Cancer by migrant background in Belgium

Van Hemelrijck, Wanda

DOI:
10.33612/diss.170347004

Chapter 6

General discussion

6.1 Summary of the main results

The aim of this dissertation was *(1) to analyse and compare cancer mortality, incidence, and survival of individuals of migrant background and natives in Belgium and (2) to examine determinants that contribute to discrepancies between Belgians and migrant origin groups during the 2000s by breaking down findings into duration of stay and generational status, and by adjusting for SEP, demographic traits, and tumour stage at diagnosis*.

In *Chapter 2*, the mortality levels for various cancer sites among native Belgians and French, Dutch, Italian, Turkish, and Moroccan first- and second-generation migrants were presented using the Census-linked registry data from October 2001 to December 2011. These mortality rates were compared and the contributing role of individual SEP and level of urbanisation of the neighbourhood were examined. In the article, I concluded that there was site-specific variety in cancer mortality by migrant background with generally lower lifestyle-related cancer mortality rates (i.e., lung, colorectal, head and neck, breast) among first-generation immigrants from Italy, Turkey, and Morocco compared to native Belgians. In contrast, mortality from infection-related cancers such as those of the stomach and liver was higher among first-generation Italians, Turks, and Moroccans (except liver among Turks). The cancer mortality profile of first-generation French and Dutch migrants also varied somewhat from that of Belgian natives: French men had higher lung, head and neck, and liver cancer; Dutch men had lower lung and head and neck cancer mortality, in contrast to higher rates for the latter among the Dutch. Convergence up to native mortality rates was demonstrated among second-generation Italian and Moroccan migrants for lung and female breast cancer, as well as prostate cancer for Italian men and head and neck cancer for Italian women. Also, in the second-generation, liver cancer mortality among Italians and French men, lung cancer among Dutch women, and cancer of the head and neck among Dutch men and French women was comparable to that of Belgians.

Lifestyle-related cancer mortality among Italian, Turkish, and Moroccan migrants was lower than for Belgians despite a lower SEP on average and higher level of urbanisation in the living environment. These determinants only explained the higher French lung and head neck cancer mortality.

After demonstrating site-specific cancer mortality differences by migrant background and the contributing role of SEP and urbanisation, I focused on other determinants of cancer mortality for the same migrant background groups in the urban areas of Antwerp, the Brussels Capital Region, Charleroi, Ghent, and Liège in *Chapter 3*. More specifically, a multilevel structure was introduced in the updated Census-linked registry data from 2001 to 2014 and the extent to which the presence of same-origin country peers in the neighbourhood was associated with tobacco-related cancer mortality among migrants was scrutinised. Correlations between same-origin presence with individual SEP and neighbourhood-level deprivation were taken into account. Whether those neighbourhood composition effects were dependent on generational status and SEP was furthermore verified by using interaction terms. Three indicators were used to measure same-origin group presence, and each was introduced with a linear and categorical specification in separate analyses. This chapter was inspired by the literature on ethnic density and social networks, exploring potential social capital mechanisms on risk behaviour within same-origin country networks by using tobacco-related cancer mortality as a crude proxy for tobacco consumption. The findings from this study revealed that neighbourhood migrant networks are likely to matter for men: within migrant background groups, tobacco-related cancer mortality tended to be lower for individuals living in a neighbourhood with larger presence of the same origin group. The opposite result was only found among Turkish men. Among Dutch and French men, protective same-origin effects were attributable to the concentration of socioeconomic benefits in neighbourhoods inhabited by large numbers of Dutch and French migrants. Interaction terms revealed that same-origin effects differed by generational status and SEP: the detrimental effect

was limited to second-generation Turkish and Moroccan men, and the same-origin effect was more protective among lower versus highly educated Dutch men. After using various measures with different specifications in the analyses, it became clear that the choice of measure is an important reason for (not) finding same-origin effects, and that the effects for some groups are a matter of high versus low presence rather than linear increases in measures.

In the subsequent study (*Chapter 4*) female breast cancer was scrutinised and incidence and survival thoroughly examined among native Belgian, French, Dutch, Italian, Turkish, Moroccan, and Sub-Saharan African women. These outcomes were studied separately for pre- and postmenopausal diagnoses because risk and prognostic factors are known to differ by age at diagnosis. I also looked at the role played by SEP and reproductive behaviour (parity and age at first childbearing) for incidence inequalities, and SEP and stage at diagnosis for survival discrepancies between groups. Finally, differences in premenopausal breast cancer risk and survival by generational status were analysed to verify whether hereditary factors were plausible explanations for the observed discrepancies. The results showed an overall lower breast cancer risk for migrant origin versus Belgian women for the period 2004-2013, which was most pronounced for Turkish, Moroccan, and Sub-Saharan African women and clearer for post- than premenopausal breast cancer. The gap in breast cancer incidence between Belgium versus Turkish and Moroccan women was in large part due to lower educational levels, having more children, and having them at younger ages on average among the latter. Second-generation migrant women did not have a lower premenopausal breast cancer risk than Belgians. With regards to survival, two groups stood out: survival observed from 2004 to 2017 was lower for premenopausal Moroccan compared to native Belgian patients, whereas it was higher for pre- and postmenopausal Italian patients. The Moroccan disadvantage was limited to the first generation and was explained by later stages at diagnosis and lower educational levels. We could not attribute the Italian survival benefits to

socioeconomic traits or tumour stage. These findings exclude a genetic susceptibility to more aggressive breast cancer subtypes for Moroccan women and rather point to differences in help-seeking behaviour.

In the final study (*Chapter 5*) I tested the theory of 'a rapid epidemiologic transition' for site-specific cancer incidence observed between 2004 and 2013. This theory describes the contributions of infection- and lifestyle-related disease to migrant mortality among those migrating from less-industrialised countries to highly industrialised ones. It furthermore formulates how these disease risks and mortality levels change with time after migration. For cancer, the theory implies higher infection-related cancer incidence compared to natives in the country of destination that decreases to native levels after a short length of stay. Lifestyle-related cancer risk is lower than for natives and increases slowly with time. Some disease risks, such as for non-cardia stomach cancer, are 'pre-programmed' during critical periods in early life and are less susceptible to change after migration. To test these assumptions, colorectal, infection-related (non-cardia stomach cancer, hepatocellular carcinoma, Hodgkin lymphoma), and separate non-cardia stomach cancer incidence rates were calculated for Belgian natives, and French, Dutch, Italian, Turkish, and Moroccan first-generation migrants by shorter (less than 30 years) and longer duration of stay (as of 30 years) in Belgium. Rates for the migrant background groups were compared to those of Belgian natives. The assumptions from the theory were confirmed for Turkish and Moroccan men: these latter groups had higher colorectal cancer incidence rates with longer versus shorter lengths of stay, but the risk remained lower than for Belgians. An initially higher infection-related cancer risk no longer differed from Belgians' after 30 years in the country, but non-cardia stomach cancer incidence was persistently high. Results for Italian men were similar, although their colorectal cancer risk did not differ from that of Belgians. Differences in risk between Belgian natives and Dutch and French migrants were not expected, yet higher infection-related cancer incidence for French men regardless of length of stay was observed. A higher

hepatocellular carcinoma incidence (a cancer type with mixed infection- and lifestyle-related aetiology) for this group explained this observation. No clear changes in cancer incidence with length of stay were found for women, perhaps because robust estimates were hard to find for those with shorter stays, or because different risk transitions occur by gender after migration. Adjustments for SEP and civil status did not alter the findings.

6.2 Interpretation of key findings

The empirical chapters revealed several common denominators throughout the study findings of this dissertation, namely: (1) the observed heterogeneity of outcomes, (2) the strong suggestions of behavioural differences and their determinants, and (3) the convergence of migrant to Belgian native cancer outcomes. Throughout those three themes, the 'social determinants of cancer' model discussed in the general introduction generally constituted an important explanatory framework. However, the site- and origin-specificity of the study results demonstrated that the epidemiologic conditions that individuals have been subject to throughout their lifetimes are crucial additional determinants of cancer by migrant background in Belgium. Using both frameworks yields a multi-layered picture of determinants that also does justice to the temporal (i.e. before, during, after migration) and spatial (i.e. in the country of origin and/or destination) variation in when certain determinants exerted an influence on cancer outcomes for migrants.

6.2.1 The heterogeneity in outcomes by cancer site, migrant origin group, and gender

A recurring response to the question of how cancer mortality, incidence, and survival among migrant groups compares to that of Belgian natives is that 'it depends'.

Discrepancies look different depending on which cancer we consider, the migrant origin group we are focusing on, and whether we are referring to rates of men or women. The study findings of this dissertation can subsequently be broadly categorised along three axes: lifestyle- versus infection-related cancer, migrant origin from a traditional labour recruitment country or a neighbouring country, and men versus women. Only the main findings regarding breast cancer survival cannot clearly be captured along these lines.

