Gender and educational differences in the association between smoking and health-related quality of life in Belgium

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A B S T R A C T

Previous studies have shown that smoking has a significant and negative association with health-related quality of life (HRQOL). A question remains, however, as to whether this association between smoking and HRQOL differs by gender or educational level. To examine this question, we extracted data from the 2013 Belgian Health Interview Survey ($n = 5668$). HRQOL was assessed using the descriptive system of the EuroQol 5D-5L that consists of 5 dimensions and the resulting index score. Linear and logistic multivariable regression models were fitted to estimate the association between HRQOL and smoking for each educational level and gender. Also, interaction terms were introduced in the full regression models and the Wald test was used to assess model fit. Our findings show that among men, there is no significant association between smoking and HRQOL, and no effect modification by educational level. Among women, however, daily smokers have shown significantly lower HRQOL scores compared with never smokers, but only among females with a low and intermediate educational level. The lower EQ-5D index scores among female daily smokers with lower education was due to higher odds of reporting problems in anxiety/depression, mobility, pain, and usual activities. To conclude, information on the association between HRQOL and smoking is useful for the development of smoking cessation interventions. Our findings suggest the importance of tailoring these interventions to the needs of the women with lower education.

1. Introduction

It is widely documented that tobacco smoking is associated with various chronic diseases, disability and mortality (CDC, 2017; Van Oyen et al., 2014). Smoking has also been associated with other measures of general health and well-being including health-related quality of life (HRQOL) (Maheswaran et al., 2013; Vogl et al., 2012). Indeed, a number of studies have examined the association between smoking and HRQOL in diverse settings and populations and using different ways to measure HRQOL. Based on a recent review of these studies, it could be concluded that smokers have worse HRQOL than non-smokers and that the strength of the association increases with the number of cigarettes smoked (Goldenberg et al., 2014).

Assessing the association between smoking and HRQOL is important as HRQOL generates a holistic multidimensional measure of well-being that encompasses people's evaluation of their physical, mental, emotional and social functioning. It is a measure that goes beyond direct measures of health and focuses on the impact health status has on

quality of life (Hennessy et al., 1994). Therefore, HRQOL allows a better understanding of the impact of smoking on well-being, thereby supplementing the well-known impact of smoking on mortality and morbidity. HRQOL also allows to provide a positive context for encouraging smoking cessation by focusing on the positive gains in quality of life (Wilson et al., 1999).

HRQOL has also gained significant importance on the policy level as it is often used to inform public health and health care policy. HRQOL can indeed be used as an input to calculate quality-adjusted life years (QALYs), one of the most commonly reported measures of benefit in health economic evaluations (McCaffrey et al., 2016). Therefore, HRQOL can be instrumental in informing economic evaluations of interventions related to tobacco smoking, be it prevention, cessation or treatment interventions.

The association between smoking and HRQOL has already been well established. A question still remains however as to whether this association varies by sex and socioeconomic status (SES). This is an important question since studies have indicated lower HRQOL among

women and among people with lower SES (Mielck et al., 2013), and have found important variations by sex and SES in the patterns of smoking and the health impacts of smoking (Graham et al., 2006; Pampel and Rogers, 2004; Peters et al., 2015).Such information on a differential association between smoking and HRQOL may further refine targeting strategies for smoking cessation interventions (Wilson et al., 2004), yet few studies have examined this issue. For instance, some studies analysed whether the association between HRQOL and smoking differ by gender, but reached inconsistent conclusions (Coste et al., 2014; Laaksonen et al., 2006; Wilson et al., 2004). No study has however assessed whether the association between HRQOL and smoking varies by SES. Nonetheless, a number of studies have shown that the negative association between HRQOL and chronic diseases such as hypertension, diabetes and obesity is greater among people with a lower SES (Kinge and Morris, 2010; Mielck et al., 2014; Stafford et al., 2012).

In this context, the purpose of the current study is to use Belgian data to explore whether the association between HRQOL and smoking differs by gender and SES.

