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ORIGINAL ARTICLE

# Employment outcomes of adolescent and young adult (AYA) cancer survivors and their partners: A Dutch population-based study

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## Abstract

**Background:** The aim of this population-based registry study was to examine the impact of cancer on employment outcomes in adolescent and young adult (AYA) survivors and their partners and associated sociodemographic and clinical characteristics.

**Methods:** A total of 2456 AYA cancer patients, diagnosed in 2013 and aged 18 through 39 years old, were selected from the Netherlands Cancer Registry and linked to employment data from Statistics Netherlands, from which 1252 partners of AYAs could be identified. For both patients and their partners, a control group with same age, migration background, and sex was selected. The impact (i.e., causal effect) was estimated by implementing a doubly robust difference-in-differences method, from 3 years before to 5 years after cancer diagnosis.

**Results:** Patients suffered a reduced employment probability (3.8 percentage points) and number of hours worked when employed (3.8%). This effect was larger for females, and individuals with a migration background, high tumor stage, or diagnosed with a central nervous system tumor/hematologic malignancy. In regard to employment, no significant effect could be found for the patients' partners, although a 5.5 percentage-point increase in employment probability was found in partners who were either unemployed or worked fewer than 400 hours.

**Conclusions:** A cancer diagnosis significantly affects employment outcomes of AYA patients with cancer. Patients at risk should have access to services such as job counseling to help them return into society in the best possible way. No objective impact on partners' employment outcomes was found; however, subjective well-being was not taken into account.

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**Plain Language Summary**

- This study estimated the causal effect of a cancer diagnosis on employment outcomes.
- Adolescent and young adult cancer survivors face a reduction in both employment probability and the number of hours worked when employed.
- Partners that were unemployed or worked the least number of hours a year before diagnosis had a 5.5 percentage-point increased employment probability, but for other partners effects are small.

**KEYWORDS**
adolescents and young adults, AYAs, cancer, difference-in-differences, employment, survivors

## INTRODUCTION

Adolescents and young adults with cancer (AYAs; those aged 15–39 years at initial cancer diagnosis) are historically an understudied group in research but are considered to be a distinct patient population. More than 80% of AYAs diagnosed with cancer survive at least 5 years after diagnosis.[1] Additionally, the number of AYAs diagnosed with cancer has grown over the past decades. Together, these phenomena imply that a growing number of AYA cancer survivors will live with a history of cancer and its implications.[1]

Encountering cancer during a developmentally precarious time can complicate the experiences typical to this life phase such as developing emotional and financial independence; cultivating self-confidence, self-sufficiency, and sense of identity; pursuing education, vocation, or a career; experiencing social and romantic intimacy; and making sexual and reproductive choices appropriate to young adulthood.[2] AYAs with cancer experience specific and unique psychosocial stressors and life disruptions that affect their physical and psychosocial functioning.[3] Social functioning is among the most severely affected health-related quality-of-life domains among AYAs with cancer.[4] An important factor contributing to a healthy social life is employment; surviving cancer is associated with reduced income, employment probability, and hours worked.[5–10] Few studies have investigated employment-related issues among AYA cancer survivors specifically to date. Leuteritz et al.[11] and Parsons et al.[12] investigated return to work for this group; however, both studies used survey data and did not include a control group, making it difficult to examine the objective causal impact of cancer on employment outcomes.[13]

Although little research has examined employment effects associated with a cancer diagnosis as an AYA,[14] even less research has been conducted among family members of patients, including their partners.[15] It is possible that the partners of patients also face employment difficulties; partners may have to compensate for lost income by becoming employed or increasing their working hours. They could also decrease their working hours to spend more time with their ill partner and to act as a caregiver to their partner and any other dependents. These decisions may be made out of necessity rather than personal preference. Multiple studies have found that health shocks (e.g., acute hospitalization, cancer diagnosis) can have a negative effect on partner employment outcomes,[16–19] although not all studies identified similar effects.[20]

Given that little research has focused on the employment-related effects of surviving cancer on AYAs and/or their partners, the objectives of this study were to investigate (1) the long-term (5-year) causal impact of cancer on employment outcomes of both AYA cancer survivors and their partners and (2) the sociodemographic and clinical characteristics associated with this causal impact.

## METHODS

### Data sets and study sample

For this study, data were used from both the Netherlands Cancer Registry (NCR) and Statistics Netherlands (CBS). The NCR contains clinical information, such as tumor type and treatment, of all individuals diagnosed with cancer in the Netherlands. For this study, all individuals aged 18 to 39 years who were diagnosed with cancer in 2013 for the first time and who survived at least 5 years after their initial diagnosis were selected for inclusion. The selected cases were linked to their unique CBS identification number (based on their six-digit postal code, date of birth, and sex), and enriched with the CBS data, leading to a pseudonymized data set. Figure A1 in the appendix shows the selection procedure. Patients' partners were selected based on household information from CBS, which includes information on the position of an individual within a household. Partners were selected when they were the partner of a patient within a household for at least the 2 years before diagnosis, although aged ≤59 in 2013 (because older partners reached retirement age within the timeframe of the study).

From the CBS data, a control group was randomly selected with a comparable age, sex, and migration background as the patients, using a 1:10 ratio. Given that the data of patients are available from 2010 to 2018, controls were restricted to have data available in these years as well. For partners, a control group was randomly selected with a comparable age, sex, and migration background, and relation duration before 2013, using a 1:5 ratio. Note that the partner controls were pulled from the full population included in the CBS data.