6.2.1.1 Cancer site

Because the most frequent causes of cancer death in Belgium for the past decades have been lung cancer for men and breast cancer for women [26], differences in mortality for these two cancer sites particularly contributed to the all-cancer mortality discrepancies between migrants and natives. Looking at site-specific patterns, however, risk and mortality mainly varied according to the lifestyle- or infection-related aetiology of the cancer under study. This site-specific variance casts doubt on the role of selection hypotheses for the study findings, and rather points to the relevance of 'migration as a rapid epidemiologic transition'.

Where discrepancies between Belgian natives and Dutch and French migrants were observed, they were limited to lifestyle-related cancer sites. For migrants from Italy, Turkey, and Morocco, however, lifestyle-related cancer risk and mortality (i.e. lung, colorectal, head and neck, breast cancer) tended to be lower whereas they had a higher infection-related cancer incidence and mortality rate (i.e., [non-cardia] stomach, liver). These three origin countries were also the traditional countries for male labour recruitment for Belgium during the 1960s and 1970s. Because these migrants needed to be healthy to migrate and work in Belgian industry, the 'healthy migrant effect' could apply to them. However, such positive health selection could not explain the higher infection-related cancer risk and mortality for these three groups. This site-specific pattern of cancer inequalities furthermore discredits the salmon bias

(i.e., return migration of those in ill health). In fact, return migration would mainly have to be reserved to migrants with lifestyle-related cancers to explain the advantages of those remaining in Belgium, and does not explain why infection-related cancer risk and mortality were higher. These findings add to the fact that return migration itself was already described as unlikely in prior research due to high-quality health services and the tendency to settle with family in the country of destination [7]. The variation in outcomes observed does, however, suggest that the theory of 'migration as a rapid health transition' is relevant to cancer because it shows that the respective roles of infection- versus lifestyle-related cancer sites resemble those in the country of origin [5,121,122,241]. These cancer outcomes among Turkish and Moroccan migrants furthermore correspond to the site-specific diversity previous research has demonstrated for non-Western migrants in Europe and other continents, but elaborate site-specific European evidence regarding Italian migrants was lacking [7,39,41,129]. It is important to note here that changes in incidence and mortality are expected to occur with time spent in Belgium according to the transition theory. This point will be elaborated on in Section 6.2.3 on convergence in outcomes

6.2.1.2 Origin

In addition to finding site-specific variance in incidence and mortality, variation was mainly visible in the study between migrants from post-war labour recruitment countries (Italian, Turkish, Moroccan) and from neighbouring countries (French, Dutch). We have touched upon this in the previous section by showing that a pattern of lower lifestyle-related but higher infection-related cancer incidence and mortality described was observed among traditional labour migrants, whereas for migrants from neighbouring countries cancer inequalities were limited to lifestyle-related cancer sites.

Notably, there were slight variations in the pattern found among migrants from traditional labour recruitment countries. For example, no substantial differences from

native rates were found for lung cancer mortality among Turkish men, and for colorectal cancer risk and mortality among Italians and Moroccan women. Prostate cancer mortality was only lower among Italian men. The relevance of the theory of migration as a rapid epidemiologic transition seems more straightforward for migrants from Turkey and Morocco, because the theory was formulated for migrants from countries of origin in an earlier stage of the epidemiologic transition. We might not have considered the transition theory for the cancer risk and mortality of Italians because of their European origin if it were not for their similar cancer risk and mortality to those of Turkish and Moroccan migrants. This Italian pattern has recently been confirmed by an additional Belgian study on cancer mortality too [42]. Because the lion's share of Italian migrants aged 40 to 70 years old in 2001 were labour migrants from southern Italy who left due to the local socioeconomically disadvantaged context at that time, their region of origin may have been characterised by a higher prevalence of infectious carcinogens [253–255,260]. As such, our results suggest that migration may have entailed a move between epidemiologic contexts for many first-generation Italians in Belgium as well.

For migrants from neighbouring countries, we mainly found tobacco- (i.e., lung, head and neck) and alcohol-related (i.e., liver, head and neck) cancer risk and mortality differences. French men were subject to higher lung and liver cancer mortality and hepatocellular carcinoma incidence, and French migrants of both sexes had elevated head and neck cancer mortality compared to Belgians. Dutch men had lower lung and head and neck cancer mortality in contrast to high lung cancer mortality among women. The higher French and lower Dutch male lung cancer mortality was also observed in other Belgian studies, but the increased lung cancer mortality among Dutch women was not [41,44]. This may be due to younger ages of the study cohorts in these other studies. Although the overall epidemiologic context between France, the Netherlands, and Belgium is not known to differ, we might consider that the

behavioural component of that context does vary and underlies the results found for migrants from neighbouring countries (Section 6.2.2).

6.2.1.3 Gender

All analyses in this dissertation were stratified by gender due to the sex-specificity of some of the cancer sites we wanted to focus on (i.e., prostate cancer and the limited occurrence of breast cancer in men), whereby gender emerged as a third aspect of heterogeneity in our findings. The magnitude of and discrepancies in lifestyle-related cancer risk and mortality varied between men and women, especially for smoking- and alcohol-related cancers. Incidence and mortality rates for these were lower among women, particularly from Italy, Turkey, and Morocco. It is argued in the literature that different results according to gender may be expected because men and women may migrate under different circumstances and the social determinants of health can have a different impact on them [31,84,140,141,159,192]. For example, the sharp Italian, Turkish, and Moroccan gender contrast in lung and head and neck cancer could be interpreted through the different gender-specific 'diffusion of smoking in the country of origin versus Belgium [141,193], but could also be related to generally male labour migration versus female family reunification. Male lifestyle-related cancer outcomes may therefore have been more impacted by their occupational exposures to carcinogens, their contact with Belgian natives, and their lower SEP [84,140]. These behavioural aspects will be discussed more elaborately in section 6.2.2.

The themes of cancer site, origin group, and gender in the results of this thesis are important contributions to the literature. This diversity in findings shows that different results can be expected according to each of these themes, and that not all previously formulated explanations for health and cancer inequalities between migrant and native groups are applicable to all groups in the same way. Our findings call for an in-depth consideration of the context of migration in terms of motives and the epidemiologic circumstances in the country of origin at the time of migration,

including behavioural patterns, to understand how different cancer outcomes come about. We discuss the suspected behavioural underpinnings of our outcomes in more detail below (6.2.2). Additional aspects of the heterogeneity in cancer outcomes within migrant groups – that of generational status and length of stay in Belgium – will be addressed in 6.2.3.

6.2.2 A pivotal role for behavioural differences and their determinants

Because cancer mortality and incidence in Belgium are primarily shaped by a small number of lifestyle-related sites (i.e. prostate, female breast, lung, and colorectal cancer) [26,63,239], the inequalities detected between Belgian natives and migrant background groups in this dissertation are mainly thought to capture underlying differences in behavioural aspects that predispose to those cancer sites.

In the framework of social determinants for cancer and the theory of migration as a rapid epidemiologic transition, behaviour takes on a pivotal role [56,84,121,122]. As a layer within the social determinants, behaviour is influenced by migrant origin, SEP, gender, and the living environment, and it impacts cancer mortality, incidence, and survival [56,84]. In the transition theory, behaviour can be perceived as one of the elements (i.e., the risk factor component) of the epidemiologic context in the countries of origin and destination. It affects the overall levels of man-made or lifestyle-related cancer whereas the sanitary conditions and the health system (i.e., the therapeutic component) affect infection-related disease risk and mortality more [121].

In this dissertation, underlying behavioural differences between groups entail lifestyle and behaviour pertaining to help-seeking and care utilisation. The lifestyle component can be further subdivided into 'risk behaviour' for cancer incidence and mortality, and 'reproductive behaviour' that has implications for breast cancer mortality, incidence, and survival in particular. The first contains aspects such as tobacco and alcohol

consumption, a sedentary lifestyle, and a diet with low intake of fibre, fruits, and vegetables, whereas the second pertains to female ages at childbearing, parity (i.e., the number of children), breastfeeding, oral contraceptive use, and so on. To support our interpretations, descriptive statistics (frequency estimations with 95% confidence intervals) from the Belgian Health Interview Survey (HIS) are listed in Tables 6.1a and b and referred to throughout the following paragraphs.