2. Methods

2.1. Study population

The Belgian Health Interview Survey (BHIS) is a cross-sectional household survey that has been periodically organized since 1997. The participants are selected from the national register through a multistage stratified sample of the population. For this study we used data from the BHIS 2013 and included only participants aged 15 years and older. The participation rate in the survey was 57% at the household level. The detailed methodology of the survey is described elsewhere (Demarest et al., 2013). The final sample had a population of 5668 individuals. Data on demographic information and SES were collected through face-to-face interviews, whereas HRQOL and smoking were assessed via self-administered written questionnaires.

2.2. Measures

A three-category variable was used to differentiate between never smokers, former smokers and daily smokers. This categorization was based on two questions: 1) Have you smoked at least 100 cigarettes (about 5 packs) or the equivalent amount of tobacco in your entire life (Yes/No)?; 2) Do you smoke at all nowadays (Yes, daily; Yes, occasionally; Not at all)? Only daily smokers were considered as smokers. Occasional smokers were dropped from the analyses as the number of people in this category was too small ($n = 260$) to allow reliable conclusions to be drawn.

Educational level was used as a proxy for SES. Educational level was based on the highest level of education achieved in the household. We recoded this variable into three categories (UNESCO, 2006): low (lower secondary education or less), intermediate (higher secondary education), and high (higher education).

HRQOL was assessed using the EuroQol 5D-5L (EQ-5D-5L) questionnaire. It is a standardized and widely used instrument that has been applied to a broad range of health conditions in different populations. A number of studies have used this instrument to assess the association between HRQOL and smoking and smoking-related diseases (Maheswaran et al., 2013; Vogl et al., 2012). The EQ-5D-5L has two main components: the descriptive system and the visual analogue scale. In this study we used only the descriptive system, which defines HRQOL in terms of five dimensions (5D): 'mobility', 'self-care', 'usual activities', 'pain/discomfort' and 'anxiety/depression'. Each of these dimensions has 5 levels (5L) of perceived problems: (level 1) no problems, (level 2) slight problems, (level 3) moderate problems, (level 4) severe problems, and (level 5) extreme problems. There are 3125 (5^5) possible health states generated by combining one level from each of the dimensions.

For example state 11111 indicates no problems on any of the 5 dimensions, while state 12345 indicates no problems with mobility, slight problems with self-care, moderate problems with doing usual activities, severe pain or discomfort and extreme anxiety or depression.

Each health state is converted into a single EQ-5D index score using an algorithm based on public preferences for different health states. In Belgium, such an algorithm is so far only available for the EQ-5D-3L questionnaire (3 levels of responses instead of 5) (Cleemput, 2010). Therefore, using a cross-walk function, the EuroQoL Group mapped the EQ-5D-5L health states to EQ-5D-3L health states (Van Hout et al., 2012). Applying both algorithms to the EQ-5D-5L health states thus resulted in the calculation of an EQ-5D index score for each respondent, ranging from −0.158 (worst health state) to 1 (most optimal health state). See more details on the calculation of the ED-5D-5L index score in the supplementary files.

2.3. Data analysis

Firstly, descriptive summary statistics by age, sex and educational level were calculated for the EQ-5D index score and for each of the 5 dimensions.

Secondly, multivariable linear regression modelling was used to study the association between the EQ-5D index score and smoking while controlling for a number of covariates. Logistic regression modelling was performed to study the association of each of the dimensions, dichotomized into 'no problems' (level 1) and 'any problem' (levels 2 to 5), with smoking while controlling for the same covariates. The choice of covariates was guided by previous studies in the field. Therefore, in addition to including age, gender and education in these models, we controlled for marital status (married or legally cohabiting, widowed, divorced, never married), country of birth (Belgian, Non-Belgian but citizen of the European Union, non-Belgian and citizen of other countries), region of residence (Brussels, Flemish Region, Walloon Region), obesity (subjects with a Body Mass Index greater than or equal to 30 were considered obese), healthy eating defined as eating at least 5 portions of fruit and vegetables daily (yes/no) and alcohol over-consumption defined as more than 14 drinks a week for women and 21 drinks a week for men (yes/no). We controlled for socio-demographic factors as these have an important impact on HRQOL and on smoking. We controlled for health behaviour factors as unhealthy behaviours tend to cluster. The variance inflation factor for the relationship between smoking and the other included covariates equalled 1.06, indicating no risk of multicollinearity.