Partners that were together with one of the patients earlier in their life but are not in the same household anymore during this study are excluded from the patient control group. Exact matching was used for patients, whereas a combination of exact and nearest neighbor matching was used for the partners because the pool of potential controls was smaller and it was not possible to find an exact match in all cases.

## Study measures

Clinical characteristics were extracted from the NCR and included: tumor type, cancer stage (based on TNM and Ann Arbor), cancer treatment, and the number of different treatments.

Sociodemographic characteristics and employment-related outcomes were extracted from CBS. Employment outcomes were observed from 3 years before diagnosis up to 5 years after diagnosis.

Sociodemographic characteristics included: age (in 2013 year of diagnosis), gender, migration background (either first- or second-generation migration background), partner status, highest education level achieved (primary, secondary, or tertiary), and number of children (only used in partner analyses).

Employment-related outcomes included number of hours worked (this contains all hours worked as an employee, summed over different employers if someone worked for multiple organizations), self-employment, and type of contract (permanent or temporary). Using the number of hours worked, an individual is considered employed when working at least 52 hours in a given year. This is based on the Eurostat and U.S. Bureau of Labor Statistics definitions of working at least 1 hour per week, adjusted for yearly data.[21,22] The number of hours worked was analyzed only for those individuals considered to be employed by this definition. For this study, long-term effects are defined as 5 years after cancer diagnosis.

## Statistical analyses

The descriptive statistics contain frequencies, percentages, and means. Difference-in-differences (DiD) analysis were used to estimate the causal effect of a cancer diagnosis on employment outcomes. This method identifies a causal effect by comparing differences between changes in the treatment group (i.e., the cancer patients) and changes in the control group under a set of assumptions. The treatment effect thus represents the difference in effect between those diagnosed with cancer and those not diagnosed with cancer. The key assumption is the parallel trends assumption, which assumes that the outcome of both the treatment and control group would have developed similarly in the absence of treatment.[23] The effect estimated using DiD is the average treatment effect on the treated (ATT), which from now on will be referred to as treatment effect or ATT. The ATT can be time-specific for different years after diagnosis, which is used for dynamic treatment effects, or aggregated over all postdiagnosis years, which will be referred to as the overall effect.

Typically, the DiD is implemented using a regression formulation, generally referred to as two-way fixed effects estimation.[23–25] However, these estimates may be biased when treatment effects are heterogeneous in covariates or when trends differ based on covariates, which is likely to be the case in our study.[26,27] To solve this problem, a doubly robust DiD estimator was used. This method can estimate the ATT consistently when these problems occur. It combines two different estimation methods, outcome regression, and inverse probability weighting, to make it robust to misspecification.[26] Treatment effects were calculated for 6 postdiagnosis years and the average of these was taken to calculate the overall treatment effect.[28] The different ATTs found in different posttreatment years also provide insight into the development of effects, whereas the treatment effects estimated before diagnosis are used to assess the plausibility of the parallel trends' assumption. If this assumption holds, the treatment effects estimated before diagnosis should be zero, indicating that the employment outcomes developed in a similar way for the treatment and control group before the diagnosis. This is assessed by implementing a Wald test to test whether the estimated pretreatment coefficients are jointly equal to zero.

For different clinical characteristics, ATTs were separately calculated for subsets of only patients with this characteristic and their controls. Differences in the treatment effect by sociodemographic characteristics are discussed using the triple differences estimator.[29,30] This is a regression-based method that uses interaction terms between the treatment effect and the sociodemographic characteristics. Because the threshold for being considered employed, which was chosen as working at least 52 hours per year, could influence the results, sensitivity analyses were performed using higher thresholds, including 100, 200, 400, and 1600 hours per year, with 1600 hours per year reflecting close to full-time employment. Additionally, the treatment effects are estimated separately for different age groups because the lives of AYAs can be different per age group. Young AYAs are often still studying, whereas older AYAs are more likely to have a partner and children. Analyses are conducted separately for AYAs aged 25 years or younger, 26 up to and including 32 years, and 33 years and older at diagnosis.

To assess whether there is a significant difference between the treatment and control group regarding the duration of the relationship with their partner after the time of diagnosis, a Kaplan–Meier test was used. The Kaplan–Meier test was implemented using STATA version 16.1. The other analyses are all performed using R version 3.6.2.

# RESULTS

Table 1 contains the number and percentage of individuals with different sociodemographic characteristics for both the treatment and control groups of patients and partners. Clinical characteristics are tabulated for the patients. 57.8% of the patients are female, and a