6.2.2.1 Behavioural differences

Because lung cancer is the most important cancer cause of death among men and breast cancer among women in Belgium, behaviours that affect incidence and survival for these two sites play a particularly large role for the observed inequalities in this thesis. Nevertheless, the findings suggested discrepancies in behaviours that underlie other cancer risks as well. Overall, behaviour seemed more protective for cancer incidence and mortality among Italian, Turkish, Moroccan, and Sub-Saharan African migrants, but detrimental among French men and Dutch women. With regards to survival, the findings point to later stages at diagnosis due to delayed help-seeking among Moroccan women.

Firstly, the most notorious *risk factor* for cancer overall and that of the lung in particular is *tobacco consumption*: being a smoker and heavier consumption among smokers increases cancer risk [49]. The lower lung cancer mortality among Italian and Moroccan migrants and Turkish women compared to native Belgians in this thesis therefore suggests lower tobacco consumption, whereas the higher mortality among French men and Dutch women suggests higher consumption in the decades prior to our follow-up period (2001-2011) for these groups. These rates pertain to smoking behaviour in the past due to long lag times (20 to 30 years) between smoking and the manifestation of lung cancer mortality [192]. International and Belgian smoking rates support this interpretation: still in 2007, the estimated smoking prevalence in the French population aged 15 years and older (37% men, 32% women) was higher than

in Belgium (31% men, 24% women) [261]. Research has also pointed out high and growing lung cancer mortality among Dutch women from the mid-1970s to mid-1990s for cohorts born after WWII and still showed higher smoking rates among Dutch (29%) than Belgian women (21%) aged 45 to 64 years old in 2001-2004 [262–264]. A lower tobacco consumption and lung cancer mortality rate was shown for Moroccan (2% smokers, Table 6.1a), Turkish (9% smokers, Table 6.1a), and Italian women (19.9% smokers, WHO data, ages 15 and over) in survey results [73,80,237,240,261,265,266]. Prior evidence is inconclusive about smoking among Moroccan migrant men. Table 1a and prior research from France point to a comparable or even higher smoking prevalence versus natives (33% in 2007, WHO data) [112,240,261,266]. Yet, a Belgian study on registry data demonstrated the most outspoken lung cancer risk advantages among Moroccan men for smoking-related subtypes [267]. Smoking was potentially less common at the time of migration to Belgium, which manifested in lung cancer mortality advantages decades later when smoking behaviour had already increased. Alternatively, healthier dietary habits were said to offset similar tobacco consumption between Moroccan migrant and Belgian native men, and their low alcohol consumption (an estimated 0.2% overconsumes alcohol, Table 6.1a) may also play a role [240,251]. In fact, lung cancer mortality is increased with higher alcohol consumption, but the evidence is unclear as to whether this is an independent risk factor for lung cancer, if it correlates with tobacco consumption, or if both risk factors combined have an aggravated effect [49,268].

In addition to lower mortality from lung cancer, lower consumption of tobacco, alcohol, or both are also suggested by lower mortality from cancer of the head and neck in the study findings for Italians of both genders and Dutch, Turkish, and Moroccan men, since both behaviours are risk factors for cancer of the head and neck as well [49]. Survey data showed lower *alcohol consumption* among Moroccan and Turkish migrants compared to natives in Belgium, France, and the Netherlands during the late 1990s to 2013 (Table 6.1a) [113,240,266]. This likely corresponds to behaviour

in the country of origin at the time of migration. WHO data using survey estimates about individuals aged 15 and over were in line with this hypothesis: abstaining from alcohol consumption was the norm in Morocco (92% men, 97% women) and Turkey (83% men, 95% women), in contrast to Belgium (5% men, 14% women) in 2016 [261]. Also in Italy, refraining from alcohol consumption was more common (15% men, 39% women), and the amount of alcohol consumed among 'drinkers' was lower [261]. In the Netherlands levels of consumption were also lower, but not by much. In contrast, this thesis points to high levels of alcohol consumption in the form of higher head and neck and liver cancer mortality, and higher hepatocellular carcinoma incidence, among French migrant men**.** Previous reports stating that France has high levels of heavy alcohol consumption support this assumption [240,261]. The increased liver cancer mortality among Italian and Moroccan migrants in the study findings was more likely due to the aetiological contribution of hepatitis viral B and C infections to this cancer site [243,269].

The results furthermore suggest that in addition to low levels of alcohol consumption, a healthy body mass index (BMI) may have contributed to lower colorectal cancer mortality and incidence Moroccan and Turkish men compared to native Belgians. These aspects, in addition to high physical activity and a healthy diet, are protective against colorectal cancer [49,251], and were suspected to underlie lower colorectal cancer mortality for these migrant groups in other European and Australian research as well [42,69,112,266,270,271]. Levels of physical activity and BMI did not differ between Turkish and Moroccan, and host country native men in Belgium and the Netherlands during the late 1990s and early 2000s (Table 6.1b) [48,113], but the estimated mean BMI was lower among men in Turkey (22.6) and Morocco (21.6) than for Belgians (24.6) in 1975. At that time migration from these countries to Belgium was still frequent [261], and the then lower BMI may have had an influence on later colorectal cancer risks.

For female breast cancer, this thesis confirms that *having children at young ages and having (multiple) children* contribute to a large part of the incidence and mortality discrepancies between migrants and Belgian natives. This is especially true for postmenopausal breast cancer and for Italian, Turkish, and Moroccan women. Prior research had already hypothesised that *reproductive behaviour* underlies lower breast cancer risks [5,39,76,150], since having children at young ages, having (multiple) children, longer breastfeeding, and abstaining from oral contraceptives and hormone replacement therapy (HRT) are associated with decreased incidence [49,108]. Especially breast cancers that are hormone-sensitive, usually diagnosed at later ages, are subject to these behaviours [49,108,272]. For Sub-Saharan African women, the factors accounted for in the analyses did not explain their lower incidence. Other reproductive (i.e., longer breastfeeding, less use of oral contraceptives and HRT), and risk behaviours (i.e. healthier nutrition, lower body weight, and lower alcohol consumption) may lie at the root of their breast cancer risk advantage [251].

In addition to different risk and reproductive behaviour suggested by the findings, help-seeking and care utilisation appeared to differ through our survival analyses: later stages at diagnosis were observed for premenopausal breast cancer patients of Moroccan origin compared to Belgians, which explained the lower survival for the first. Although premenopausal breast cancer is more commonly diagnosed at later stages than postmenopausal breast cancer in general [272], this discrepancy between groups may be a pointer of later help-seeking or worse access to care in Moroccan women [273,274].

6.2.2.2 Determinants of behavioural differences

Behaviour does not occur in a vacuum of migrant background. Firstly, I repeatedly described in section 2.2.1 that behavioural patterns common in the country of origin probably underlie cancer outcomes in Belgium. Secondly, I discussed a multi-layered process in the general introduction whereby 'macro-level' socioeconomic policy – the

social determinants – in society determines how individuals are positioned in the social hierarchy at a 'micro-level' and how 'meso-level' environments in which people live are shaped. Gender and migrant background are furthermore criteria by which individuals' socioeconomic resources are distributed in the former process and are also tied to behavioural norms and values in their own right. This section discusses how determinants of behaviour manifested in the findings of this dissertation.

The findings first revealed fundamental behavioural differences by *gender* independent of SEP. In Section 6.2.1.3 of this discussion, I already touched upon the lower tobacco and alcohol consumption suggested by lower mortality from lung and head and neck cancer, and incidence from hepatocellular carcinoma among women. The gaps were also described as wider among Italian, Turkish, and Moroccan women. For tobacco consumption, a different timing and gender gap in the so-called 'smoking epidemic' in these women's countries of origin likely affects smoking in the country of destination [121,192,193]. According to the model of the smoking epidemic in highly industrialised countries, male tobacco consumption has 'spread' as risk behaviour for lung cancer about 20 years prior to uptake among women due to lower societal acceptability among the latter. Tobacco consumption accelerated quickly among women once it was introduced, however [192]. This and the decades of lag between smoking and lung cancer mortality may have contributed to the gender difference in lung cancer among Italians in our findings, whilst Italian women aged 45 to 64 had higher smoking rates than Belgian women in 2001-2004 [264]. In addition, research has observed larger gender-gaps in the smoking epidemic in a number of countries that included Turkey and has attributed this to country variation in economic, cultural, and political determinants of smoking [193]. Some gender differentiation was also visible for colorectal cancer among Moroccans, where a risk or mortality advantage was apparent among men but not women, suggesting differences in alcohol consumption, diet, physical activity, and/or BMI. Although BMI and physical activity have not been shown to differ between Moroccan and native men in prior research,

among Moroccan women BMI was substantially higher and physical activity than natives in the Netherlands and Belgium [48,113]. The lower participation in the labour market and the transition from rural to urban living environments upon migration from Morocco to Belgium may have resulted in a vastly more sedentary lifestyle among women in contrast to men [48,140].