Thirdly, to assess effect modification by gender, interaction terms between smoking and gender were introduced in the full regression models and a Wald test was used to evaluate whether the inclusion of the interaction terms would improve the fit of the model. If the Wald test was statistically significant, then we stratified the regression analysis by gender. The same approach was used to assess effect modification by educational level.

All analyses were weighted and have accounted for the complex study design of the BHIS. Confidence intervals were calculated at the 95% level. The analyses were performed in STATA 13 using appropriate svy commands.

3. Results

The mean EQ-5D index score was 0.812, ranging from −0.158 (worst health state) to 1 (most optimal health state). When considering the separate dimensions, the percentage of individuals who reported any problem varied from 7% for self-care to 18% for usual activity, 18% for mobility, 27% for anxiety/depression and 50% for pain/discomfort. As shown in Tables 1 and 2, the EQ-5D score was significantly lower among daily smokers compared with never smokers, even after adjusting for age and for a series of covariates (coefficient of −0.055 with a 95% CI of −0.074; −0.035). As shown in Table 2, for all dimensions except for self-care, the likelihood of reporting any problem was

Table 1

Mean EQ-5D index score and prevalence of any problem on the EQ-5D dimensions by sociodemographic characteristics and smoking status, Belgian Health Interview Survey, 2013.

	% of N	EQ-5D score		Mobility		Self-care		Usual activity		Pain/discomfort		Anxiety/depression	
	(N = 5668)	Mean[a]	95%CI	%[a]	95%CI	%[a]	95%CI	%[a]	95%CI	%[a]	95%CI	%[a]	95%CI
Sex													
Male	47.25	0.835	0.825–0.844	15.45	13.76–17.32	5.48	4.40–6.81	14.87	13.17–16.74	46.67	44.12–49.24	22.42	20.40–24.59
Female	52.75	0.790	0.780–0.801	21.19	19.22–23.30	8.32	7.02–9.83	20.70	18.78–22.75	53.53	51.00–56.05	30.57	28.43–32.81
Age													
15–24	9.71	0.898	0.883–0.913	4.51	2.80–7.19	0.48	0.12–7.90	6.55	4.48–9.50	28.76	23.78–34.33	21.78	17.25–27.11
25–44	31.77	0.851	0.838–0.863	9.80	7.89–12.11	2.67	1.66–4.27	12.81	10.74–15.20	42.30	39.04–45.62	24.43	21.84–27.21
45–64	35.52	0.800	0.788–0.811	17.60	15.34–20.11	6.32	4.95–8.02	17.68	15.54–20.04	55.40	52.36–58.40	29.85	27.23–32.61
65 +	23.01	0.730	0.712–0.748	39.70	36.11–43.42	17.66	15.03–20.65	31.58	28.19–35.18	64.49	60.86–67.96	27.23	24.09–30.62
Educational level													
Low	22.66	0.733	0.714–0.752	33.38	29.88–37.07	17.43	14.62–20.65	32.01	28.59–35.63	59.63	55.89–63.25	32.53	29.00–36.26
Intermediate	31.90	0.815	0.802–0.827	18.67	16.45–21.11	5.40	4.28–6.80	18.72	16.42–21.26	49.32	45.95–52.70	27.03	24.25–29.99
High	45.44	0.848	0.838–0.857	11.01	9.32–12.97	3.03	2.13–4.29	10.45	8.96–12.14	46.37	43.53–49.22	23.54	21.37–25.86
Smoking status													
Daily	19.83	0.772	0.755–0.790	21.28	18.35–24.54	6.62	4.99–8.73	23.32	20.20–26.76	55.14	51.18–59.04	37.52	33.75–41.44
Former	21.74	0.809	0.795–0.824	20.47	17.47–23.83	6.55	4.86–8.77	17.32	14.65–20.35	55.00	51.12–58.82	25.04	22.10–28.24
Never	58.43	0.826	0.816–0.836	16.69	14.97–18.57	7.22	6.03–8.64	16.30	14.62–18.14	46.75	44.27–49.24	23.64	21.69–25.70
Total	100.00	0.812	0.804–0.819	18.43	17.06–19.89	6.95	6.07–7.96	17.90	16.56–19.31	50.23	48.33–52.13	26.66	25.10–28.27