**TABLE 1** Sociodemographic and clinical characteristics treatment and control groups.

| | Patients | | Partners | |
|---|---|---|---|---|
| | Treatment ($N = 2456$) No. (%) | Control ($N = 24,560$) No. (%) | Treatment ($N = 1252$) No. (%) | Control ($N = 6231$) No. (%) |
| Gender | | | | |
| Male | 1036 (42.2%) | 10,360 (42.2%) | 826 (66.0%) | 4102 (65.8%) |
| Female | 1420 (57.8%) | 14,200 (57.8%) | 426 (34.0%) | 2129 (34.2%) |
| Migration background | | | | |
| No | 1992 (81.1%) | 19,920 (81.1%) | 1034 (82.6%) | 5143 (82.5%) |
| First generation | 213 (8.7%) | 2130 (8.7%) | 119 (9.5%) | 600 (9.6%) |
| Second generation | 251 (10.2%) | 2510 (10.2%) | 99 (7.9%) | 488 (7.8%) |
| Age in 2013, years | | | | |
| Age < 26 | 393 (16.0%) | 3930 (16.0%) | 26 (2.1%) | 140 (2.2%) |
| 26 ≤ age < 33 | 727 (29.6%) | 7270 (29.6%) | 323 (25.8%) | 1594 (25.6%) |
| Age ≥ 33 | 1336 (54.4%) | 13,360 (54.4%) | 903 (72.1%) | 4497 (72.2%) |
| Education level | | | | |
| Primary | 112 (4.6%) | 1166 (4.7%) | 19 (1.5%) | 96 (1.5%) |
| Secondary | 1216 (49.5%) | 12,117 (49.3%) | 409 (32.7%) | 2026 (32.5%) |
| Tertiary | 722 (29.4%) | 7195 (29.3%) | 385 (30.8%) | 1936 (31.1%) |
| Missing | 406 (16.5%) | 4082 (16.6%) | 439 (35.1%) | 2173 (34.9%) |
| Type of tumor | | | | |
| Breast | 493 (20.1%) | - | - | - |
| Bone, cartilage, and soft tissue | 67 (2.7%) | - | - | - |
| Central nervous system | 75 (3.1%) | - | - | - |
| Digestive system | 115 (4.7%) | - | - | - |
| Endocrine | 123 (5.0%) | - | - | - |
| Female genital | 193 (7.9%) | - | - | - |
| Hematologic | 321 (13.1%) | - | - | - |
| Head and neck | 44 (1.8%) | - | - | - |
| Lung | 22 (0.9%) | - | - | - |
| Male genital | 433 (17.6%) | - | - | - |
| Skin[a] | 510 (20.8%) | - | - | - |
| Urinary tract | 50 (2.0%) | - | - | - |
| Other[e] | 10 (0.4%) | - | - | - |
| Stage at diagnosis | | | | |
| I | 1351 (55.0%) | - | - | - |
| II | 539 (21.9%) | - | - | - |
| III | 233 (9.5%) | - | - | - |
| IV | 106 (4.3%) | - | - | - |
| Missing | 227 (9.2%) | - | - | - |
| Type of treatment[f] | | | | |
| Organ surgery[b] | 1340 (54.6%) | - | - | - |
| Local surgery[c] | 709 (28.9%) | - | - | - |
| Radiotherapy | 720 (29.3%) | - | - | - |

**TABLE 1** (Continued)

| | Patients | | Partners | |
|---|---|---|---|---|
| | Treatment ($N$ = 2456) No. (%) | Control ($N$ = 24,560) No. (%) | Treatment ($N$ = 1252) No. (%) | Control ($N$ = 6231) No. (%) |
| Chemotherapy | 1014 (41.3%) | - | - | - |
| Hormonal therapy | 1014 (41.3%) | - | - | - |
| Mean (SD) relationship duration before year of diagnosis (in years)[d] | - | - | 4.581 (1.956) | 4.583 (1.975) |
| Mean (SD) number of children before year of diagnosis[d] | - | - | 1.326 (1.067) | 1.325 (1.060) |

[a]92.0% melanoma, 8.0% nonmelanoma.

[b]Surgery affecting the organ where tumor is located, including, for example, partial gastric resection.

[c]Minimal invasive surgery, including for example polypectomy.

[d]This information is only provided for partners because it is derived from the household data set, which was used to find the partners of patients. The number of children refers to the number of children living in the same household as the partners, and thus also in the same household as the patients who were partnered based on the household data set.

[e]These are diagnoses with tumor types that do not fall within any of the mentioned categories.

[f]Percentages > 100 because patients can receive multiple types of treatment.

larger proportion of partners are male. More than half of the patients are aged 33 years or older at cancer diagnosis. The most common types of cancer within AYA survivors are breast, skin, and male genital cancer. Fifty-five percent of patients were diagnosed with stage 1 cancer.

In Figure 1A the trend in employment and the log number of hours worked (if employed) of patients and their controls are shown. The vertical line denotes the last year before diagnosis. Before diagnosis, both groups show a similar trend, whereas the patients show a decrease in employment compared with the control group after diagnosis. For the log hours worked, similarly trends are equivalent before diagnosis and the number of hours worked are decreased among the patients compared with the controls after treatment. Figure 1B shows similar plots for the partners of patients and corresponding controls. The trend before diagnosis is not clearly parallel. The plausibility of the parallel trends assumption holding is assessed further in Figure 2, by checking if treatment effects before diagnosis are jointly zero using the $p$ values of Wald tests. The employment of partners slightly increases relative to the controls after diagnosis, whereas hours worked when employed decreases.

Using Kaplan–Meier estimation for the survival function of relationships for both the partners and their controls, no significant difference is found. A log-rank test on both survival functions being equal has a $p$ value of .53 and therefore the equality of them cannot be rejected. Hence, there is no selection bias due to a difference in dropout.

## Employment outcomes of AYA patients with cancer

### Overall and dynamic treatment effect

In Table 2, the overall treatment effects of a cancer diagnosis on different employment outcomes are presented. On average, the employment probability is decreased by 3.8 percentage points in the 5 years after diagnosis. Patients who are employed face a reduced number of hours worked by 3.8%. For patients, the probability of being self-employed decreases by 1.3 percentage points, whereas the probability of having a permanent contract when employed does not significantly change.