Secondly, the study findings imply that at the 'micro-level' a lower *SEP* does not always equate to worse cancer outcomes among individuals of migrant background. Higher alcohol and tobacco consumption with lower SEP were suggested by the large impact of SEP-indicators on lung and head and neck cancer mortality, especially for men. For French men, SEP even explained the worse outcomes for these cancers as compared to Belgians. However, SEP had a non-decisive role for Italian, Turkish, and Moroccan groups: these groups had lower mortality from these cancer sites despite their generally lower SEP than Belgians. Their risk behaviour seems more strongly impacted by other determinants, such as behavioural patterns in the country of origin, than by their socioeconomic circumstances in Belgium. Scholars have pointed out that adjusting for SEP-indicators may not have the same effect for migrants from highly industrialised versus less industrialised countries [85,275,276]. The associations observed between SEP, behaviour, and consequent cancer outcomes in the country of destination probably depend on how behaviour and SEP are associated in the country of origin. Although risk behaviour for cancer is typically associated with lower SEP in Belgium, this social gradient is less commonly observed in less industrialised countries [277,278]. This may have been the case in southern Italy, Turkey, and Morocco during the 1950s to late 1970s, when migration to Belgium was at its peak. The fact that SEP-effects were larger for men than women in these groups yet again suggests that, due to their migration history, men were more involved in the Belgian labour market [44,140,238]. Especially occupational status may therefore have played a more important role as a 'social stratifier' for men than women.

The study results also indicated that overall lower educational attainment explained the survival disadvantage for Moroccan premenopausal breast cancer patients: lower educational levels compared to Belgian patients were associated with later stages at diagnosis, underlying lower survival. Because breast cancer is highly amenable to medical intervention, any difference in resources that allows women to access important health interventions such as early detection might increase discrepancies [109,176,233]. As such, educational levels may represent resources such as knowledge, literacy, host country language proficiency, and risk awareness that allow women to identify physical symptoms as potentially indicative of breast cancer and seek help from a medical provider at an early stage [109]. The help-seeking delays suggested by the findings are even more plausible in light of prior research that reported help-seeking delays among migrants or Moroccan women, which were associated with lower literacy, SEP, host country language proficiency, (breast) cancer risk awareness, in addition to more origin-specific aspects such as health beliefs and perceptions of the health system [116,117,279,280]. However, it deserves mentioning that survival may also have been affected by other experiences such as accessibility issues due to administrative, literacy or language barriers, as well as a lack of cultural competence of system and provider [106,214].

Thirdly, the findings of this dissertation revealed *ethnic density or same-origin effects* on tobacco-related cancer mortality within migrant background groups. Those results suggest ties between tobacco consumption and *the built environment* (meso-level), measured as neighbourhood composition. For Italians of both genders (protective) and Turkish men (detrimental) these effects persisted after adjustment for individual SEP and neighbourhood deprivation, but ethnic density effects among French and Dutch men were attributable to the concentration of socioeconomic benefits in highly French and Dutch concentrated areas. This effect attenuation provides further evidence for a more 'typical' social gradient in risk behaviour among migrants from highly industrialised countries, whereas other determinants may matter more for

migrants from less industrialised settings. One possibility is that the network of peers from the same origin country in the neighbourhood exerts social capital effects for Italian and Turkish men. Social capital has been coined a 'cross-cutting' social determinant of health in social epidemiology because individuals do not adopt behavioural patterns in isolation [84,103]. For example, smoking may be encouraged or discouraged through support, norms and values present in the network [90]. The different direction of the effect for Italian versus Turkish men may mean that these groups have differing norm and value sets regarding smoking that translate into different same-origin group effects on cancer [105].

As another aspect of the built environment at the meso-level, the study results showed that whether migrants settle in higher or lower urbanised areas has implications for their cancer outcomes, although it did not explain any of the discrepancies observed between migrants and Belgian natives. Its role was furthermore smaller than that of SEP. *Urbanisation* was mostly significant for lung, head and neck, and breast cancer among Moroccan and Turkish migrant, corroborating prior research that found elevated risks and mortality for these cancer sites in urban versus rural areas before [281,282]. Some of the differences by unequal deprivation levels, yet the authors hypothesised that differential care utilisation and risk factors likely caused the remaining difference [281,282]. The higher inclination of especially Turkish and Moroccan individuals to inhabit Belgian urban areas probably explains why urban effects were particularly pronounced for them.

Finally, the results of this thesis suggest *interactions* between aspects of the social determinants framework. More specifically, traits of the built environment may exert a different influence on cancer outcomes depending on individual characteristics. In my findings, same-origin group or ethnic density effects (the built environment) on tobacco-related cancer mortality were only detrimental among second-generation Turkish and Moroccan men, and more beneficial among lower versus higher educated Dutch men. The first observation is in line with prior research suggesting that living in

areas with higher ethnic density implies a 'social blockage' for second-generation migrants and has detrimental effects for health [168]. The second observation suggests that having a lower SEP among Dutch men is buffered by overall high levels of socioeconomic privilege in Dutch-concentrated areas. Those neighbourhoods are probably less conducive to tobacco consumption because high-SEP peers smoke less and the organisation of public spaces may discourage it (e.g. less tobacco vendors around, more parks) [93,94,105].

6.2.3 Cancer outcomes and the migrant's life course: evidence of convergence to Belgian native levels?

Up until now, I have discussed the heterogeneity in cancer risk, mortality, and survival of Belgian natives and migrant background groups and the key contribution of underlying behavioural differences. As mentioned in Section 6.2.1, migrant-specific characteristics such as generational status and length of stay are also important aspects of the diversity in cancer outcomes observed in our results. Subcategorising migrant background groups according to these characteristics brought in a migrant-specific life course perspective on cancer outcomes and supported an understanding of the extent to which cancer outcomes and their underlying behavioural determinants were subject to change after migration. Overall, I conclude that where convergence of cancer risk and mortality with time and generation is evident for most cancer sites studied, the speed at which this occurs is less clear from the study findings. This thesis furthermore offers compelling evidence for convergence in cancer survival to native level in the second generation.

The findings showed changes in cancer outcomes among individuals of Italian, Turkish, Moroccan, and Sub-Saharan African origin, yet it is important to state upfront that the second generation of these origin groups aged 40 and older was relatively small except for the Italians, thus hampering robust mortality and incidence

estimations. Convergence down to native Belgian rates occurred for stomach and liver cancer mortality in the second generation and for infection-related cancer incidence after 30 years of stay in Belgium. This is in line with other research observing decreasing stomach and liver cancer mortality among Italian men from the 1990s to 2000s and may point to a lower presence of infectious agents in Belgium, but also a decreasing trend in prevalence in the countries of origin over time [42]. Upward convergence to native rates manifested in the second generation for mortality of cancer of the head and neck among Italians, and lung cancer and breast cancer mortality and (premenopausal) breast cancer risk in all migrant background groups. Converging colorectal cancer incidence rates among Turkish men and Moroccan migrants of both genders with 30 or more years of stay in Belgium were also observed, but rates were still substantially lower than among Belgian natives. The patterns for cancer of the lung, head and neck, and female breast suggest that smoking, reproductive behaviour and other hormonal exposures (e.g., breastfeeding, HRT, oral contraceptive use) changed substantially in one generation for Italian, Turkish, and Moroccan migrants, in addition to alcohol consumption for Italian migrants. BMI (as a related to dietary and physical activity patterns) and alcohol consumption among Turkish and Moroccan men may have altered over the course of 30 years as well, but differences between first- and second-generation migrants were less clear for these migrants because colorectal cancer incidence and mortality rates for the second-generation could not be calculated. These findings are supported by prior research about converging reproductive behaviour, smoking, alcohol consumption (Italians), and physical activity in the second generation [158,283,284]. Food and alcohol consumption among Turks and Moroccans have been shown to be rather steady lifestyle aspects over time [110,124–126,148,285,286] .

Crucially, only non-cardia stomach cancer incidence was persistently elevated among Italian, Turkish, and Moroccan migrants in Belgium in the findings, regardless of length of stay. This supports the evidence that early exposure to H. pylori in the origin country

'preprogrammes' the later-life risk for this cancer and does not seem subject to change due to migration [5,133,241]. This validates the importance of critical exposures to cancer risks in early life previously described in life course epidemiology and coined 'the unfinished agenda of migration as a rapid epidemiologic transition' [121,122].

