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Abstract

Among the OECD countries, France ranks fifteenth in terms of cancer mortality, with a standardized age-specific rate per 100,000 inhabitants equal to 197 in 2018. We estimate, for the first time in France, the effect of prostate and testicular cancers on labour market participation (employment, unemployment and sick leave) in the male population, up to five years after the cancer onset. Based on a French medico-administrative database, we perform a difference in difference analysis combined with an exact matching method in order to control selection effect (lagged variables) and fixed unobservable individual heterogeneity. We find that the detrimental long-term effect of both cancers on employment differs importantly: it increases significantly over time to 14.1 percentage points for prostate cancers but only to 1.4 percentage points for testicular cancers. The year after diagnosis is characterized by a very significant increase in sick leave (+27-28 pp), due to the need of intensive care. Prostate cancer leads to a permanent and increasing exit from the labour market reaching a ceiling four years after diagnosis (-14.2 pp for employment) in favour of non-employment situations (+15.8 pp in t+5). These results demonstrate the ineffectiveness of French public policies put in place to support job retention or return to work for cancer survivors.

Keywords: Male reproductive organs cancers, labour market participation, difference in differences estimator, France

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1. Introduction

Among the OECD countries, France ranks fifteenth in terms of cancer mortality, with a standardized age-specific rate per 100,000 inhabitants equal to 197 in 2018. The estimated number of cancer deaths is 157,400 in 2018 (1). The prostate cancer is the leading male cancer in terms of incidence (50,430 in 2015) and is the third leading cause of cancer deaths (8,115 in 2015). However, a significant decline in prostate cancer mortality appeared since 1990 due to an improvement in the management of this cancer (2). The median age at diagnosis in 2015 is equal to 65. The age-standardized 5-year net survival is the highest of all tumours for men, 93%. The sequelae of treatment for prostate cancer can be difficult to bear and reconcile with work (urinary incontinence), while other after-effects may cause psychological disorders (troubles of sexuality).

Apart from prostate cancer, specifically main male cancers are testicular cancers with less than one hundred deaths. Testicular cancer ranks 15th among men's cancers, with an estimated 2,769 cases in 2018 (2). The median age at diagnosis is 35 in 2018. This is the lowest onset age of all cancers in France. The age-standardized mortality rate is 0.2% and the age-standardized net survival of people with testicular cancer is 93% after five years.

The occurrence of both these cancers affect employment. The proximity of the retirement age for a large part of prostate cancer survivors reduces the marginal gain of job retention. However, more and more male cancer survivors are still working at the onset of the disease for both reasons. First, the retirement age is postponed since 1993. Second, the implementation of organized screening for allowed to lower the age of diagnosis. The 2014-2019 Cancer Plan proposes actions to limit the adverse effect of cancer on the professional path. Then, cancer survivors may receive working conditions accommodations, additional individual rights to vocational training, but also access insurance and employment without any

discrimination (after ten years without cancer recurrence). Helping male cancer survivors to deal with potential mental health problems belongs to care priorities. Among the likely protecting factors of well-being, return to work has been proved as particularly helpful. Hence, unemployment is significantly correlated with depression and anxiety disorders for prostate and testicular cancer survivors (3, 4). Those stylized facts reinforce the relevance of this work, especially because French studies (5-7) remain parsimonious . The aim of this study is to focus on cancers of the male reproductive system and to evaluate their impact on employment, unemployment and sick leave.

The research focusing on labour market outcomes of prostate and testicular cancer survivors remains rare. The average percentage of prostate cancer patients returning to work was 80% one year after diagnosis (8). However, the work prognosis for prostate cancer survivors worsens over time with a significant drop in the employment rate (9, 10). Absenteeism seems to remain high with time after prostate diagnosis (11, 12). However, considering sickness absence episodes longer than one month, Alleaume *et al.* (13) report that 51.4% of a sample of workers diagnosed with a prostate cancer in France in 2010 had no sickness absence. Studies in Finland and Norway show no difference between survivors and healthy controls with respect to employment status (14, 15). In a meta-analysis, covering 36 different studies with three devoted to the testicular cancer, De Boer et al. (16) show that unemployment rates were not significantly higher for survivors. This result is confirmed in Israel (17). Finally, studies of sick leave episodes confirmed that work ability of testicular cancer survivors was only temporary affected. Absenteeism of survivors increases significantly during the first year after diagnosis but then decreases regularly to finally balance with absenteeism of healthy controls after five years (12, 18).