The overall effects on employment and hours worked are included for different thresholds to address the sensitivity of the results to the employment threshold value of 52 hours per year (Appendix Table A1). When using a threshold of 100 or 200 hours, results for both employment and hours worked are comparable to the threshold of 52 hours. When a threshold of 400 hours is used, the effect on employment increases slightly in magnitude, whereas the effect on the number of hours worked becomes smaller. Effects using a threshold of 1600 hours are reported as well, with employment decreasing by 3.1 percentage points.

Appendix Table A2 includes the overall treatment effects on AYA cancer by age groups. For the group of patients aged 25 or younger, the employment probability decreases by 6.8 percentage points, whereas this effect is more comparable to the overall effect reported in Table 2 for the other groups. The magnitude of the effect on hours worked also seems larger for the youngest group compared with the other age groups, but this effect is not statistically significant.

In Figure 2, the dynamics of the treatment effect over time are shown for different outcomes. The diagnosis of cancer is denoted as year 0. Given the $p$ values of the Wald tests, there is no evidence for a treatment effect before the diagnosis, which strengthens the parallel trends assumption. The treatment effects on (A) employment, (B) log hours worked, and (C) self-employment are largely stable over time. The effect measured in the year of diagnosis is smaller, which could be due to the timing of the diagnosis at a later point within the year. The treatment effect does not disappear over time for any of these outcomes. The effects thus persist long after the diagnosis. The probability of (D) having a permanent contract when employed increases at first but decreases in the long term.

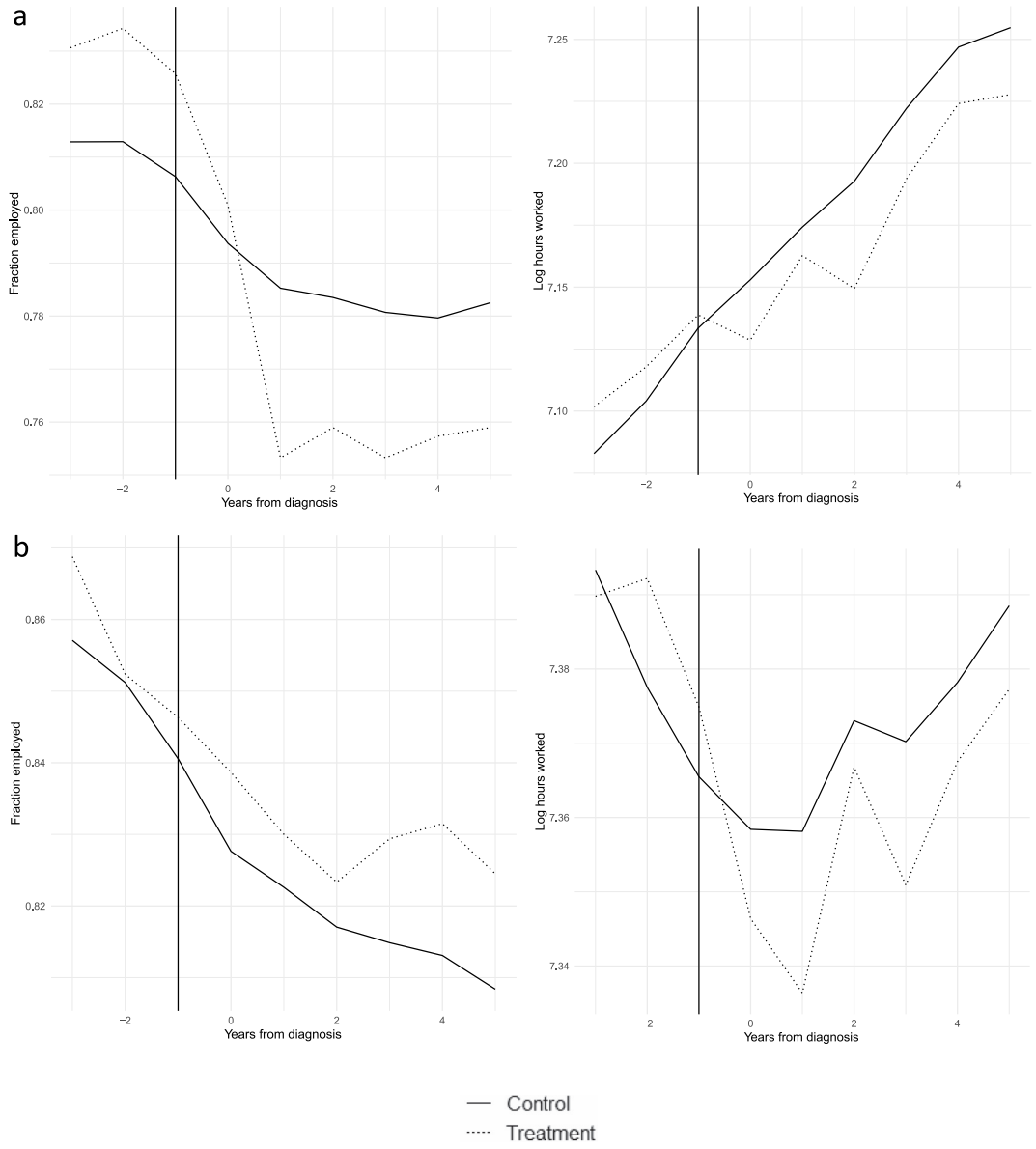


**FIGURE 1** Employment (left) and log hours worked (right) of patients and their controls (A) and partners and their controls (B) over time.

