physical Activity Questionnaire used by Health Survey England (IPAQ) differed from the Godin questionnaire (GLTEQ) used in the current study. BC participants were less likely to be married/in a civil partnership than men with prostate cancer (69% vs 78%, $p < 0.001$). A comparison with relationship sta-

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Table 4 – Exercise by demographic/clinical features for cross-sectional (*n* = 1299) and longitudinal (*n* = 295) T1 cohorts and BMI for cross-sectional (*n* = 1596) and longitudinal cohorts (*n* = 277)

	Activity levels (*N* = 1594)								Body mass index (*N* = 1873)									
	Insufficiently active		Moderately active		Active		Did not v	*p* value	Underweight (<18.5)		Normal (18.5–24.99)		Overweight (25–29.99)		Obese (30+)		Did not answer	*p* value
Age (yr)																		
<65	103	49%	23	11%	86	41%	40		<5	≤2%	64	28%	99	43%	65	28%	23	
65–74	355	62%	63	11%	159	28%	130		3–6	1%	187	29%	276	42%	181	28%	57	
75–84	480	75%	52	8%	106	17%	206		7	1%	253	34%	360	48%	134	18%	90	
85+	145	87%	9	5%	13	8%	122	<0.001	6	3%	122	51%	81	34%	31	13%	49	<0.001 [a]
Sex																		
Male	852	67%	112	9%	301	24%	345		12	1%	456	31%	674	46%	325	22%	143	
Female	231	70%	35	11%	63	19%	153	0.16	8	2%	170	42%	142	35%	86	21%	76	<0.001
Social Deprivation Index [b]																		
1 (affluent)	249	61%	44	11%	112	28%	80		6	1%	167	37%	202	45%	72	16%	38	
2	293	68%	40	9%	100	23%	105		6	1%	175	36%	202	41%	104	21%	51	
3	235	72%	29	9%	64	20%	101		<5	≤2%	121	32%	169	45%	86	23%	50	
4	154	75%	13	6%	39	19%	106		<5	≤2%	85	31%	118	43%	69	25%	36	
5 (deprived)	152	69%	21	10%	48	22%	106	0.06	<5	≤2%	78	28%	125	44%	79	28%	44	0.006
Number of long-term conditions																		
0	244	57%	48	11%	136	32%	89		<5	≤2%	180	42%	182	43%	60	14%	92	
1	316	64%	57	11%	124	25%	140		5	1%	209	36%	248	42%	125	21%	50	
2	258	75%	24	7%	64	18%	99		5	1%	117	29%	187	46%	97	24%	39	
3	158	80%	14-17	7%	26	13%	83		6	2%	78	30%	106	41%	67	26%	24	
4	107	86%	<5	3%	14	11%	87	<0.001	<5	≤2%	42	21%	93	47%	62	31%	14	<0.001 [a]
Type of bladder cancer																		
NMIBC	583	66%	83	9%	222	25%	241		14	1%	333	32%	438	43%	240	23%	104	
MIBC	483	71%	60-63	9%	135	20%	246	0.04	6	1%	278	34%	368	45%	162	20%	110	0.16
Missing	17	61%	<5	14%	7	25%	11		<5	≤2%	15	44%	10	29%	9	26%	5	
Total	1083	68%	147	9%	364	23%	498		20	1%	626	33%	816	44%	411	22%	219	

BMI = body mass index; IMD = Index of Multiple Deprivation; MIBC = muscle-invasive bladder cancer; NMIBC = non–muscle-invasive bladder cancer.

[a] BMI underweight and normal categories combined for chi-square comparison due to low numbers.

[b] *N* = 1 patient IMD income quintile missing.

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tus across England and passive smoke exposure across England was not possible due to a lack of similarity of the questions asked in the current study. Office for National Statistics relationship status lacked "separated" and "single" categories [31]. Health Survey England (2017) asks about hours of smoke exposure, but location is unspecified.

3.5. Interaction between lifestyle factors

We observed interactions between various lifestyle factors (Supplementary Table 1). Physical activity levels dropped with increasing BMI ($p < 0.001$) and with increasing smoking exposure (eg, 35% of nonsmokers were "active" vs 4% of current smokers, $p < 0.001$). Relationship status was not associated with BMI, but current smokers were more likely to be divorced (20%) or single (16%), than married (8%, $p < 0.001$) respondents.

3.6. Lifestyle and demographic factors

Younger participants were less likely to be smokers (eg, 38% of <65 yr olds were nonsmokers vs 27% for 75–84 yr olds, $p < 0.001$), more likely to use e-cigarettes (18% in the <65 yr vs 6% in the 75–84 yr group, $p < 0.001$), and more likely to have had passive smoke exposure (57% for <65 yr vs 45% for 75–84 yr, $p = 0.008$; Table 2). Younger participants were also more likely to be classified as active (41% for <65 yr vs 17% for 75–84 yr, $p < 0.001$) and more likely to be overweight/obese ($p < 0.001$; Table 4). Women were less likely to be smokers ($p < 0.001$) but more likely to have been exposed to passive smoke (60% females vs 45% males, $p < 0.001$; Table 2). Individuals living in deprived areas were more likely to be current smokers (19% least affluent vs 6% most affluent, $p < 0.001$), to use e-cigarettes (15% least affluent vs 7% most affluent, $p < 0.001$), and to have had passive smoke exposure (55% least affluent vs 45% most affluent, $p = 0.02$; Table 2). Smoking was associated with an increasing likelihood of more LTCs ($p = 0.03$), whilst e-cigarette use was not. None of smoking, e-cigarette use, or passive smoke exposure was associated with BC phenotype (Table 2).