[a] Weighted and accounted for the complex study design of the Belgian Health Interview Survey.

significantly higher among daily smokers compared with never smokers. Former smokers had significantly higher odds of reporting pain/discomfort compared with never smokers. Also, as seen in Table 1, compared with daily smokers, former smokers had a significantly higher EQ-5D index score and a lower probability of reporting problems on the usual activity and anxiety/depression dimensions.

3.1. Gender differences

The association between the EQ-5D index score and smoking was significantly different by gender as shown by the statistically significant Wald test ($p = 0.0015$). The stratified analysis displayed in Table 2 shows that after adjusting for all considered covariates, the association between the EQ-5D index score and smoking remained significant for women (coefficient of -0.091 with a 95% CI of $-0.119; -0.063$) but not for men (coefficient of -0.021 with a 95% CI of $-0.046; 0.004$). In terms of dimensions, compared with never smokers, female daily smokers had higher odds of reporting any problem in all domains except for self-care. Among males, after adjusting for the covariates, no association with daily smoking was observed for any of the dimensions, in line with the findings for the EQ-5D index score.

3.2. Educational and gender differences

The association between the EQ-5D index score and smoking was significantly different by educational level for women ($p = 0.0043$) but not for men ($p = 0.3199$).

The regression analyses in Table 3 confirmed the lack of association between smoking and HRQOL among males. The findings among women (Table 4) showed that female daily smokers with a low and intermediate educational level have significantly lower EQ-5D index scores than their never smoker counterparts (coefficients respectively of -0.106 (95% CI $-0.179; -0.033$) and -0.114 (95% CI $-0.153; -0.074$)). Among highly educated women, daily smokers did not show any statistically significant difference in the EQ-5D index score compared with never smokers, but former smokers showed a significantly lower EQ-5D score compared with never smokers (coefficient of -0.040 with a 95% CI of $-0.071; -0.009$). The significantly lower EQ-5D index among the female daily smokers with a low educational level compared with their never smoker counterparts was due to the higher odds of reporting problems in mobility and anxiety/depression. For female daily smokers with an intermediate educational level,

problems with mobility, usual activity, pain/discomfort and anxiety/depression were important contributors. For highly educated female former smokers, problems with pain/discomfort were the significant contributors. However, for the models of the 5 dimensions, the Wald tests for the interaction between smoking and educational level were not statistically significant.

In addition, as a sensitivity analysis, we added in our multivariable models a number of variables to assess the presence of a number of chronic diseases in the past 12 months (asthma, bronchitis, heart diseases, diabetes, hypertension, cancer) and the presence of a depression in the past 12 months. The results of these additional models (see Table A in the supplementary files) are comparable to the results presented here.

4. Discussion

The aim of this study was to examine whether the association between smoking and HRQOL varies by gender and educational level. Among men, we found no significant association between smoking and HRQOL, and no effect modification by educational level. Among women, however, daily smokers have shown significantly lower HRQOL scores compared with never smokers, but only among females with a low and intermediate educational level. The lower EQ-5D index among female smokers with a lower educational level compared with never smokers was due to higher odds of reporting problems in anxiety/depression, mobility, pain and usual activities. We also found a significantly lower EQ-5D score for former smokers compared with never smokers, but only among highly educated women.