## Heterogeneity of treatment effects

In Table 3, the heterogeneity of treatment effects with respect to sociodemographic characteristics is shown. Interactions of the treatment effect with another variable correspond to the additional effect on that type of patient. The effect on both employment and hours worked is smaller for higher educated patients compared with lower educated patients but is not significant. The treatment effect on employment is larger for female patients compared with male patients, with a significant 4.3 percentage points additional decrease in employment probability when a patient is female. Patients with a migration background show a stronger treatment effect on both employment probability and hours worked than patients without a migration background. Being married or having a partner does not significantly affect the treatment effects compared with having no partner.

Table 4 shows the treatment effects on patients stratified by different clinical characteristics. Central nervous system (CNS) tumors had the largest effect on employment probability with a decrease of 22.9 percentage points. Its effect on hours worked seems large as well, although statistically insignificant, which is likely from the small group size. Breast and hematologic tumors had a relatively large negative effect on both employment probability and hours worked as well. Hematologic malignancies resulted in a 14.1% decrease in the number of hours worked. Endocrine tumors did not significantly affect the employment probability, but the number of hours worked decreased significantly by 11.2%. Furthermore, the effect on employment probability increases when

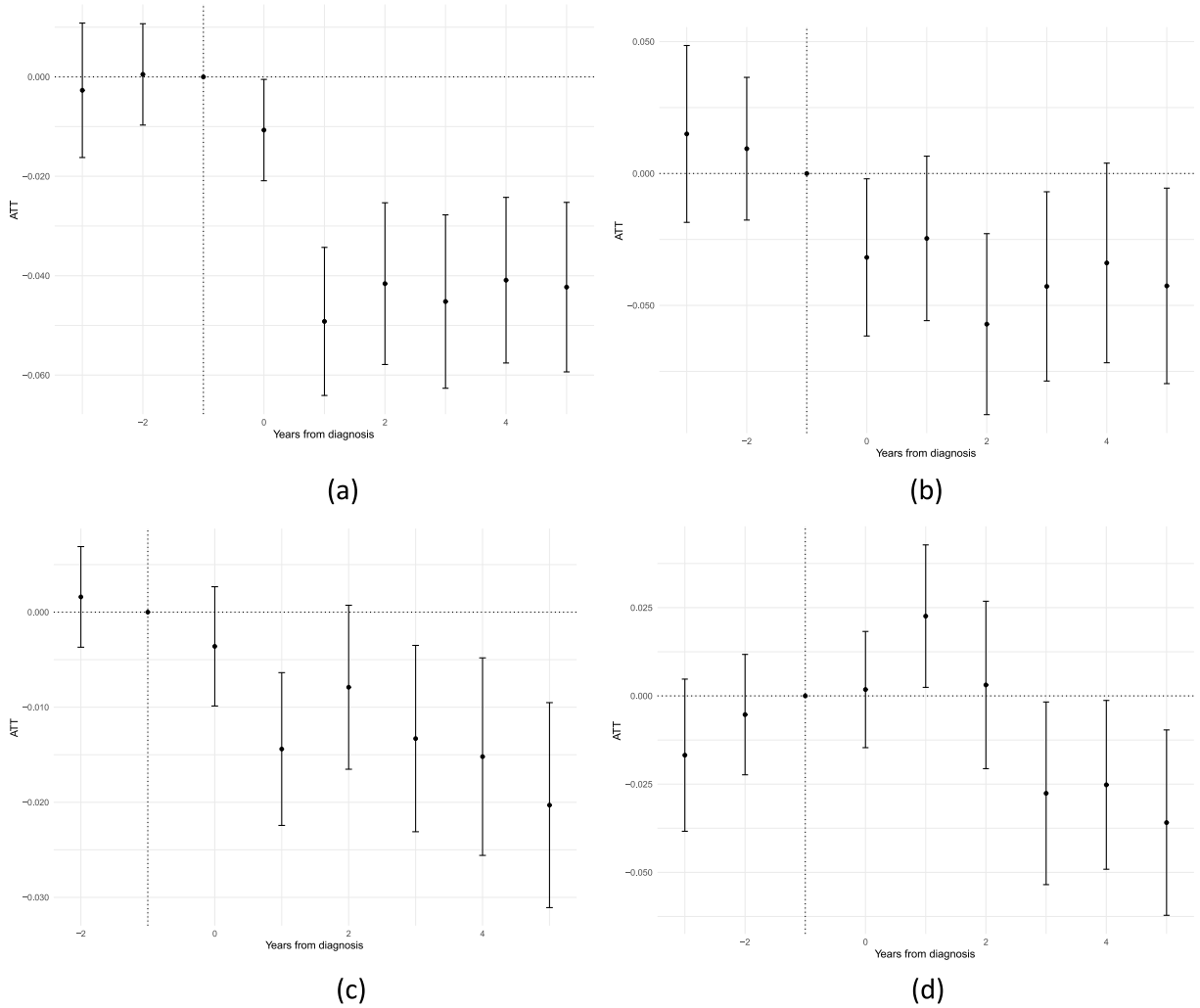


**FIGURE 2** Dynamic treatment effect on employment (A), log hours worked (B), self-employment (C) and the probability of having a permanent contract when employed (D) for patients with a 95% confidence interval. The vertical dotted line denotes the last year before diagnosis and ATT denotes the average treatment effect on the treated. (A) *p* value Wald test for joint nullity of effects before diagnosis: .84. (B) *p* value Wald test for joint nullity of effects before diagnosis: .64. (C) *p* value Wald test for joint nullity of effects before diagnosis: .58. (D) *p* value Wald test for joint nullity of effects before diagnosis: .32.