The post-migratory mortality and risk patterns correspond to the transition theory assumptions: 'rapid' decreases in infection-related disease for Italian, Turkish, and Moroccan migrants as they spend more time in Belgium, and slower changes in lifestyle-related afflictions such as colorectal cancer because behaviour probably alters more gradually after migration [121]. Nevertheless, the study results cannot express how rapid or slow changes in other lifestyle-related cancer outcomes (i.e., lung, prostate, breast, head and neck) were as we only reported them by generation. Furthermore, a distinct pattern was observed for Italians, and no clear cancer risk transition was found for women where it was for men, suggesting that risk and mortality changes vary by origin country and gender. This corresponds to the literature that criticises a unidirectional view on acculturation as a change from behaviour 'imported' from the country of origin towards behaviour prevalent in the country of destination. Instead, behaviour is affected by what is and is not considered the norm or acceptable for male and female community members, especially among those migrating as adults [110,124–126,148,285,286]. Because migration occurred at adult ages for almost 88% of the study cohort, this is an important consideration.

In addition to mortality and incidence rates, survival rates for premenopausal Moroccan breast cancer patients had converged to native rates in the second generation. Improvements in Dutch and/or French language proficiency, increased (breast) cancer risk awareness, and knowledge of the Belgian health system may have put them at a lower disadvantage compared to their first-generation counterparts [233]. Considering how scant the evidence on survival differences between first- and second-generation migrants is, this is an important contribution to the literature.

6.3 Methodological considerations

The interpretations of the study results go hand in hand with several methodological considerations. Most follow the administrative nature of the data we used.

The *richness of the data* is an undeniable strength of this thesis: the nationwide coverage, information on migrant traits such as generational status and duration of stay, the individually based SEP measures, information on settlement at the neighbourhood level, coverage of different cancers and outcomes, and a follow-up of more than a decade. This combination of nationwide cause-specific mortality and cancer registry information with records on migrant background is rare, with the Nordic countries, the Netherlands, and New Zealand as prior examples. Other databases are usually region- or state-based (e.g., Germany, US). For the other countries of origin covered in our study population, cancer registration is either largely missing (Sub-Saharan Africa), based on a limited number of urban regions (France, Morocco), or does not cover the entire population yet (Italy, Turkey) [261,287–291]. The Belgian data facilitated site-specific cancer mortality analyses by migrant background for a variety of cancers and allowed us to adjust them for individual SEP, which is a rare possibility in especially incidence and survival analyses and helps to avoid the potential ecological fallacy that aggregated measures bring about [292]. In other research, SEP-measures were generally aggregated at the level of census tracts or other small spatial units [13,15,58,293]. Settlement information at the neighbourhood-level furthermore for an exploration neighbourhood effects on migrant cancer outcomes. Although here the risk of ecological fallacy was introduced by using neighbourhood same-origin presence as a measure for an individual's own same-origin social network, examining neighbourhood effects itself is quite new to migrant (cancer) research and can point to important 'meso'-levels of influence on cancer and useful levels of policy intervention.

The linkage with diagnostic information from the cancer registry furthermore permitted *an analysis of mortality, incidence, and survival*. In doing so, we have shown that a low risk of breast cancer may not extend to good survival chances, and that early detection measures need to be accessible to the entire population. This data-linkage has furthermore enabled us to test the theory of a rapid transition for cancer incidence. A downside of combining mortality, incidence, and survival in one scientific report such as this is that we need to be cautious not to assign all three outcomes to the same study population over the same time period [19], particularly as slightly different observation periods and age groups were considered in the study chapters. Mortality between 2001 and 2011 or 2014, for example, includes diagnoses from 2004 to 2014, but also cancer diagnoses from an unknown period prior to this. In addition, survival rates from 2004 to 2017 also related to deaths from breast cancer occurring after the period that was covered in the mortality analyses. Additionally, the breast cancer incidence and survival analyses included younger ages (30 to 69 years old) than were included in the other chapters. This combined with the fact that the incidence follow-up started three years later (2004) than for mortality (2001) means that only women aged 43 or older in Chapter 4 have also been included in the reported breast cancer mortality rates in Chapter 2.

An important limitation of our data is *the cross-sectional nature of the 2001 census* information from which neighbourhood, demographic, and socioeconomic information about the study population was derived. Firstly, this means by now that the population structure has changed as there is a 20-year gap between the census and the finalisation of this thesis: the EU-enlargements of 2004 and 2007 have prompted an important influx of eastern European migrants whose presence has doubled in the 2000s compared to 1990s and whose cancer outcomes thus become increasingly important [42]. Additionally, large numbers of Syrians and Afghans seeking asylum in Belgium during the last refugee crisis are now obtaining legal residence in Belgium and entering the population registry. In 2017, more Syrians

entered the registry than Polish or Moroccan migrants (almost 6,000), on top of around 3,700 Afghans [294]. These origin groups will become significant in the following census. Secondly, reproductive behaviour and educational level are probably stable variables for adults aged 40 and over, but information about the area of residence, employment, and income may not be. Therefore, either a combination of variables was selected for SEP, or educational level and home ownership as 'accumulated wealth' were preferred as these variables were less subject to change during the follow-up period. Regarding educational attainment, however, the share of older migrants from outside the EU with unknown information was extremely high (>50%) due to a high item non-response on this question in the census survey. This may be attributable to the written nature of the survey and the possible limited French or Dutch proficiency in this group. Finally, important exposures for cancer incidence and mortality outcomes in Belgium may have occurred prior to migration, whereas the socioeconomic and residential (i.e., same-origin group presence) traits we assign to them are only established later. Associations we find between these determinants and cancer outcomes may therefore capture unevenly distributed exposures prior to arriving in Belgium. Smoking behaviour underlying tobacco-related mortality was for example associated with same-origin group presence in the neighbourhood in Chapter 3, but the onset of (heavy) smoking may have started far earlier when individuals were living in a different neighbourhood or even prior to migration.

Our research findings also point to the role of *SEP* with differences by cancer site, gender, and migrant origin. Studies have found that specific indicators for SEP may not actually carry the same relevance for all groups, which could contribute to why strong SEP-effects were not always detected [179,195,276]. Occupational status, for example, can be an important indicator for traditional cohorts of male labour migrants, whereas its relevance for women migrating around the same time from the same origin countries is more limited. Employment status (i.e., employed, unemployed, missing) was included in Chapter 2 on site-specific cancer mortality, but when models

had to be more parsimonious, educational level and/or home ownership were preferred (also see above).

With regards to *the cancers studied*, we referred to stomach and liver cancer as infection-related in Chapter 2, although infectious carcinogens are only important risk factors for specific subsites of these cancers: Helicobacter pylori contributes to at least 75% of non-cardia stomach cancer cases, and viral hepatitis B and C are important contributors to hepatocellular carcinoma [49,243,245,269]. Non-cardia stomach cancer and hepatocellular carcinoma were therefore include in an 'infection-related cancers' group with Hodgkin lymphoma when the study goal was specifically to examine post-migratory changes in infection- versus lifestyle-related cancer incidence in Chapter 5. Nevertheless, even for these subsites other risk factors come into play. Dietary salt intake and tobacco consumption are additional risk factors for non-cardia stomach cancer [49,245], and hepatocellular carcinoma is tied to tobacco and alcohol consumption [49,243,269]. As a second outcome-related limitation, our in-depth analysis combining incidence and survival was limited to breast cancer, although similar studies for other cancers would undoubtedly yield significant results as well. Examples are colorectal and prostate cancer as two of the most diagnosed cancers with generally high survival, and stomach cancer as being a higher risk in specific migrant groups with generally low survival [26].

Despite the nationwide coverage of our data sources, studying cancer outcomes in minority groups in a comparatively small country brings about *problems with small numbers of cases* [295]. The mixed population of migrant background in Belgium combined with a still relatively young age structure at the time of the 2001 Census (for non-EU origin) implies small group sizes and few cancer diagnoses and deaths, which become more limited when subcategorizations by generational status and duration of stay are made. The cancer sites, origin groups, and subdivisions of groups chosen for the studies in this thesis were therefore also the result of a balancing exercise between producing important information and what is possible in regression analysis. We

ensured the calculation of absolute and relative mortality rates for the cancer outcomes studied to avoid overinterpreting rate ratios for smaller cancer sites: the rarer a cancer, the greater the disparity in its outcomes when two groups differ in susceptibility to or survival of this cancer [296,297].

A related challenge is a *broader issue with defining subgroups in the population*. Assigning individuals to migrant background groups needs to be meaningful [22], but will become increasingly complex. In the words of Dirk Geldof: "*If the 20th century was the age of migration, the 21st century will be the age of superdiversity*" [30]. Migration will more commonly be characterised by new countries of origin, multiple-origin individuals, individuals that have had stays in multiple EU countries (as is currently visible for refugee populations), diverse motives for migration, higher-order migrant generations, increased socioeconomic and legal differentiation, and more 'transnationally' connected people with more ways to stay in touch and be affected by different country settings [30,298]. This increasing diversity-in-diversity was likely ongoing for (at least part of) our study cohort. For that reason, an important limitation of this thesis is its linear approach to migration from the country of origin to Belgium, meaning that cancer-relevant exposures and mechanisms are generally assigned to one of these contexts. Nevertheless, transnational connections to other country settings, either due to prior stays in those countries or because social network members are based there, may have some impact on risk behaviour, help-seeking, and care utilisation. Adopting a superdiversity-lens in migrant cancer research would be a complex exercise but could result in a more intricate picture of the determinants that affect migrant cancer outcomes over the life course.