Interpreting the clinical importance of differences in EQ-5D scores is not straightforward. Indeed, no explicit statement has been made regarding what change in the EQ-5D score constitutes a clinically important difference. However, a minimally important difference (MID) of 0.074 points has been previously proposed in the literature (Walters and Brazier, 2005). This estimation was based on a series of conditions (leg ulcer, back pain, early rheumatoid arthritis, limb reconstruction, osteoarthritis, irritable bowel syndrome and chronic obstructive lung disease), but has been used to assess EQ-5D scores for health related behaviours (Maheswaran et al., 2013). This MID suggests that the lower EQ-5D scores observed in our study for female daily smokers with low and intermediate educational level (respectively -0.106 and -0.114) can be regarded as clinically significant. It is important however to interpret this threshold with caution (Kinge and Morris, 2010), as it was

Table 2
Association of HRQOL indicators with smoking status, stratified by sex and adjusted for age and other covariates, Belgian Health Interview Survey, 2013.

Smoking status	Coefficient EQ-5D score[a] 95% CI		OR[b] mobility 95% CI		OR[b] self care 95% CI		OR[b] usual activity 95% CI		OR[b] pain/discomfort 95% CI		OR[b] anxiety/depression 95% CI	
	Age adjusted	Fully adjusted	Age adjusted	Fully adjusted	Age adjusted	Fully adjusted	Age adjusted	Fully adjusted	Age adjusted	Fully adjusted	Age adjusted	Fully adjusted
All participants (n = 5668)												
Daily smokers	-0.061 (-0.080, -0.042)	-0.055 (-0.074, -0.035)	1.72 (1.34, 2.19)	1.66 (1.27, 2.17)	1.15 (0.80, 1.67)	1.07 (0.72, 1.57)	1.81 (1.43, 2.27)	1.64 (1.27, 2.12)	1.47 (1.20, 1.79)	1.49 (1.20, 1.85)	1.93 (1.58, 2.36)	1.88 (1.49, 2.37)
Former smokers	0.002 (-0.015, 0.019)	-0.012 (-0.029, 0.004)	1.06 (0.82, 1.37)	1.26 (0.96, 1.64)	0.72 (0.49, 1.05)	0.88 (0.58, 1.34)	0.92 (0.72, 1.17)	1.09 (0.84, 1.41)	1.18 (0.98, 1.42)	1.25 (1.04, 1.52)	1.02 (0.83, 1.24)	1.19 (0.97, 1.47)
Never smokers	Ref	Ref	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Males (n = 2678)												
Daily smokers	-0.035 (-0.060, -0.011)	-0.021 (-0.046, 0.004)	1.64 (1.14, 2.36)	1.41 (0.95, 2.11)	0.95 (0.52, 1.72)	0.74 (0.41, 1.32)	1.56 (1.09, 2.23)	1.32 (0.90, 1.94)	1.33 (1.02, 1.74)	1.26 (0.94, 1.69)	1.59 (1.18, 2.13)	1.36 (0.98, 1.89)
Former smokers	-0.009 (-0.033, 0.014)	-0.010 (-0.033, 0.012)	1.21 (0.86, 1.69)	1.23 (0.87, 1.74)	0.72 (0.41, 1.29)	0.74 (0.42, 1.30)	1.04 (0.73, 1.46)	1.04 (0.73, 1.48)	1.19 (0.92, 1.55)	1.15 (0.88, 1.51)	1.13 (0.84, 1.53)	1.23 (0.90, 1.67)
Never smokers	Ref	Ref	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Females (n = 2990)												
Daily smokers	-0.106 (-0.134, -0.077)	-0.091 (-0.119, -0.063)	2.13 (1.50, 3.01)	1.89 (1.31, 2.71)	1.60 (0.99, 2.58)	1.44 (0.87, 2.39)	2.42 (1.76, 3.31)	2.03 (1.45, 2.84)	1.82 (1.35, 2.44)	1.76 (1.31, 2.38)	2.70 (2.05, 3.55)	2.50 (1.85, 3.38)
Former smokers	-0.013 (-0.038, 0.013)	-0.014 (-0.039, 0.010)	1.30 (0.88, 1.92)	1.34 (0.90, 1.99)	0.99 (0.57, 1.71)	1.05 (0.59, 1.86)	1.09 (0.76, 1.57)	1.13 (0.77, 1.65)	1.41 (1.06, 1.86)	1.40 (1.06, 1.86)	1.12 (0.84, 1.48)	1.12 (0.84, 1.49)
Never smokers	Ref	Ref	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Fully adjusted models: age, sex, civil status, country of birth, region, education, household type, obesity, eating habits, and alcohol consumption.