**TABLE 2** Overall treatment effect on patients.

| | **Overall treatment effect (average of the 5 years after diagnosis) Estimate (SE)** |
|---|---|
| Employment | −0.038*** (0.007) |
| Log hours worked[a] | −0.039*** (0.014) |
| Self employed | −0.013*** (0.004) |
| Permanent contract | −0.010 (0.009) |

*Note*: Standard errors are clustered at the individual level. Analysis conditioned on year of birth, education level, first-generation migration background, second-generation migration background, registered partnership and marital status, and gender. In the last year before diagnosis, 6.9% of the patients were self-employed and 64% of those that were employed had a permanent contract.

[a]Values found in the table and text can slightly differ for log hours worked because the coefficient is only an approximation of the percentage change when using a log-transformed dependent variable. The true percentage change is calculated by: $100 \times (exp(coefficient) - 1)$.

***$p < .01$, **$p < .05$, *$p < .1$.

the stage increases. For the effect on the number of hours worked, this is less clear.

## Employment outcomes of partners of AYA patients with cancer

There is an overall effect on employment probability; however, this is insignificant for partners (Table 5). The number of hours worked by partners is reduced by 2.4%. Estimations are done on subsets of partners working a different number of hours before diagnosis because partners' employment decisions may differ based on the number of hours worked before diagnosis (e.g., work more to cover lost earnings; work less to take up caring responsibilities). Indeed, the effect on employment differs by hours worked before the diagnosis. For partners that were unemployed or worked less than 400 hours a year in the past year before diagnosis, a 5.5 percentage-point increase in employment probability is found. For partners who worked more than 400 hours in

**TABLE 3** Treatment effect among patients stratified by sociodemographic characteristics.

| | Education level Estimate (SE) | Gender Estimate (SE) | Migration background Estimate (SE) | Married or partner Estimate (SE) |
|---|---|---|---|---|
| Employed | | | | |
| Baseline treatment effect | −0.058* (0.032) | −0.014 (0.009) | −0.031*** (0.006) | −0.034*** (0.008) |
| Primary education (reference) | REF | | | |
| Interaction term treatment effect with secondary education | 0.002 (0.033) | | | |
| Interaction term treatment effect with tertiary education | 0.050 (0.033) | | | |
| Male (reference) | | REF | | |
| Interaction term treatment effect with female | | −0.043*** (0.012) | | |
| No migration background (reference) | | | REF | |
| Interaction term treatment effect with first-generation migration background | | | −0.040 (0.025) | |
| Interaction term treatment effect with second-generation migration background | | | −0.051** (0.022) | |
| No partner (reference) | | | | REF |
| Interaction term treatment effect with partner or married | | | | −0.014 (0.012) |
| Log hours worked[a] | | | | |
| Baseline treatment effect | −0.135* (0.080) | −0.0518*** (0.016) | −0.051*** (0.011) | −0.073*** (0.015) |
| Primary education (reference) | REF | | | |
| Interaction term treatment effect with secondary education | 0.043 (0.081) | | | |
| Interaction term treatment effect with tertiary education | 0.105 (0.081) | | | |
| Male (reference) | | REF | | |
| Interaction term treatment effect with female | | −0.025 (0.022) | | |
| No migration background (reference) | | | REF | |
| Interaction term treatment effect with first-generation migration background | | | −0.087** (0.043) | |
| Interaction term treatment effect with second-generation migration background | | | −0.106** (0.045) | |
| No partner (reference) | | | | REF |
| Interaction term treatment effect with Partner or married | | | | 0.024 (0.021) |

*Note*: SEs are clustered at the individual level. Analysis conditioned on education level and registered partnership, marital status and interaction terms between the analyzed variable, postdiagnosis, and treatment group. Because of individual fixed effects being used, time invariant covariates are not used in the regression.

[a]Values found in the table and text can slightly differ for log hours worked because the coefficient is only an approximation of the percentage change when using a log-transformed dependent variable. The true percentage change is calculated by: $100 \times (exp(coefficient) - 1)$.

***$p < .01$, **$p < .05$, *$p < .1$.

the past year before diagnosis, no significant effect is found on employment. Furthermore, no significant effect is found for any of the separate groups on hours worked.

## DISCUSSION AND CONCLUSIONS

Surviving cancer as an AYA is associated with a significant decrease in employment probability, hours worked when employed, and self-employment probability, both in the short- and long-term. In the long-term, AYAs are less likely to have a permanent contract when employed. This is in line with the research of Leuteritz et al. and Parsons et al.,[11,12] although they could not identify a causal effect. Both studies used survey data, whereas our investigation is based on registry data. Leuteritz et al. used data from a survey in Germany that included predominantly female patients and a diversity of types of diagnoses. Parsons et al. investigated effects in the United States, with predominantly male patients and multiple cancer types. Our findings are also largely similar to those of previous studies, which did not focus on AYAs, although the magnitudes of effects differ.[5–10,31]