Using administrative panel data, we estimate, for the first time in France, the effects of prostate and testicular cancers on employment outcomes up to five years after their onset. We perform a difference-in-differences analysis combined with a dynamic matching approach. The paper is organized as follows. Section 2 presents the methods. The results are reported in section 3 followed by a discussion in section 4.

2. Methods

We use the HYGIE data set constructed from the merger of two administrative sources: the National Pension Fund and the National Health Insurance. The resulting sample contains individual information on the recipients (all active and retired private sector employees), their professional careers, medical consumption and sick leaves. The HYGIE data set is a random sample of the recipients aged 22 to 70 years who contributed to the general pension fund at least once in their live and received sickness benefits for at least one health service in 2003, 2004 or 2005. The total sample includes information about 499,595 workers with at least three years of presence, including 265,017 men. The dataset follows this sample of male individuals since their entry in the labour market, over 27 years on average with a total of 6,970,104 observations.

We can observe the onset of the cancer from the beginning of the professional career to 2008. Thanks to the International Classification of Diseases, we identify the prostate and testicular cancers based on a first registration in the long-term disease administrative scheme.

Employment outcomes

We consider four outcome variables as various situations in the labour market. The first three are mutually exclusive labour market occupation status constructed from the quarterly compulsory contributions of the workers to the general health insurance scheme. These

contributions are made when the worker is active and are different when employed or unemployed. “Employment” status corresponds to at least one quarter of employment during the year; “unemployment” status corresponds to unemployment quarters only and finally inactivity corresponds to no quarter either in employment or in unemployment. The fourth outcome variable records if the worker declared at least one quarter in sickness leave.

Matching Variables

We assume that after conditioning on personal characteristics, health and labor market history, the timing of disease is random. Hence, we first control for age as age is an influential determinant of cancer diagnosis and employment status..

Also, the higher the level of education, the higher the quality of health and the likelihood to participate to the labour market. Hence, in order to proxy education, the wage of the first year in the labour market or “starting wage” is used. We divided this variable by the median starting wage of the same year and then calculated the quartiles to get four wage intervals.

As underlined in literature, previous participation in the labor market is related to the path dependence issue (19). Consequently, two variables control for past experience.

First, a variable indicates the proportion of stable employment in the worker’s employment history. This indicator is defined as the number of years with a stable employment status divided by the number of years spent in the labor market. Stable employment indicates the individual proportion of years with 4 quarters of employment contributions and no unemployment quarter. It captures the quality of labor integration of workers. We built three classes.

Second, we use a health history indicator. We assume that past health problems are associated with a lower productivity. Thus, we wish to compare workers with similar health and participation histories. The health history indicator is defined as the ratio of the number of years with at least one sick leave quarter divided by the number of years in the labor market. This indicator indicates the individual proportion of years with a significant health problem in the past career of the worker. We built three classes.

Statistical analysis

Our econometric model relies on a difference in differences method with matching. Following Heckman *et al*. (20) and Barnay *et al.* (21), we compare the individuals i in a treatment group ($T_i = 1$), experiencing a cancer at time t_i, and a control group ($T_i = 0$) that has not experienced any long-term disease yet (including cancer). Each person in the sample has two potential outcomes $(y_{0i}(t), y_{1i}(t))$ depending on whether $(y_{1i}(t))$ or not $(y_{0i}(t))$ he has experienced cancer. By definition, we only observe one of the two potential outcomes as for each treated individual, we observe an empirical counterpart of what happens with cancer but we do not observe what would have happened without cancer.

$$y_i(t) = T_i y_{1i}(t) + (1 - T_i) y_{0i}(t) = \begin{cases} y_{1i}(t) & \text{if } T_i = 1 \\ y_{0i}(t) & \text{if } T_i = 0 \end{cases}$$

For each treated individual, we observe an empirical counterpart of what happens with cancer but we do not observe what would have happened without cancer. For an effect k years after cancer, we observe what has happened to the treated:

$$\mathrm{E}(y_{1i}(t_i + k) - y_{0i}(t_i - 1) | T_i = 1)$$

and we need to estimate the following quantity, the counterfactual, what would have happened to the treated if they had no cancer[3]:

$$\mathrm{E}(y_{0i}(t_i + k) - y_{0i}(t_i - 1)|T_i = 1).$$

The first problem to solve is to define the control group; the second problem is to estimate the counterfactual from the control group.