4. Discussion

To our knowledge, this is the largest contemporary cohort describing lifestyle factors and the first to explore e-cigarette use, in those living with and beyond a diagnosis of BC. This cohort is more likely to include current smokers or those who previously smoked and engage in less physical activity than the age-equivalent general population. There have been sustained reductions in smoking rates in many countries (eg, English population that smokes: 19.8% in 2011 to 13.9% in 2019 [27], US males—50% in the 1950s to 20% in 2013 [5], and US females [32]). This population trend of reduced smoking likely contributes to the 16% reduction in the age-standardised incidence of BC seen in the UK between 2008 and 2018 [2]. In our cohort (diagnosed with BC since 2006), more respondents had been smokers than in the general population. Owing to the composition of e-cigarettes, their use has been promoted as a less harmful alternative to smoking nicotine-based cigarettes, despite a lack of long-term safety data [33,34]. E-cigarette use has generally been increasing over the past decade, with approximately 7% of adults in the UK reporting that they were current users in 2021 [35]. The majority of respondents cited that their use is to stop or reduce their use of nicotine-based cigarettes [35]. Given the known association between BC and smoking, and the "teachable" moment around the time of diagnosis of a malignancy [36], we were keen to explore the prevalence of e-cigarette use in a diagnosis of BC. Our findings that 9% of respondents with BC had used or were currently using e-cigarettes, and that all of them were tobacco smokers and some remained current cigarette smokers are all in keeping with the best available general population data on this behaviour [35]. Hence, whilst the relatively small total number ($n = 165$) reporting e-cigarette use prevents detailed identification of patterns of potential population subgroups, we can conclude that their overall pattern of use would appear to be no different from that seen in the general population.

Our BC cohort was found to be less physically active than the general population aged over 55 yr, with decreasing physical activity levels being associated with increased BMI and increased smoking exposure. However, the BC cohort was less likely to be overweight and more likely to be underweight than the general population aged ≥55 yr. A similar pattern of weight distribution has been reported for men living with and beyond prostate cancer to that for the general population. These results are of interest. However, the potential interdependence of these factors alongside the increased prevalence of smoking and higher levels of socioeconomic deprivation in the BC cohort precludes causal inference. Similarly, we found an association between relationship status and smoking status both of which could be due to underlying related factors (eg, socioeconomic deprivation). Despite our inability to use these data to identify causal association, the findings of greater adverse lifestyle factors would suggest an opportunity for lifestyle interventions to be further promoted in those diagnosed with BC in the UK.

As the study used data from the NDRS to identify participants, nearly all patients (with a likely minimum of ~98%) who had a diagnosis of BC within a 10-yr window were approached, removing the bias towards particular geographic areas or hospitals [37]. Response rates for the cross-sectional cohort [23] were similar to the response rates for BC patients, as reported by the Department of Health to a previous smaller national patient-reported outcome survey (54%) [38].

4.1. Study limitations

There are various limitations to consider. Our sample size was large, but the response rate for the cross-sectional study was only 55%. Nonresponders were older and living in less affluent areas than responders [23], so our findings may not fully represent the whole BC population (the socioeconomic profile of respondents differed from national incidence figures [39]). With regard to the longitudinal

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study, many potential participants were not recruited. Missing data levels were low, except for the GLTEQ physical activity questionnaire. A systematic review noted that this questionnaire may be limited in cancer survivors due to inaccuracy in recall of physical activity and differences in perception of exercise intensity [40]. Whilst a strength of our work is a direct comparison with population-based data by geographic area (Yorkshire and England), we do not have matched case-control data and the study region may not represent the whole of England (especially with regard to ethnicity). The lifestyle intelligence is self-reported and so subject to inaccuracy. There is some evidence that the self-report by cancer patients of risky behaviours may not be truly representative. This is pertinent for smoking (authors have shown inconsistencies between self-reporting of smoking status and cotinine blood tests [41,42]) and exercise (reports detail that self-declared exercise levels overestimate activity compared with wrist-worn trackers [43]). We also lacked baseline data to determine whether our observed associations existed prior to diagnosis. Finally, no data on alcohol consumption are available as part of this study. We would recommend that future studies address this gap.

5. Conclusions

We found a high prevalence of lifestyle risk factors in people with BC and that this does not change as they live beyond their diagnosis. More attention by health and social care services to promote lifestyle intervention and support for positive health enhancing behaviours are required if this population is to experience enhanced health outcomes.

***Author contributions*:** Zoe Rogers had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Glaser, Absolom, Catto, Downing.
Acquisition of data: Mason.
Analysis and interpretation of data: Catto, Glaser, Absolom, Downing, Conner.
Drafting of the manuscript: Catto, Glaser, Rogers.
Critical revision of the manuscript for important intellectual content: Catto, Glaser, Absolom, Downing, Conner.
Statistical analysis: Rogers, Mason, Downing, Jubber.
Obtaining funding: Glaser, Catto.
Administrative, technical, or material support: Bottomley.
Supervision: Downing.
Other: None.

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***Ethics statement*:** The study received the following ethical approvals: Yorkshire & Humber, South Yorkshire Research Ethics Committee (17/YH/0095), Health Research Authority Confidentiality Advisory Group (17/CAG/0054); Office for Data Release (ODR1718_089, ODR1718_137, and ODR1920_114), and NHS Digital Data Access Request Service (DARS-NIC-129819-V5P5Z-v2.4, DARS-NIC-194387-K3H5K-v1.0, and DARS-NIC-374924-C8S5Y). Participants consented to the cross-sectional study by returning a completed questionnaire. Participants to the longitudinal study were consented at the recruiting NHS hospital. Participants declined to participate in the study by (1) not responding, (2) returning a blank survey, or (3) telephone using the freephone helpline.

***Data sharing*:** All relevant data are included in the article and its supplementary information files.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.euf.2023.04.003.

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