**TABLE 4** Treatment effect on patients with different oncological characteristics.

| | Treatment effect, employment Estimate (SE) | Treatment effect, log hours worked[a] Estimate (SE) |
|---|---|---|
| Type of tumor | | |
| Breast ($N$ = 493) | −0.056*** (0.014) | −0.083*** (0.025) |
| Hematologic ($N$ = 321) | −0.048*** (0.018) | −0.152*** (0.036) |
| Skin ($N$ = 510) | 0.000 (0.011) | 0.007 (0.026) |
| Male genital ($N$ = 433) | −0.009 (0.016) | 0.019 (0.031) |
| Female genital ($N$ = 193) | −0.031 (0.025) | 0.060 (0.057) |
| Endocrine ($N$ = 123) | −0.016 (0.028) | −0.119* (0.068) |
| Digestive system ($N$ = 115) | 0.005 (0.030) | −0.060 (0.054) |
| CNS ($N$ = 75) | −0.229*** (0.049) | −0.147 (0.112) |
| Stage at diagnosis | | |
| I ($N$ = 1351) | −0.007 (0.008) | −0.009 (0.018) |
| II ($N$ = 539) | −0.056*** (0.015) | −0.078*** (0.027) |
| III ($N$ = 233) | −0.071*** (0.022) | −0.040 (0.043) |
| IV ($N$ = 106) | −0.090*** (0.031) | −0.076 (0.063) |

*Note*: SEs are clustered at the individual level. Analysis conditioned on birth year, education level, first-generation migration background, second-generation migration background, registered partnership and marital status, and gender. *N* reported is the total number of individuals used for analyses of employment. Because only the patients who are employed are used for analyses on the number of hours worked, sample sizes for the number of hours worked are smaller.

[a]Values found in the table and text can slightly differ for log hours worked because the coefficient is only an approximation of the percentage change when using a log-transformed dependent variable. The true percentage change is calculated by: 100 × (*exp*(*coefficient*) − 1).

***$p < .01$, **$p < .05$, *$p < .1$.

**TABLE 5** Treatment effects on partners of patients.

| | Employment Estimate (SE) | Hours worked[a] Estimate (SE) |
|---|---|---|
| Total ($N$ = 1252) | 0.008 (0.008) | −0.024* (0.014) |
| By different yearly hours worked in 2012 | | |
| Unemployed or hours worked < 400 ($N$ = 221)[b] | 0.055** (0.028) | −0.070 (0.173) |
| 400 ≤ hours worked < 1600 ($N$ = 281) | 0.014 (0.016) | −0.005 (0.026) |
| Hours worked ≥ 1600 ($N$ = 744) | −0.002 (0.006) | −0.013 (0.009) |

*Note*: SEs are clustered at an individual level. Analysis conditioned on birth year, education level, first-generation migration background, second-generation migration background, number of children in 2012, registered partnership and marital status, and gender. *N*: the total number of individuals used for analyses of employment. Because only the partners that are employed are used for analyses on the number of hours worked, sample sizes for the number of hours worked are smaller. The cutoff points are chosen to make 3 groups representing: unemployed partners or those working a small amount of hours per week, partners working a moderate number of hours per week, and partners working close to full time (with working 36 hours per week often being considered full-time in the Netherlands).

[a]Values found in the table and text can slightly differ for log hours worked because the coefficient is only an approximation of the percentage change when using a log-transformed dependent variable. The true percentage change is calculated by: 100×(exp(coefficient) − 1).

[b]Only a small proportion of the partners who worked less than 400 hours in 2012 worked at least 52 hours, leading to a much smaller sample for estimations on hours worked for this group. In 2012, only 39 partners in the group worked more than 52 hours, with a total of 59 partners being considered employed at some point in the considered period. The small group likely causes the large SE and unreliable estimation.

***$p < .01$, **$p < .05$, *$p < .1$.

These studies were conducted in various countries: Norway, the United States, Denmark, Canada, and Finland. They consider different patient groups, with Vaalavuo focusing solely on breast cancer survivors and Gunnes et al. investigating the economic effects of cancer for patients diagnosed before 25 years old.

The negative effects on employment and hours worked found in this study are larger for women, people with a migration background, patients with a high tumor stage at diagnosis, and patients diagnosed with CNS or hematologic malignancies. This is largely in line with previous findings.[11,31,32] However, previous studies that did not focus on AYAs specifically often found a larger effect on male patients.[5–7] This difference may possibly be explained by the more common division of labor along traditional gender roles among older patients with cancer with men employed in paid labor outside the home and women engaged in unpaid domestic labor in the household. This labor division might be different for a younger generation of cancer patients. Other possible explanations for differences between studies may be due to differences between countries, the distribution of cancer types, and age groups.

Other studies have shown that return to work by cancer survivors is related to fewer psychological problems.[33–35] Additionally, a study has shown that AYAs returning to work are less likely to report financial distress resulting from cancer,[11] and employment is also associated with a positive effect on the quality of life after a cancer diagnosis.[36] The results of our study and others stress the importance of reducing employment related effects of cancer for those at risk. Employment-related issues could be reduced by providing AYA cancer survivors with flexible working arrangements, job counseling, training, and rehabilitation services.[32,37] AYA-specific care could also play a role in reducing employment-related effects. For example, the involvement of a medical social worker or AYA nurse specialist as part of a multidisciplinary care team could help to identify and address these issues.[38] It is imperative for health care providers to be educated on these issues to provide the best support or know where to find the right resources because of the complexity of employment-

related issues. Future research should investigate what the underlying cause of the problem is and which solution is most effective to promote work-related outcomes for those at risk.