With panel data, the definition of the treated set varies over time. We consider individuals i who are in the data set from year t_i^- to year t_i^+. The individuals who are treated at date $t_i \in [t_i^-, t_i^+]$ were not treated before this date. Therefore, the treated can be used as controls before the onset of the cancer. We advocate the use of these future treated in the control group for the following reason: if we did not, we would only keep in the control group these working men who, over a long period, will never have a long-term disease. These individuals would then serve as a match to estimate what would have happened to the persons with a cancer. We doubt that this would produce a good reference because the people to whom no disease ever happens have little chance to be representative of the general population. One may think of them as being more healthy than the general population. Therefore, if their performance in the labour market in the absence of health events may be superior to the performance of the general population, we would underestimate the effect of cancer on the outcome variables. We thus use the people that did not have any long-term disease (including cancer) before or during year $t_i + k$ as the control group for the treated i evaluated on the period $[t_i - 1, t_i + k]$:. This control group includes both the people that will never suffer from a long-term disease, and the people that will have a long-term disease after $t_i + k$. The

[3] Notice that these within-individual differences allow us for eliminating the fixed effects unobserved heterogeneity.

condition on year $t_i + k$ is needed to make sure that the outcome of a control is not influenced by a health event.[4] Moreover, this control group corresponds to the definition that is used in all cross-section studies.

The counterfactual estimation is performed by looking for individuals with similar characteristics as the treated among the not treated. It remains to choose a matching method. Ideally, we would like the treated and the non-treated to be identical, so that the non-treated could be used to produce a credible estimate of what would have happened to the treated if they had not been treated. Following the literature exposed in Rubin (22), we use exact matching for the birth year and coarsened exact matching (interval matching) for the starting wage, past stable employment and past sick leaves. This exact matching produces high matching rates because there are a large number of controls. In our application, the matching rate is between 98.4% and 100%. The estimator is defined as:

$$\widehat{\mathrm{ATT}}(k) = \frac{1}{I}\sum_{i\in I}\left(y_i(t_i + k) - y_i(t_i - 1) - \frac{1}{J(i)}\sum_{j\in J(i)} y_j(t_i + k) - y_j(t_i - 1) \right)$$

$$k \in \{1, \dots, 5\}$$

where I is the treated set and their number, and $J(i)$ the set of i's twins and their number:

$$J(i) = \left\{ j : t_j > t_i + k, X_j = X_i \right\}$$

where X_i is the vector of the matching variables. Matching is done with replacement: we use all the twins available for each treated in order to reduce the bias of the estimator (23, 24).

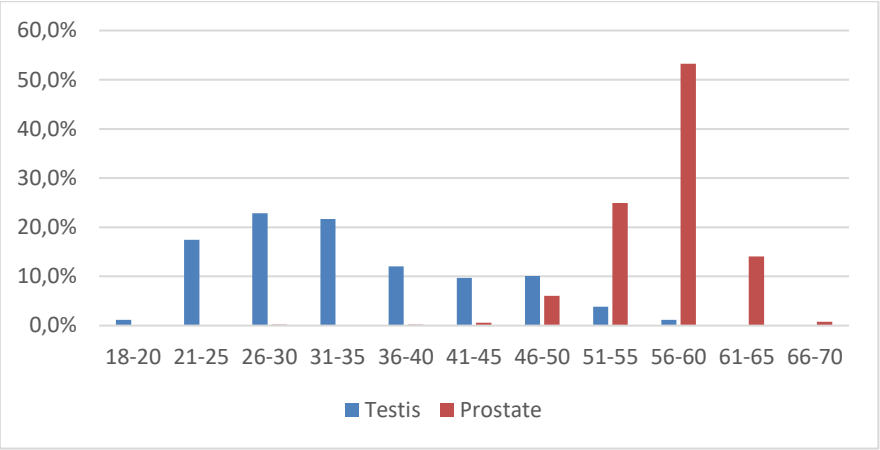
[4] Le t_j be the treatment date of a twin in the control group, we impose the condition $t_j > t_i + k$. When j is not treated, we set $t_j = \{+\infty\}$ and the condition is always valid.

Our difference-in-differences estimator measures the causal effect of cancer on labour market outcomes before and after the onset on individuals affected (first difference) compared with individuals not affected by long term illness (second difference). This method has the further advantage to eliminate both individual unobserved heterogeneity and time fixed effects.