[a] Regression coefficient based on a multivariate linear regression.

[b] Odds ratio based on a multivariate logistic regression.

Table 3

Association of HRQOL indicators with smoking status, stratified by educational level, Males, Belgian Health Interview Survey, 2013.

Smoking status	EQ-5D score		Mobility		Self-care[c]		Usual activity		Pain/discomfort		Anxiety/depression	
	Coefficient[a]	95%CI	OR[b]	95%CI	OR[b]	95%CI	OR[b]	95%CI	OR[b]	95%CI	OR[b]	95%CI
Low education (n = 582)												
Daily smokers	0.041	(− 0.012; 0.095)	0.89	(0.45; 1.76)	0.43	(0.19; 0.95)	0.59	(0.32; 1.11)	0.64	(0.35; 1.14)	0.95	(051; 1.74)
Former smokers	0.015	(− 0.044; 0.074)	1.18	(0.64; 2.18)	0.53	(0.22; 1.27)	0.72	(0.38; 1.37)	1.07	(0.60; 1.91)	0.92	(0.48; 1.76)
Never smokers	Ref	Ref	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Intermediate education (n = 860)												
Daily smokers	− 0.036	(− 0.073; 0.001)	1.66	(0.95; 2.91)	1.03	(0.39; 2.68)	2.25	(1.26; 4.02)	1.26	(0.79; 2.00)	2.15	(1.25; 3.68)
Former smokers	0.002	(− 0.039; 0.043)	1.10	(0.59; 2.05)	0.68	(0.26; 1.81)	0.95	(0.51; 1.74)	0.88	(0.55; 1.41)	1.29	(0.73; 2.28)
Never smokers	Ref	Ref	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
High education (n = 1236)												
Daily smokers	− 0.033	(− 0.073; 0.007)	1.37	(0.50; 3.76)	1.03	(0.16; 6.89)	1.01	(0.42; 2.43)	1.74	(1.04; 2.90)	1.18	(0.68; 2.06)
Former smokers	− 0.021	(− 0.047; 0.005)	1.26	(0.74; 2.15)	1.25	(0.49; 3.20)	1.39	(0.79; 2.42)	1.34	(0.92; 1.96)	1.42	(0.91; 2.21)
Never smokers	Ref	Ref	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

[a] Regression coefficient based on a multivariate linear regression fully adjusted for age, civil status, country of birth, region, household type, obesity, eating habits and alcohol consumption.

[b] Odds ratio based on a multivariate logistic regression fully adjusted for the same covariates.

[c] Very few participants had any problem in self-care and in some cases a number of variables predicted the outcome perfectly. As a result, STATA dropped a number of observations in this model and the N for the males in the three educational categories are respectively: 503, 746 and 1198.

derived from clinical studies that were designed to assess the efficacy of treatment interventions. Furthermore, the MIDs may vary by condition and none of the studies focused specifically on smoking.

Our finding of a significant negative association between HRQOL and smoking among lower SES women is compatible with findings in the literature showing that women may be more susceptible to the health impacts of smoking than men. For instance, in a large US study, women who smoked had higher odds of having poor self-rated health, heart disease and current asthma compared with male smokers (Syamlal et al., 2014). A meta-analysis has shown that although smoking considerably increased the risk of coronary heart disease in both sexes, women who smoke have a 25% higher excess relative risk of coronary heart disease compared with men who smoke (Huxley and Woodward, 2011). Another meta-analysis concluded that the increase in mortality and morbidity risk from low to high levels of smoking was greater for females than for males (Mucha et al., 2006). Furthermore, it is important to highlight that even after controlling for a number of chronic diseases (asthma, bronchitis, heart diseases, diabetes, hypertension, cancer, asthma) in the models (see Table A in the supplementary files), the negative association between HRQOL and smoking among women with a low and intermediate educational level was still statistically significant and the coefficients were higher than the clinical threshold of 0.074 points.