Although there are sizable effects on patients outcomes, spillover effects on partners are mixed. No significant impact on the employment probability is found in a sample with all partners. However, the effect on employment probability of partners that were unemployed or worked less than 400 hours in the past year before diagnosis is large and significant. An explanation could be that partners who worked little or not at all have to compensate for earnings losses caused by the cancer diagnosis. A decrease in the number of hours worked is found when considering all partners. This could be due to the fact that partners reduce their work hours to spend more time with patients. The treatment effect on employment probability for partners differs from the findings of other studies concerning health shocks.[16–19] This may indicate that partners of young people are affected differently than older partners; however, it could also be attributed to the different social security systems of countries that have been studied in the literature. Help with employment-related issues, such as vocational rehabilitation services, should target the entire household but primarily the patients themselves because they face larger employment related changes. Partners should not be forgotten because they could face various psychosocial difficulties, which could not be measured with the registry data used for this study.

This study has several limitations. For the validity of our results found using the DiD estimator, it is important for trends for the treatment and control group to be parallel in the absence of treatment. Tests indicate that this assumption is likely to hold. However, even when tests indicate parallel trends before diagnosis, it does not verify that the assumption holds.[39] The existence of unobserved time-varying confounders that are not controlled for cannot be ruled out. These confounders are time-varying variables that either develop differently in the treatment or control group or have a time-varying effect, whereas there is a level difference for this covariate between both groups.[40] A large part of confounders are accounted for, such as sociodemographic characteristics, but it is still possible that unobserved confounders have affected the estimated treatment effect, potentially leading to biased results. An example of such a confounder is smoking, which is related to being diagnosed with cancer. If poorer people are more likely to smoke for example, and being poor also is related to different work trajectories, this can lead to a violation of the parallel trends assumption.

When interpreting our results, the fact that treatment effects are likely dependent on the welfare system of a given country should be taken into account. In the Netherlands, health care insurance availability is not linked to employment, which is at least partly the case in some countries such as the United States. Also, health insurance is mandatory in the Netherlands and the government supports people who cannot afford it. Therefore, the results in this study using Dutch data are not necessarily representative of potential effects in other countries. Our results might underestimate the impact on employment probability and hours worked compared with countries with less robust social security systems.

Similarly, results found for the partners are specific for those whose ill partners survived for at least 5 years after diagnosis. Fadlon et al.[20] previously found no effect on spouses of people who survived a severe health shock, but they have shown significant impacts resulting in increased paid labor participation for widows who have lost their husbands. Hence, the effects on employment outcomes for partners of deceased patients may vary significantly from those observed in partners of survivors. It is also important to note that the overall effects are likely underestimated. Effects are computed with the assumption that the 5-year posttreatment period started on January 1, 2013; however, patients are diagnosed at any moment within that year and therefore the effects may be partially obscured in the data from 2013. Finally, overall treatment effects are an estimate of the effects over multiple years, whereas the patients' life may be changing significantly at different time points in their cancer journey. Whereas the first years most likely represent the impact of effects among patients who are still under treatment, the latter years most often represent effects after treatment. However, it is possible to distinguish between such effects using the dynamic effects as shown in Figure 2.

The applied cutoff points for defining employment could have been chosen differently, which may influence the results. Only small differences were found using thresholds of 100 or 200 hours instead of 52 hours. When a threshold of 400 hours is used, clear differences can be observed. Thus, only large increases in the threshold lead to different results, in which case a part of the effect previously captured in the decreased percentage of work hours is measured as a decrease in employment.

Whereas our research focused on the entire AYA population aged 18 to 39 years, effects differ among age groups. The magnitude of effects is the largest in the youngest age group, consisting of patients being diagnosed at age 25 years or younger. Lives change especially rapidly for this group as they transition from education to employment, which may magnify effects. It is important to note that the group of young AYAs (<25 years) was small. There may also be differences in tumor types, stages, and sociodemographic variables in comparison to the other age groups. Although this analysis indicates larger effects for this group, additional research should be performed to confirm this finding.

The results of this study, based on registry data, show that AYA cancer survivors face multiple employment-related difficulties. In the long term, they are less likely to be employed or self-employed and when they are employed, they work fewer hours and are less likely to have a permanent contract. These difficulties are especially prevalent for patients suffering from CNS or hematologic malignancies, who were diagnosed with a higher tumor stage, as well as for female patients and patients with a migration background. AYA patients should receive employment-related support so they can regain as much of their normal life as possible. Furthermore, there is a slight spillover effect to partners of these patients, though this is very limited.

## AUTHOR CONTRIBUTIONS

**Polle W. Dankers**: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Validation, Visualization, Writing - original draft, and Writing - review & editing. **Silvie H.M. Janssen**: Conceptualization, Methodology, Software, Investigation, Validation, Supervision, Visualization, Project administration, Resources, Writing - original draft, and Writing - review & editing. **Mies van Eenbergen**: Funding acquisition and Writing - review & editing. **Bettina M. Siflinger**: Conceptualization, Methodology, Supervision, and Writing - review & editing. **Winette T.A. van der Graaf**: Funding acquisition and Writing - review & editing. **Olga Husson**: Conceptualization, Methodology, Software, Investigation, Validation, Supervision, Funding acquisition, Project administration, Resources, Writing - original draft, and Writing - review & editing.

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## CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

## DATA AVAILABILITY STATEMENT

Restrictions apply to the availability of the data described in this article. The data underlying this article were provided by the Netherlands Cancer Registry (NCR) and Statistics Netherlands (CBS) by permission. Data can be shared on reasonable request to the corresponding author with permission of both the NCR and CBS.

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