Notwithstanding the fact that focusing on cancer outcomes in Belgium ensured high data quality and limited bias introduced by using different data sources [12], this single *'Belgo-centric' scope* has also been a limitation. Comparisons of Belgian native mortality, incidence, and survival rates to those of migrant background groups demonstrated how the burden of cancer differed. Yet, this design did not provide

information about the population from which the migrant background groups originated and means that explanations for differences in rates often remain tentative [12]. Two-comparison studies that examine rates from non-migrants in the country of origin and migrants and natives in the country of destination could demonstrate changes in outcomes among migrants more precisely, although they can be subject to limited data quality from the country of origin [12,265,299].

6.4 Implications

The study findings and methodological considerations of this dissertation offer a myriad of opportunities for future research and policy intervention. The following paragraphs will provide an overview of the most important implications for research that aims to overcome the limitations of this thesis and advance the knowledge it provides. In the section thereafter, I will outline several policy implications.

6.4.1 Research recommendations

Even though our data sources were important assets of this dissertation, they did not allow me directly to test the role of differing risk and help-seeking behaviour and social capital effects for the study findings. To avoid 'black box epidemiology' and 'comfy zone hypotheses' for cancer patterning in migrant background, research needs to take further steps to understand the mechanisms that cause these results [22,275]. The following paragraphs provide suggestions for how this might be done.

First, testing the hypothesised role of lifestyle behaviours (i.e., diet, physical activity, smoking, alcohol consumption, reproductive behaviour, and hormonal intake) is an important step to understanding how cancer inequalities come about. Nationwide information linking site-specific cancer incidence and self-reported health-related behaviour does not exist, but HIS information does give a descriptive background of

health-related behaviour. The HIS survey samples contain limited numbers of migrant participants because they are intended to be representative of the overall Belgian population. Some countries of origin are therefore grouped (e.g. neighbouring countries, southern Europeans), and subcategorisations by duration of stay and generational status yield very low numbers. A migrant inflated HIS may provide more robust accounts of relevant behaviours as well as self-reported health problems by specific country of origin, and potentially even generational status and duration of stay in Belgium. The deliberate expansion of the sample of migrant background in the 2013 German Socio-Economic Panel (SOEP) is an example [300].

Second, learning how health promotion messages are perceived by members of various population groups through qualitative research designs could inform appropriate policy action in a context of converging lifestyle-related cancer mortality and incidence. Research questions for such a study could be: do messages aiming to reduce tobacco consumption, increase physical activity, promote a healthy diet, and encourage participation in organised screening (1) reach all migrant background groups, and (2) do they motivate all groups to undertake action to improve their health? Focus groups where individuals with the same country of origin view and discuss prevention campaigns could produce answers to these questions. Including Belgian natives would furthermore help to understand whether these health promotion messages are received in a way that is specific to migrant background or is rather common for the entire population. In a prior study, focus groups were undertaken with Moroccan migrant women living in Brussels about breast cancer screening invitations, demonstrating that targeting screening communication for this group and actively involving the general practitioner (GP) to encourage screening participation would be promising undertakings [120]. However, evidence regarding other groups in Belgium is still largely missing and at an international level it is still unclear how behaviour other than screening can most effectively be improved [301–305].

Third, differential help-seeking behaviour as reasons for later stages at diagnosis need to be examined for breast but also for other types of cancer. A sequential exploratory mixed-methods design could accommodate this research goal: a quantitative survey administered among cancer patients with native and migrant origin in hospitals could be followed by in-depth qualitative interviews with a part of the survey respondents [306,307]. Among breast cancer patients, for example, structured questionnaires could be filled out in tandem with appointments in breast clinics, focusing on the patients' socio-demographic, -economic, and migration profile and key events in the trajectory to diagnosis and care (e.g. help seeking, diagnosis, start of treatment) similar to the survey administered by Moodley and colleagues [308] and based on the *model of pathways to treatment* [309]. In addition, Cancer Awareness Measures by Cancer Research UK (e.g. knowledge of symptoms, behaviour in relation to breast changes, barriers to seeking medical help, knowledge of screening) could be included in the survey to inform about differences in awareness and their association with help-seeking intervals [310]. Subsequent interviews with a part of the respondents might delve deeper into reactions to symptoms, cancer beliefs, the role of others in the social network for help-seeking, and can give a more contextualised understanding of differences in cancer pathways between population subgroups.

Fourth, examining the role of social networks for cancer outcomes would be an important addition to our results about neighbourhood same-origin group presence and tobacco-related cancer mortality, and potentially breast cancer survival among Italian women. The utility of social networks post-migration has been shown in prior research [311,312], but their ties with cancer trajectories and outcomes among migrants have hardly been a focus for study to date. Our study on same-origin presence and tobacco-related cancer mortality gives an indication of social capital effects on smoking behaviour in several origin groups, but specific information about the composition of actual social networks (e.g. in terms of SEP and migrant background/origin), which network members influence lifestyle choices, and how

lifestyle choices are influenced (e.g. through imitating peers, sharing of health information, peer pressure, authority figures) is necessary to understand how this occurs for different origin groups. Extending questions about the role of social networks to cancer patients themselves would furthermore point to the utility of social networks after a diagnosis. Different parts of the social network may offer distinct kinds of support and strain and potentially even lead to different chances of survival [313–322]. How social networks are built and utilised differently according to migrant origin is also of great interest here to observe how key players in social networks can impact migrant cancer trajectories and where support may be lacking.

Finally, a two-comparison study that compares cancer outcomes among migrant background groups in Belgium to those of non-migrants from the same birth cohort in their country of origin rather than only Belgian natives could provide more information about actual changes in mortality, incidence, and maybe even survival [12]. Collaborating with Dutch, French, Italian, Moroccan, and Turkish cancer registries for multiple comparison studies could facilitate this. Nevertheless, data from these countries except for the Netherlands do not pertain to the entire population at this point in time, although there have been promising expansions in Italy and Turkey [287,288,290,291]. Population-based cancer registration in Sub-Saharan Africa is uncommon, thus requiring different data collection strategies for comparative studies focusing on people with a Sub-Saharan African migrant background [261].

6.4.2 Policy considerations

This thesis has illustrated that cancer outcomes by migrant background are heterogeneous, that behaviours that predispose to site-specific cancer risks and prognosis are not shaped in a social vacuum, and that cancer outcomes converge with time and for offspring in most cases. Especially the social embeddedness of behaviours implies that policy measures oriented at the individual will not suffice if the goal is to obtain low cancer risks and high survival for all origin groups. The increasing

mortality and incidence from frequent lifestyle-related cancers with duration of stay and migrant generations furthermore means that an increasing part of the population residing in Belgium needs adequate cancer prevention and care services. This section formulates a few recommendations based on these overall findings, generally with the Belgian health policy context in mind. This context entails that the Belgian federal government is responsible for financing hospitals, health care policy, and sickness- and disability payments, whereas the communities organise primary care and have their own preventive policy [323]. In terms of cancer-specific policy, Belgium's first National Cancer Plan was established in 2008, and has become part of general policy via a government agreement in 2011 [324]. Sciensano's[2] Cancer Centre is currently the facilitating, advising, and evaluating institution for Belgian cancer policy [325].

Both the fact that the results of this dissertation indicate a key role of behaviour for discrepancies in cancer outcomes and that they demonstrate converging risks and mortality of lifestyle-related cancers, points to the importance of *primary prevention* in cancer policy. Preventive measures aiming to decrease alcohol and tobacco consumption, promote a healthy diet, and increase physical activity could help decrease risks of lung, head and neck, prostate, colorectal, and partially even breast cancer [49,270]. Crucially, policy measures need to be designed with respect for the interplay of variables that shape behaviour such as gender, migrant origin, SEP, the way the living environment is organised, and the people individuals interact with [11,84,103,326]. This requires an approach that goes beyond campaigns promoting individual action, such as the 12 recommendations regarding lifestyle formulated by the fourth edition of the European Code Against Cancer (ECAC) [327]. These European recommendations were translated into the 'Prolongitudine'-campaign in 2016 by the Foundation Against Cancer in Belgium and displayed as 'guidelines for lower chances of getting cancer' in medical practices, pharmacies, and the media [328]. Helping people adopt those recommendations with respect for their own

[2] The Belgian scientific research institution for public health

socioeconomic resources and norms and values could strengthen this initiative, for example by involving general practitioners (GPs). GPs could help to find feasible ways to implement the ECAC recommendations in patients' daily lives, since most of the Belgian population has been estimated to have a regular physician [329]. Currently, yearly prevention consults are fully reimbursed for individuals aged 45 to 75 with a 'Globaal Medisch Dossier' (GMD, i.e. electronic system that supports the collection and centralisation of patient medical records) and were part of the Belgian Cancer Plan and since 2011 of federal health policy [324,330,331]. Extending this initiative to those without a GMD and younger ages could be useful to avoid health risks at older ages.