3. Results

In our sample, the mean age at cancer diagnosis is low, compared to the general population (see figure 1). Notably, the age of prostate cancer onset in our sample is significantly lower than the one observed in general population (56 years versus 68 years old). It is also somehow true of the mean age of testis cancer (34 vs 38 years old). These finding relies on a selection effect: all sampled individuals must have made a least one quarter contribution since the date of labour market entrance and be less than 70. Testis cancer is a cancer of young adults which mainly appears between 20 and 35 years old whereas more than 50 % of Prostate cancer survivors have been diagnosed between 56 and 60 years old. For this latter population, studying the effect of cancer close to the end of professional path seems consequently relevant. Furthermore, in this study, we evaluate the net effects of cancer onset on labour market outcomes of both type of cancer survivors in comparison with members of specific control groups.

Figure 1: Mean age at Cancer Onset



Moreover, sampled individuals exit the database after retirement. This is in line with our target: measuring the impact of cancers in the labor market. Attrition is much stronger for prostate cancer because some survivors prefer to retire (table 1). For testicular cancer, which happens at 34 years old on average, all the attrition is not due to retirement nor death.

Table 1: Attrition analysis

Exit from the sample between t+1 and t+5, where t is the cancer date. *Reading example:* Five years after the prostate cancer, 83% of the individuals are out of the sample (retirement: 45%; other: 52% and death: 3%).

	% Attrition between t+1 and t+5	**Attrition cause** (total = 100%)		
		Retirement	**Death**	**Other**
Prostate	83%	45%	3%	52%
Testicular	37%	3%	1%	96%

The number of men with a prostate cancer and data up to one year after its onset reaches 450. This number is subject to a strong attrition mainly due to the decision to retire, with 45% of the cases (Table 1). Table 2 reports sample statistics for both the matching and outcome variables used in our econometric method.

Table 2: Sample Statistics for matching and outcome variables

Cancer		Prostate			Testicular	
Group	**Case**	**Control**	**Difference**	**Case**	**Control**	**Difference**
N	**271**	**202,993**		**450**	**202,993**	
Age in 2008	63.5	45.1	**18.5**	40.9	45.1	**-4.1**
Starting wage						
r <= Q1	33.1%	22.9%	**10.2 pp**	17.0%	22.9%	**-5.9 pp**
Q1 < r <= Me	20.7%	25.2%	**-4.5 pp**	26.9%	25.2%	**1.8 pp**
Me < r <= Q3	28.5%	26.1%	**2.4 pp**	27.7%	26.1%	**1.5 pp**
r > Q3	17.6%	25.8%	**-8.2 pp**	28.4%	25.8%	**2.6 pp**
Employment history up to t-1						
c <= 0.5	14.6%	55.9%	**-41.3 pp**	75.6%	64.2%	**11.3 pp**
0.5 < c <= 0.7	45.5%	27.0%	**18.5 pp**	16.9%	22.9%	**-5.9 pp**
c > 0.7	39.9%	17.1%	**22.8 pp**	7.5%	12.9%	**-5.4 pp**
Health history up to t-1						
h = 0	66.6%	75.9%	**-9.3 pp**	84.2%	78.1%	**6.1 pp**
0 < h <= 0.06	26.5%	15.5%	**11.0 pp**	10.2%	14.8%	**-4.7 pp**
h > 0.06	6.9%	8.6%	**-1.7 pp**	5.6%	7.1%	**-1.5 pp**
Outcome variables in 2008						
Employment	25,2%	75,0%	**-49,8 pp**	85,2%	75,0%	**10,2 pp**
Unemployed	3,9%	3,7%	**0,2 pp**	5,5%	3,7%	**1,8 pp**
Inactive	2,0%	2,6%	**-0,6 pp**	5,9%	2,6%	**3,3 pp**
Retired	68,9%	18,6%	**50,2 pp**	3,3%	18,6%	**-15,3 pp**

Source: Hygie, authors' computations.
All difference coefficients are significant at the 1 % level

For prostate cancer, we find that the sick workers are older, have a lower education level, a less stable employment path and took more sick leaves in the past. Their health and labor situations were already worse before their prostate cancer. This illustrates the importance of matching since education, past labor and past health evolutions are confounder variables. In 2008, the workers who faced a prostate cancer work less often and are more often in inactivity than the other workers. On the contrary, the testicular cancers workers are a little younger and a little more educated than the controls. Their past situation in the labor market is better than the controls and they took less sick leaves than the controls.

