Table 5
Years of life lost (YLLs), years lived with disability (YLDs), disability-adjusted life-years (DALYs) of bladder cancer in Spain scaled to the Barcelona adult population (both sexes).

Age	Spanish population[a]	Spanish YLLs[b]	Spanish YLDs[b]	Spanish DALYs[b]	Barcelona population[a]	% population	Barcelona YLLs[c]	Barcelona YLDs[c]	Barcelona DALYs[c]
20–24	2,260,951	19.5	3.2	22.7	79,062	3.5	0.7	0.1	0.8
25–29	2,518,768	30.4	6.7	37.1	106,489	4.2	1.3	0.3	1.6
30–34	2,961,782	84.5	18.3	102.9	122,353	4.1	3.5	0.8	4.2
35–39	3,717,438	235.9	49.6	285.5	134,575	3.6	8.5	1.8	10.3
40–44	3,961,109	594.9	86.6	681.5	133,557	3.4	20.1	2.9	23
45–49	3,743,094	1549.3	200	1749.3	118,332	3.2	49	6.3	55.3
50–54	3,524,989	3529.2	487.3	4016.5	113,041	3.2	113.2	15.6	128.8
55–59	3,151,845	6089.7	784	6873.7	102,949	3.3	198.9	25.6	224.5
60–64	2,637,235	8925.8	1055	9980.8	90,465	3.4	306.2	36.2	342.4
65–69	2,370,618	10,652.2	1215.5	11,867.6	86,264	3.6	387.6	44.2	431.8
70–74	2,055,842	11,914.8	1341.1	13,255.9	77,501	3.8	449.2	50.6	499.7
75–79	1,534,114	10,967.3	1157.2	12,124.5	59,962	3.9	428.7	45.2	473.9
80–84	1,449,210	12,669.2	890.7	13,559.9	59,453	4.1	519.7	36.5	556.3
85–89	918,124	8663.1	781.3	9444.4	41,136	4.5	388.1	35	423.2
90–94	390,357	3378.9	401.5	3780.4	19,016	4.9	164.6	19.6	184.2
≥95	103,370	588	76.7	664.6	5415	5.2	30.8	4	34.8
All adults	37,298,846	79,892.7	8554.5	88,447.1	1,349,570	–	3070.0	324.7	3394.8

[a] Source: INE (2018).
[b] Source: Global Burden of disease 2016 (IHME, 2018).
[c] Barcelona YLLs, YLDs, and DALYs calculated as Spanish burden of disease metrics multiplied by the fraction of the Barcelona population over the Spanish population by age group.

treatment plant (i.e. Cardedeu) only includes conventional treatments. Thus, chemicals and energy consumption are lower compared to the Llobregat drinking water treatment plants. On the other hand, the higher impact of the production of drinking water in the Llobregat area was due to the advanced treatments (i.e. reverse electrodialysis, reverse osmosis, desalination) taking place in the drinking water treatment plants supplying this area (i.e. Abrera, Sant Joan Despí and the desalination plant). Indeed, reverse electrodialysis, reverse osmosis and desalination require high energy consumption (up to 4 kWh/m^3 of water) compared to the conventional treatments (Crittenden et al., 2005). In conclusion, the better the quality of the source of water, the simpler the treatment, the lower the environmental impact, illustrating the cost-effectiveness of improving the quality of drinking water sources.

Our study contributes new knowledge on how health and environmental tradeoffs of drinking water source choice can be integrated. We apply our integrated assessment approach to the city of Barcelona, which severs as a useful case study to explore these tradeoffs for several reasons. Barcelona includes 1) a range of water treatment technologies; 2) intermediate THM levels comparable with other countries in Europe (Evlampidou et al., 2020); 3) high levels of bottled drinking water, which are comparable to Italy, Germany or Portugal (Conway, 2020). Findings from our case study provide valuable insights into the health and environmental tradeoffs of drinking water source choice that are informative for similar populations and settings in Europe. Our analytical approach could be applied in further work including a larger set of water treatment and population behaviour contexts to explore whether the balance of tradeoffs are context dependent.

Total THM levels were slightly lower in the Llobregat compared to the Ter water supply area (≈30 vs. 40 μg/L). Since it was usually the opposite in the past (ASPB, 2012), current concentrations illustrate the reduction of THM occurrence and improvement of drinking water quality after incorporating advanced water treatments (e.g. reverse osmosis, reverse electrodialysis) in ≈2009. Unexpectedly, this has not been mirrored by a lower bottled water consumption in the Llobregat water supply area, where approximately 71% of the population consumes usually bottled water, vs. 43% in the Ter area. Indeed, bottled water consumption has increased throughout Barcelona, from approximately 54% in 2006 (Font-Ribera et al., 2017) to approximately 58% in 2016 (ASPB, 2019). These findings suggest that bottled water consumption could be motivated by subjective factors other than objective water quality.

Our results support the argument that bottled water consumption should be reduced in settings where public drinking water is safe. In the European Union, the new drinking water directive (EC, 2020) aims to reduce plastic bottle consumption by increasing confidence in and improving access to tap water to meet drinking water needs. Understanding the reasons that influence drinking water preferences and personal choices is necessary to eventually design interventions. A main explanatory variable for bottled water consumption is perception of poor tap water quality (March et al., 2020). In turn, risk perception of drinking water quality is influenced by organoleptics (especially flavour), perceived water chemicals, external information, past health problems, and trust in public suppliers (Doria et al., 2009).

In-house water treatment systems are emerging as an alternative to bottled water when tap water is unattractive due to bad taste, odour, or lime presence (March et al., 2020). In our study population, 16% of subjects report the use of domestic drinking water filters as main drinking water choice. However, given the lack of specific input data, our HIA and LCA estimates for the scenario where all the population uses domestic filters requires several simplifying assumptions. First, we lacked information on specific filters used by the population. We assigned values corresponding to carbon filter jars, which appear to be popular choices

Table 6
Mean (95% confidence interval) population attributable fraction (PAF), years of life lost (YLLs), years lived with disability (YLDs), and disability-adjusted life years (DALYs) for bladder cancer in the Barcelona population attributable to THM under the four drinking water consumption scenarios, based on health impact assessment.

Local health impacts (bladder cancer)				
Scenario	PAF (%)	YLLs	YLDs	DALYs
S1: Current	3.1 (1.5, 4.6)	93.9 (46.6, 142.1)	9.9 (4.9, 15)	103.9 (51.5, 157.1)
S2: All tap water	10.1 (5.2, 14.7)	309.1 (158.7, 451.7)	32.7 (16.8, 47.8)	341.8 (175.5, 499.4)
S3: All bottled water	0.1 (0, 0.1)	2.2 (1.1, 3.3)	0.2 (0.1, 0.3)	2.4 (1.2, 3.6)
S4: All filtered tap	1.2 (0.6, 1.7)	35.6 (17.9, 53.2)	3.8 (1.9, 5.6)	39.4 (19.8, 58.9)