In addition to individual-level intervention and undertaking research that assesses how the ECAC recommendations are received and used by migrant background and SEP (see above in Section 6.4.1), I would advise complementing individual-based campaigns with community-based initiatives. Community-based interventions involve various actors such as GPs, community centres, religious leaders in a local area [332], and could be more effective for population groups that cluster in specific (urban) areas in Belgium. In Brussels, for example, Forest Quartier Santé is a local non-profit organisation that has coordinated a project aimed to prevent smoking uptake among preadolescents (aged 11 to 18) in 2009 [333]. The project intended to equip youngsters with psychosocial tools to deal with both external (peer, advertising, role-modelling) and internal (psychosocial, stress) pressures that promote tobacco consumption in their local community. Moreover, social workers that were in regular contact with inhabitants of more deprived neighbourhoods were trained to promote critical attitudes towards tobacco consumption and discourage social influences from peers on smoking in the community. Although this project did not target migrants, the more deprived neighbourhoods in Forest are more densely populated by Moroccan migrants. Considering the observed detrimental associations between same-origin presence in the neighbourhood and tobacco-related cancer mortality among second-

generation Turkish and Moroccan men in this thesis, such community-level prevention campaigns could be particularly helpful. Process and outcome evaluation of such initiatives would subsequently be informative to reach a set of best practices and test out translatability of programmes to other communities.

At the federal level, adopting the 'Health in all policies'-approach would be the overall goal. Public policy in which the entire scope of policy domains warrants health promotion and health equity, even when health and equity are not their priorities, is a key element in the primary prevention of noncommunicable diseases such as cancer [334]. This would benefit the entire population and could entail that healthy foods are broadly available, affordable, and promoted; that public spaces are conducive to (affordable) physical activity and discourage risk behaviour; and that tobacco and alcohol consumption are not put forward as unavoidable parts of social life. Achieving such a 'culture' change at the macro-level would definitely be most challenging, and may even prove undesirable for federal governments in a context where the sales of high-risk goods (i.e. tobacco, alcohol) yields income from taxes [335].

The findings regarding breast cancer indicate that, although 'overscreening' women for breast cancer (i.e., performing mammograms before the age of 50) is considered an issue with providing adequate health care in Belgium [336], the younger ages at diagnosis for some migrants and the Moroccan premenopausal survival disadvantage require an alternative to organised screening for these women. This idea fits a larger discussion in Belgian cancer policy, namely of implementing specific early detection mechanisms for women at different breast cancer risks in which the GP plays a decisive role [335]. Before such initiatives become common practice, population level initiatives (e.g. through mass media, medical offices) that encourage breast cancer risk awareness without causing undue alarm, complemented with more targeted community-level initiatives, could promote appropriate help-seeking behaviour. The community-level approach might add to federal ones by considering how women of migrant origin shape their help-seeking behaviour when symptoms that may be

indicative of breast cancer are detected. For example, prior research has shown that having previously heard of or discussed breast cancer symptoms in social networks demonstrably encourages help-seeking among women who found symptoms [116,279,337,338]. This knowledge could be applied by sharing information about breast cancer symptoms by community organisations at social events, or in more informal social settings.

On the health system side, literacy and language barriers to help-seeking for some women of migrant origin need to be removed by avoiding sole reliance on written communication in French, Dutch, and German in health promotion messages, and facilitating the use of interpreters at all levels of care. Furthermore, it would be important for care providers to be informed about differing breast cancer risks by origin (i.e., tumour biology, younger ages at diagnosis) and implement this knowledge in their daily practice. Information on site-specific diversity in cancer risks could be included in the 'physician and society' courses in Belgian medical school curricula, but also in continued education programmes for GPs. Moreover, the Belgian Health Care Knowledge Centre guidelines for referring women with breast cancer symptoms from GPs to specialist care (among which there is screening) could include a step in the decision-making tree for referral that requires the physician to consider a woman's migrant and socioeconomic background and how these may impact breast cancer risk [339,340].

As a more general recommendation, assessing how cancer policy initiatives in Belgium affect population subgroups of native Belgian and migrant origin in addition to SEP seems like a requirement for further policy planning. This would be a good addition to the evaluative practices currently performed by the Cancer Centre, especially as the initial Cancer Plan evaluation did not foresee examining the impact of actions and measures on public health [324,335]. Continuing the data linkage between population and cancer registries that has laid the data foundation for this thesis is a prerequisite for an overview of inequalities in cancer and will be a good way

to monitor discrepancies in mortality, incidence, survival and how they change after policy implementations. Adding data about participation in cancer screening programmes by registering country of birth (of the parents) at the level of the screening unit or organisation and centralising the information would also be important. Prior evidence suggest lower screening participation by Turkish and Moroccan women in Flanders and the Brussels Capital Region Table 6.1b [119,120], but there are no administrative data sources to inform policy about actual screening uptake.

Table 6.1a Estimated share of the population that uses tobacco, overconsumes alcohol and consumes five fruits and vegetables a day by country of birth in percentages with 95% confidence intervals, ages 40-69, information from the Health Interview Survey (pooled 1997-2001-2004-2008-2013 waves)

	Current smoker			Heavy smoker*		
Men	Yes N % [95% CI]	No N % [95% CI]	Unknown N % [95% CI]	Yes N % [95% CI]	No N % [95% CI]	Unknown N % [95% CI]
BE	2533 30.0 [28.7,31.4]	4995 61.2 [59.9,62.6]	871 8.7 [8.0,9.5]	977 11.3 [10.5,12.3]	6382 78.1 [77.0,79.2]	1040 10.6 [9.8,11.4]
FR/NL/GE/LU	116 28.5 [22.7,35.2]	222 58.9 [52.0,65.5]	54 12.6 [8.7,17.8]	47 11.6 [7.6,17.1]	286 74.2 [67.6,79.9]	59 14.2 [10.0,19.8]
S-EUR	99 23.3 [18.5,28.8]	203 59.9 [53.5,65.9]	82 16.9 [12.8,21.9]	53 11.5 [8.2,15.9]	248 71.5 [65.7,76.7]	83 17.0 [12.9,22.0]
TU	23 33.5 [20.4,49.7]	33 32.8 [21.8,45.9]	44 33.8 [22.1,47.8]	13 12.0 [5.6,23.9]	42 51.5 [37.5,65.3]	45 36.5 [24.3,50.7]
MO	71 18.8 [13.8,25.1]	140 49.3 [41.3,57.4]	115 31.9 [24.8,39.8]	26 6.2 [3.5,10.5]	179 60.4 [52.4,67.9]	121 33.4 [26.3,41.4]
SSA	14 16.3 [8.3,29.4]	64 67.1 [54.4,77.7]	26 16.6 [10.1,26.0]	5 6.0 [2.4,14.5]	72 76.4 [65.6,84.5]	27 17.6 [10.9,27.2]
Women						
BE	1974 21.9 [20.7,23.0]	6025 69.5 [68.2,70.8]	831 8.6 [7.8,9.5]	750 8.0 [7.3,8.8]	7200 82.7 [81.5,83.7]	880 9.3 [8.5,10.2]
FR/NL/GE/LU	107 24.7 [18.8,31.8]	292 65.8 [58.9,72.1]	66 9.5 [6.8,13.1]	34 7.3 [4.4,11.9]	361 82.5 [77.4,86.7]	70 10.2 [7.4,13.8]
S-EUR	72 19.2 [14.1,25.7]	226 63.2 [56.3,69.5]	74 17.6 [13.3,22.9]	26 4.8 [3.1,7.4]	270 76.3 [70.4,81.3]	76 18.9 [14.3,24.7]
TU	10 8.8 [3.9,18.8]	34 38.9 [27.1,52.3]	55 52.3 [39.3,64.9]	<5 3.5 [0.9,12.2]	40 44.3 [31.9,57.4]	55 52.3 [39.3,64.9]
MO	8 2.2 [1.0,4.7]	158 62.7 [54.4,70.3]	106 35.1 [27.7,43.3]	<5 0.7 [0.2,3.1]	164 64.2 [56.0,71.7]	106 35.1 [27.7,43.3]
SSA	14 8.0 [4.2,14.7]	85 73.2 [63.2,81.3]	27 18.8 [12.0,28.2]	<5 0.7 [0.2,2.6]	97 80.6 [71.2,87.5]	27 18.8 [12.0,28.2]