Prostate cancer survivors have a lower probability of employment than controls while the reverse is true for testicular cancer survivors. This situation is not only due to the disease but is also probably related to education, past working career and likely age of the sick workers.

Table 3 presents the cancer effects on the four outcome variables in the labor market up to five years after the cancer onset.

Employment decreases progressively from one year after the prostate cancer onset. We find that the probability of being in employment declines by 3.9 pp (percentage points) in the first year and by 4.1 pp in the second year. This effect corresponds to the effects of treatments and the initial sequelae. As expected, an increase in the probability of sickness leave accompanies the reduced probability of being in employment. It raises by 27.8 pp on the first year and 16.8 pp during the second year. These two years correspond to times of treatment, and absenteeism is a well-known phenomenon after a cancer diagnosis. In prostate cancer, certain treatment options have stronger effects, especially problems of incontinence and sexual disorders. The former may be particularly difficult to reconcile with specific occupations. We find that from three to five years after diagnosis, the probability of being in employment strongly declines steadily with time: -7.9 pp at t+3, -14.2 pp at t+4 and -14.1 pp at t+5. Two types of transitions are associated with the prostate cancer. First, the men that are close the retirement age choose to stop working. We see it through the attrition statistics (Table 1). Second, other men are simply driven out of the labor market, since we find few transitions toward unemployment but a large increase in inactivity.

Table 3: Cancer effects

Note. Line « E(y(t-1)|T=1) » represents the activity of the worker one year before cancer: the sum of the columns « employment », « unemployment » and « inactivity » is equal to 100%. The line « ATT(k) » gives the estimates of the average effect of the treatment (cancer) on the treated k years after its onset: the sum of the columns « employment », « unemployment » and « inactivity » is equal to 0. The « sickness leave » coefficient must be interpreted separately. The Student statistics refers to the ATT(k). The ATT(k) are in percentage points: they can be added directly to the « E(y(t-1)|T=1) » line. ** significant at the 5 % level, * significant at the 10 % level.

Cancer	Treated % matched	Employment	Unemployment	Inactivity	Sickness leave
Prostate					
E(y(t-1)|T=1)	**450**	86.5%	10.2%	3.4%	5.4%
ATT(1)	98.4%	**-3.9%****	**-0.4%**	**+4.3%****	**+27.8%****
Student		5.35	0.91	17.86	50.18
E(y(t-1)|T=1)	**312**	88.3%	8.4%	3.2%	6.5%
ATT(2)	99.0%	**-4.1%****	**-1.0%***	**+5.1%****	**+16.8%****
Student		4.63	1.67	12.01	34.03
E(y(t-1)|T=1)	**208**	88.3%	7.3%	4.4%	5.8%
ATT(3)	99.0%	**-7.9%****	**+1.0%**	**+6.9%****	**+11.0%****
Student		6.64	1.24	21.14	50.25
E(y(t-1)|T=1)	**136**	88.9%	4.4%	6.7%	5.9%
ATT(4)	99.3%	**-14.2%****	**+4.9%****	**+9.3%****	**+4.5%****
Student		10.75	5.24	25.72	5.64
E(y(t-1)|T=1)	**76**	88.2%	3.9%	7.9%	1.3%
ATT(5)	100%	**-14.1%****	**-1.8%****	**+15.8%****	**+0.8%**
Student		10.66	2.47	15.51	0.82
Testicular					
E(y(t-1)|T=1)	**267**	94.4%	1.9%	3.7%	2.2%
ATT(1)	100%	**-3.1%****	**+0.1%**	**+3.1%****	**+27.3%****
Student		4.97	0.18	10.63	69.56
E(y(t-1)|T=1)	**243**	94.7%	2.1%	3.3%	2.1%
ATT(2)	100%	**-2.1%****	**+0.5%****	**+1.6%****	**+10.0%****
Student		3.26	2.43	4.59	106.49
E(y(t-1)|T=1)	**220**	94.5%	1.4%	4.1%	2.3%
ATT(3)	100%	**-1.7%****	**+2.1%****	**-0.4%****	**+4.5%****
Student		2.50	5.29	2.82	9.70
E(y(t-1)|T=1)	**190**	95.3%	1.6%	3.2%	2.1%
ATT(4)	100%	**-0.9%**	**0.0%**	**+0.8%****	**+1.3%****
Student		1.52	0.03	5.42	10.65
E(y(t-1)|T=1)	**167**	95.2%	1.2%	3.6%	2.4%
ATT(5)	100%	**-1.4%****	**-0.2%***	**+1.6%****	**+1.8%****
Student		1.99	1.65	12.24	4.14

