SHORT COMMUNICATION

Health Outcomes and Direct Healthcare Costs in Patients with Melanoma: Associations with Level of Education

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Malignant cutaneous melanoma has become an important public health issue and an economic concern due to the increasing costs of care (1, 2). The costs of melanoma are major factor for consideration by healthcare policymakers in planning appropriate allocation of resources (3). There is a well-documented relationship between socioeconomic status and the incidence of melanoma. According to a systematic review by Jiang et al. (4), higher-income, better-educated groups are at greater risk of developing melanoma than other social groups, but are less likely to be diagnosed with later-stage melanoma. Education level is also likely to be associated with costs, because it can affect people's health-related behaviour and their propensity to access healthcare services (5). However, although several studies have considered health inequalities, no studies examined whether patients' level of education affects the individual direct costs of patients with melanoma.

The aim of this study was to investigate differences in health outcomes and direct healthcare costs in patients with melanoma according to the patients' level of education.

METHODS

Data. The present study considered 599 cases of melanoma diagnosed in 2015 in 4 provinces of the Veneto Region and recorded by the Regional Cancer Registry [6]: data analysis was based only on cases with known thickness at diagnosis and available educational level, resulting in a total of 433 patients.

TNM stage at diagnosis was classified as early (TNM stages I and II) or advanced (TNM stages III and IV). Age was grouped as follows: <40, 40–49, 50–59, 60–69, 70–79 and 80+ years. Level of education was collected from the Hospital Discharge Records database and classified as "low" for patients who had up to middle-school diploma, or "high" for patients who had high-school diploma or further studies. The presence of chronic conditions was assessed using the Adjusted Clinical Group (ACG) system (7, 8).

Costs were assessed from the perspective of the Italian NHS. Each patient was linked via an anonymous unique identification code to all administrative data regarding hospital admissions, ambulatory care services, drug usage, access to the emergency room, medical devices used at home, and hospice admissions, in order to compute the direct costs up to one year after diagnosis.

Statistical analyses. Patients' costs are presented as means and 95% confidence intervals (CI). Differences in categorical variables and in continuous variables by education level were tested using Fisher's exact test and Mann–Whitney test, respectively.

Logistic regression was performed to assess the association between education and TNM stage at diagnosis, adjusting by sex, age group and presence of a chronic condition. Cox's proportional hazards model was used to estimate the risk of melanoma-specific death and overall mortality 3 years after the diagnosis, and a linear regression model was used to estimate the relationship between education and overall costs in the first year after diagnosis, adjusting both models by sex, age group, presence of a chronic condition and stage at diagnosis (**Table I**). To manage the skewed distribution of costs, the linear model was estimated on their logarithmic transformation. A sensitivity analysis was also conducted subsequently, adding clinical trials drug costs, since administrative data do not track drug usage within clinical trials. R 3.5.2 statistical package was used for record linkage and all statistical analyses. Data analysis was performed on anonymous aggregated data with no chance of individuals being identifiable.

RESULTS

A higher education was associated with a lower risk of melanoma being diagnosed at an advanced stage (odds ratio (OR) 0.43; 95% CI 0.19–0.91) (data not shown). Moreover, melanoma-specific 3-year survival was not associated with the level of education (data not shown).

The costs incurred for better-educated patients were 24% (95% CI 11–35) lower than those for patients with less schooling **(Table I)**. Similar results were found when including the estimated costs for the drug therapies administered within clinical trials (data not shown).

Finally, when specific healthcare activities and admissions were considered, a better education was significantly

Table I. Linear regression analysis of the relationship between direct costs of melanoma in first year after diagnosis and level of education, stage at diagnosis, age, sex and chronic disease

	Coefficient	Exp(coefficient) (95% CI)	*p*-value
Intercept	7.874	2,626.86 (2,099.60–3,286.53)	<0.01
Level of education (reference: low)			
High	−0.27	0.76 (0.65–0.89)	0.01
Stage at diagnosis (reference: early)			
Advanced	0.99	2.71 (2.10–3.49)	<0.01
Age (reference: <40)			
40–49 years	0.04	1.04 (0.81–1.34)	0.74
50–59 years	−0.05	0.95 (0.73–1.24)	0.73
60–69 years	0.01	1.01 (0.78–1.32)	0.92
70–79 years	0.01	1.01 (0.76–1.33)	0.97
>80 years	0.02	1.02 (0.74–1.39)	0.91
Sex (reference: female)			
Male	0.03	1.04 (0.90–1.20)	0.64
Chronic disease (reference: No)			
Yes	−0.04	0.96 (0.80–1.15)	0.64

Adjusted R^2=0.226. CI: confidence interval.

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associated with a 48% decrease in the costs of hospital admissions (95% CI 12–69%) (data not shown).

DISCUSSION

Lower schooling was associated with a higher risk of advanced-stage melanoma and higher treatment costs in the first year after diagnosis. On the other hand, there was no significant relationship between level of education and melanoma-related mortality.

Studies on the relationship between level of education and direct costs of cancer patients are rare. Higher costs were assciated with a lower level of education, as well as with the prevalence of metastases, younger age, and tumour-related surgical procedures in a study on pancreatic cancer patients (9). The current study on melanoma likewise showed that less-educated patients incur significantly higher costs than the better-educated subgroup. In more detail, level of education was significantly associated with higher costs relating to hospital admissions, possibly because less-educated patients may be more likely to need hospital readmissions, as suggested by a previous study (10). Another study found that socioeconomic status predicts hospital readmission among patients with advanced cancer within a year after diagnosis (11).

An alternative (or complementary) explanation for the observed difference in hospital-related costs could be that a higher proportion of better-educated (and therefore possibly more affluent) patients might rely on private clinics for elective surgical procedures, in order to reduce waiting times for surgery (12). This could apply in particular to early-stage patients. However, this is not the case in the current study, since there were no differences in the number of hospital admissions between patients with early-stage melanoma by education level.

One limitation of this study is that information on level of education was missing for a relevant proportion of patients (23%), especially among those with early-stage melanoma who were not admitted to hospital. Any consequent selection bias would reduce the difference in distribution by stage and education level, thereby also lowering the differences in costs (13).

Another issue concerns the reliability of our data on patients' level of education. A previous study conducted in Italy examined the validity of information regarding education recorded in the hospital discharge records, finding it to be good-to-excellent (14).

Finally, the current study lacked details on lifestyle-related confounders and other socioeconomic parameters that might mediate the effects of education on the study outcomes. However, previous studies indicate that the relationship between income and health outcomes is attributable mainly to differences in high-school educational attainment, and that education absorbs the income inequality effect because it is a more powerful predictor of variability in health outcomes (15). Furthermore, the impact of socioeconomic level on health outcomes is likely to be reduced within a system offering universal coverage, such as the Italian NHS.

In conclusion, the disadvantages affecting less-educated patients with melanoma warrant health promotion campaigns aimed at improving their knowledge about this disease and enabling them to interact more effectively within the healthcare system.

The authors have no conflicts of interest to declare.

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