Smoking has also been found to have higher psychosocial impacts on women. For instance, it has been reported that women's smoking played an important role in their life. Women often encountered harsh consequences from smoking such as poor self-image, a sense of inferiority and a sense of having lost control over their own actions, while this was not the case for men who reported fewer negative consequences from smoking and perceived their smoking largely as an unproblematic habit (Sohlberg, 2015). Another study has shown that female smokers who unsuccessfully try to quit were more likely to report physical and mental distress than those who did not try to quit smoking, while no significant difference in the frequency of physical and mental distress was reported by male smokers who tried to quit compared to those who did not (McClave et al., 2009). This higher psychosocial impact among women further supports our findings as the EQ-5D instrument accounts for mental health.

Table 4

Association of HRQOL indicators with smoking status, stratified by educational level, Females, Belgian Health Interview Survey, 2013.

Smoking status	EQ-5D score		Mobility		Self-care[c]		Usual activity		Pain/discomfort		Anxiety/depression	
	Coefficient[a]	95%CI	OR[b]	95%CI	OR[b]	95%CI	OR[b]	95%CI	OR[b]	95%CI	OR[b]	95%CI
Low education (n = 702)												
Daily smokers	− 0.106	(− 0.179; − 0.033)	1.91	(1.02; 3.58)	1.22	(0.57; 2.61)	1.56	(0.85; 2.87)	1.30	(0.72; 2.35)	3.05	(1.72; 5.42)
Former smokers	0.005	(− 0.066; 0.076)	1.27	(0.61; 2.67)	0.74	(0.25; 2.20)	0.89	(0.40; 1.97)	1.71	(0.86; 3.40)	0.83	(0.40; 1.70)
Never smokers	Ref	Ref	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Intermediate education (n = 948)												
Daily smokers	− 0.114	(− 0.153; − 0.074)	2.30	(1.30; 4.07)	2.02	(0.87; 4.70)	2.43	(1.45; 4.09)	2.49	(1.56; 3.96)	3.19	(1.94; 5.27)
Former smokers	0.012	(− 0.028; 0.052)	1.01	(0.50; 2.03)	1.27	(0.47; 3.45)	1.06	(0.54; 2.08)	1.06	(0.63; 1.77)	0.95	(0.55; 1.65)
Never smokers	Ref	Ref	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
High education (n = 1340)												
Daily smokers	− 0.037	(− 0.075; 0.000)	1.06	(0.45; 2.46)	0.83	(0.17; 4.04)	1.80	(0.88; 3.67)	1.30	(0.78; 2.16)	1.60	(0.97; 2.62)
Former smokers	− 0.040	(− 0.071; − 0.009)	1.73	(0.96; 3.13)	1.45	(0.67; 3.39)	1.45	(0.83; 2.53)	1.59	(1.09; 2.34)	1.44	(0.98; 2.12)
Never smokers	Ref	Ref	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

[a] Regression coefficient based on a multivariate linear regression fully adjusted for age, civil status, country of birth, region, household type, obesity, eating habits and alcohol consumption.

[b] Odds ratio based on a multivariate logistic regression fully adjusted for.

[c] Very few participants had any problem in self-care and in some cases a number of variables predicted the outcome perfectly. As a result, STATA dropped a number of observations in this model and the N for the females in the three educational categories are respectively 639, 783, 1219.

However, are women with a low SES more susceptible to the health impact of smoking than women with a high SES?