Source: Hygie, authors' computations. *Reading example:* for prostate cancer, the employment probability is 86.5% one year before cancer and is reduced by 3.9 percentage points one year after cancer, reaching 86.5%-3.9%=82.6% for the workers one year after a prostate cancer. At the same time, the proportion of workers in sick leaves reaches 5.4% without cancer and 5.4%+27.8%=33.2% one year after a prostate cancer. These estimates were obtained from a sample of 450 workers with a prostate cancer, whose 98.4% could be matched.

The number of men with a testicular cancer with at least one year of additional data is 267. Five years after, attrition due to sampling leaves 167 men. The effect of the testicular cancer is much smaller on employment than the effect of the prostate cancer. The decrease in the probability of being employed one year after the diagnosis remains quite small: 3.1 pp and it is rather decreasing over time to reach only 1.4 pp after five years. On the contrary, the use of sickness leaves is strong during the two first years (+27.3 pp and +10 pp respectively), which correspond to the main phase of surgery and chemical treatments. After three years, the consequences observed are relatively limited since a return to a state of health is compatible with work. But it does not mean that there are no sequelae, especially at a psychological level (25). Nevertheless, the average effect on inactivity becomes negligible after five years (1.6 pp).

4. Discussion

We measure, for the first time in France, the employment effects of the occurrence of prostate and testicular cancers up to 5 years after the administrative registration of the disease. The econometric method seems robust thanks to a double difference method combined with an exact matching in order to control selection effect (lagged variables) and fixed effects unobserved heterogeneity.

However, our study presents some limitations. For instance, the medical data collected do not allow identifying the stage of the cancer, the treatments or the sequelae. In addition, we target the analyses related to the occurrence of a first registration in ALD and thus exclude the evaluation of the effect of several ALD or recurrence on professional trajectories. Furthermore, this study does not claim to assess the mechanisms that may explain this progressive exit from the labor market.

Our findings underline common effects following the occurrence of these both male cancers. First of all, the year after diagnosis is characterized by a very significant increase in sick leave (+27-28 pp), due to the need of intensive care. This short-term absenteeism is well known in the literature (see Bradley (2006) for prostate cancer). The professional path is then systematically affected, particularly following prostate cancer. Prostate cancer leads to a permanent and increasing exit from the labor market reaching a ceiling four years after diagnosis (-14 pp for employment) in favor of non-employment situations (+16 pp to t+5).

For late onset prostate cancer, deadweight effects may alter the individual preferences and reinforce the disutility to work at an advanced age. Indeed, the French system is characterized by private early retirement schemes or disability pensions, which lead survivors close to retirement date to anticipate their exit from the labor market. Another driver of exclusion from the labor market after a cancer diagnosis is workplace discrimination. In France, Paraponaris *et al.* (26) report that cancer survivors two years after diagnosis suffer from perceived discriminatory behaviors from their colleagues or hierarchy. All other things being equal, these behaviors increase the likelihood to lose jobs by 15%. Discrimination at work seems particularly pregnant among prostate cancer survivors (27).

For patients suffering from testicular cancer, it is likely that post-treatment psychological interventions could be useful although the consequences on labor market variables seem to less visible.

These results may then demonstrate the ineffectiveness of public policies put in place to support job retention or return to work for cancer survivors. They require reinforcing public action, which may appear on several stages. Upstream, health policies could intervene on screening in order to reduce the severity of cancers and their deleterious impact on well-

being. However, screening for these cancers remains questionable. For instance, in prostate cancer, screening *via* Prostatic Specific Antigen has many limitations due to the risk of over-treatment. A policy goal could attempt to improve job security, sustainability and adaptation of working conditions (28) by reducing the impact of prostate and testicular cancers. Another policy target should be to increase the (re)integration of cancer survivors by intervening at the beginning of the professional career by implementation a follow-up psychosocial care. Even if the negative effect is weak, this is particularly relevant for testicular cancers survivors who can face to long-term psychiatric disorders, fear of recurrence and a reduced quality of life (29).

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