It has been hypothesized that due to their favorable social circumstances and better health status, people with a high SES may be less susceptible to the harmful effect of tobacco smoking compared with people with a low SES who already experience multiple threats to their health (e.g., poor diet, low physical activity, high stress, exposure to air pollution at home or at work, etc.) (Pampel and Rogers, 2004). There is still no consensus in the literature about such a differential health impact on smoking (Charafeddine et al., 2012), but a recent study has assessed whether the educational level affects the association between smoking and healthy life expectancy among men and women in Denmark (Bronnum-Hansen and Jeune, 2015). They found that the difference in healthy life expectancy between smokers and non-smokers was larger for women with a lower educational level compared with women with a higher educational level. The inverse was true for men; the difference in healthy life expectancy between smokers and non-smokers was larger for men with a higher educational level. They concluded that women with low education were more vulnerable to the effects of smoking than highly educated women, while highly educated men were found to be more vulnerable to the effects of smoking than their counterparts with lower education.

4.1. Limitations

A number of study limitations need to be acknowledged. A first potential limitation is the use of self-reported data on smoking. Although the validity of self-reported smoking has been questioned, a number of studies have found the validity of self-reported smoking to be high in the general population and among various subgroups including educational categories (Rebagliato, 2002; Vartiainen et al., 2002). Still, it cannot be excluded that a bias has been generated due to systematic differentials in under-reporting by socio-demographic groups (Fisher et al., 2008; West et al., 2007). Previous studies have found that people with a lower educational level may underreport their smoking status (Caraballo et al., 2001; Wagenknecht et al., 1992). Sensitivity to the social stigma associated with smoking has been cited as one reason for this underreporting.

In addition, many of the studies on HRQOL and smoking have found that as smoking intensity increases, HRQOL decreases. In our analyses, we did not include smoking intensity. However, it could be that women with a low and intermediate SES are heavier smokers compared to women with a high SES, and that this contributed to the differential effect that we observed. Therefore, we performed additional analyses (see Table B in the supplementary files) using a smoking indicator that differentiated between heavy smokers, light smokers and non-smokers. The results of this sensitivity analysis were in line with the results published in this manuscript.

A final limitation is the use of cross-sectional data that does not allow determining whether the associations detected reflect a causal relationship. This issue is especially of importance for the dimension anxiety/depression as it is well acknowledged in the literature that those with a mental disorder are more likely to smoke (Mykletun et al., 2008). Still, recent longitudinal studies have reported a cause-effect relationship between cigarette smoking and depression in which tobacco use increases the risks of depression symptoms (Argondizo Dos Santos et al., 2010). Further longitudinal studies would allow determining a causal association between smoking and HRQOL.

4.2. Implications and conclusion

The results of this study have clinical as well as policy relevance. In the clinical field, information on HRQOL and smoking is useful for the development of smoking cessation interventions. Studies have shown that women living in disadvantaged socioeconomic circumstances are particularly likely to become regular smokers and encounter more

challenges in quitting than the general population (Hemsing et al., 2015). Qualitative studies (Greaves, 2015; Greaves and Hemsing, 2009) have provided some insights into the reasons why women with lower SES smoke, including the need to control anger, to manage stress, to reward themselves and to facilitate social relationships. In comparison to these short-term benefits of tobacco smoking, a future health gain from quitting may seem less important. Findings from our study provide a positive context to encourage smoking cessation by focusing on the positive gains in the current quality of life. This is especially the case since our findings show that the HRQOL of female former smokers with low SES is not significantly different from the HRQOL of female never smokers with low SES. On the policy level, our findings confirm the importance of accounting for gender and SES when undertaking economic evaluations of smoking cessation interventions. Given that HRQOL is used as input for cost-effectiveness analyses, our finding of a large and significant reduction in HRQOL among women with low SES suggests a greater gain from smoking cessation in this group. Therefore, developing effective smoking cessation programs for this subpopulation is a very critical, albeit challenging (Hemsing et al., 2015), task. Such programs should provide different forms of support as our findings have shown that four of the five EQ-5D dimensions (depression/anxiety, mobility, usual activity and pain/discomfort) were significant contributors to the lower HRQOL among this group.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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Transparency document

The Transparency document associated with this article can be found, in online version.

Appendix A. Supplementary files

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ypmed.2017.09.016.

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