** smoking 20 or more cigarettes a day; CI: confidence interval; BE: Belgium, FR: France, NL: the Netherlands, GE: Germany, LU: Luxemburg, S-EUR: southern Europe, TU: Turkey, MO: Morocco, SSA: Sub-Saharan Africa*

Table 6.1a (Continued)

	Overconsumption of alcohol*			Five a day		
	Yes	No	Unknown	Yes	No	Unknown
Men	N % [95% CI]	N % [95% CI]	N % [95% CI]	N % [95% CI]	N % [95% CI]	N % [95% CI]
BE	980 11.6 [10.7,12.6]	6283 76.7 [75.5,77.8]	1136 11.7 [10.9,12.6]	192 2.2 [1.8,2.6]	1277 18.0 [16.8,19.2]	6930 79.9 [78.6,81.0]
FR/NL/GE/LU	59 15.7 [11.3,21.4]	267 69.0 [62.4,74.9]	66 15.3 [11.2,20.6]	9 2.1 [0.9,4.7]	83 21.6 [16.6,27.6]	300 76.3 [70.2,81.5]
S-EUR	20 4.8 [2.8,8.0]	278 76.8 [71.2,81.6]	86 18.5 [14.2,23.7]	12 2.0 [0.8,5.1]	53 11.7 [8.5,16.0]	319 86.3 [81.7,89.9]
TU	<5 1.4 [0.4,4.4]	53 64.9 [50.8,76.7]	44 33.8 [22.1,47.8]	<5 4.2 [1.4,11.9]	23 23.1 [13.4,36.8]	73 72.7 [58.9,83.1]
MO	<5 0.2 [0.1,1.0]	198 62.4 [54.1,70.0]	126 37.4 [29.8,45.7]	20 7.9 [4.0,15.2]	73 24.2 [17.2,32.8]	233 67.9 [59.8,75.7]
SSA	7 3.7 [1.6,8.4]	67 73.2 [62.0,82.1]	30 23.1 [14.7,34.4]	5 2.9 [1.1,7.6]	39 31.2 [20.9,43.9]	60 65.9 [53.3,76.6]
Women						
BE	593 6.4 [5.8,7.1]	7127 81.8 [80.7,82.9]	1110 11.8 [10.9,12.8]	259 3.4 [2.8,4.0]	1295 16.9 [15.8,18.0]	7276 79.7 [78.5,80.9]
FR/NL/GE/LU	47 11.7 [7.5,17.8]	335 75.0 [68.4,80.7]	83 13.3 [9.5,18.4]	25 4.0 [2.1,7.4]	72 17.9 [12.9,24.4]	368 78.1 [71.5,83.6]
S-EUR	7 1.4 [0.5,4.5]	288 77.9 [71.6,83.2]	77 20.7 [15.6,26.9]	13 2.9 [1.5,5.6]	39 12.5 [7.8,19.5]	320 84.5 [77.7,89.6]
TU	0	44 46.0 [33.5,59.1]	55 54.0 [41.0,66.5]	<5 3.3 [0.8,12.3]	28 31.5 [20.6,44.9]	68 65.2 [51.8,76.6]
MO	<5 0.5 [0.1,3.5]	160 58.2 [49.3,66.6]	111 41.3 [32.9,50.2]	20 6.3 [3.8,10.2]	59 23.7 [16.0,33.5]	193 70.1 [60.7,78.0]
SSA	7 5.5 [2.3,12.9]	92 75.4 [65.8,83.5]	27 19.1 [12.1,28.9]	7 3.1 [1.4,6.9]	49 42.9 [31.5,55.0]	70 54.0 [42.1,65.4]

** > 14 drinks a week for women, >21 for men; ** eating at least 5 portions of fruits and vegetables a day; CI: confidence interval; BE: Belgium, FR: France, NL: the Netherlands, GE: Germany, LU: Luxemburg, S-EUR: southern Europe, TU: Turkey, MO: Morocco, SSA: Sub-Saharan Africa*

Table 6.1b Estimated share of the population with overweight status, physical activity, and screening attendance by migrant background in percentages with 95% confidence intervals (CI), ages 40-69 or target ages for screening, information from the Health Interview Survey (pooled 1997-2001-2004-2008-2013 waves)

	Overweight*			Physically active**		
Men	Yes N % [95% CI]	No N % [95% CI]	Unknown N % [95% CI]	Yes N % [95% CI]	No N % [95% CI]	Unknown N % [95% CI]
BE	5162 61.7 [60.3,63.1]	3093 36.9 [35.6,38.3]	144 1.3 [1.1,1.7]	2107 27.4 [26.1,28.6]	2801 31.7 [30.4,33.0]	3491 41.0 [39.6,42.2]
FR/NL/GE/L	212 53.5 [46.6,60.3]	178 46.2 [39.4,53.2]	<5 0.3 [0.1,1.0]	90 25.0 [19.6,31.4]	132 31.7 [25.9,38.3]	170 43.3 [36.5,50.3]
S-EUR	248 68.2 [61.9,73.9]	132 31.1 [25.5,37.4]	<5 0.6 [0.2,1.8]	53 14.8 [10.7,20.1]	125 31.9 [26.2,38.3]	206 53.3 [46.7,59.7]
TU	63 65.9 [50.6,78.4]	35 32.4 [20.1,47.9]	<5 1.7 [0.4,7.1]	7 4.2 [1.7,9.8]	32 32.3 [21.2,46.0]	61 63.5 [49.8,75.3]
MO	189 57.8 [49.7,65.6]	127 38.3 [30.9,46.3]	10 3.9 [1.3,10.8]	19 5.1 [2.8,9.3]	109 32.5 [25.4,40.5]	198 62.3 [54.3,69.8]
SSA	62 62.5 [49.6,73.9]	41 37.1 [25.8,50.0]	<5 0.4 [0.1,2.8]	14 14.0 [7.7,24.2]	41 47.9 [35.4,60.6]	49 38.1 [26.8,50.9]
Women						
BE	3826 43.6 [42.2,45.1]	4748 53.7 [52.3,55.1]	256 2.7 [2.3,3.1]	1504 18.5 [17.4,19.7]	3731 40.8 [39.5,42.2]	3595 40.6 [39.2,42.1]
FR/NL/GE/L	176 37.4 [31.3,44.0]	274 59.7 [53.1,66.0]	15 2.8 [1.4,5.5]	72 13.5 [10.0,18.0]	176 42.3 [35.8,49.2]	217 44.2 [37.5,51.1]
S-EUR	180 48.8 [42.0,55.6]	177 46.2 [39.5,53.1]	15 5.0 [2.6,9.4]	40 12.9 [8.5,19.2]	153 45.1 [38.5,51.9]	179 42.0 [35.4,48.7]
TU	74 73.0 [59.1,83.6]	19 16.0 [9.1,26.8]	6 10.9 [3.9,26.9]	<5 4.8 [1.5,14.2]	36 37.9 [26.2,51.2]	60 57.3 [44.2,69.5]
MO	190 72.7 [65.4,78.9]	61 20.8 [15.5,27.4]	21 6.5 [3.6,11.5]	11 6.9 [2.3,19.1]	85 28.0 [21.7,35.2]	176 65.1 [56.4,73.0]
SSA	72 49.3 [38.0,60.7]	49 47.7 [36.3,59.3]	5 3.0 [1.1,8.0]	17 14.5 [7.8,25.2]	53 43.1 [32.0,54.9]	56 42.2 [31.8,53.8]

** BMI>=25; **30minutes of moderate to vigorous leisure time physical activity daily; CI: confidence interval; BE: Belgium, FR: France, NL: the Netherlands, GE: Germany, LU: Luxemburg, S-EUR: southern Europe, TU: Turkey, MO: Morocco, SSA: Sub-Saharan Africa*

Table 6.1b (Continued)

	FOBT last 2 years (50-74)*			Mammography last 2 years (50-69)		
	Yes	No	Unknown	Yes	No	Unknown
Men	N % [95% CI]	N % [95% CI]	N % [95% CI]	N % [95% CI]	N % [95% CI]	N % [95% CI]
BE	259 4.6 [3.9,5.3]	1622 30.7 [29.2,32.3]	4668 64.7 [63.1,66.3]	N/A		
FR/NL/GE/L	18 4.6 [2.4,8.7]	82 27.0 [20.5,34.6]	198 68.4 [60.5,75.4]			
S-EUR	11 2.5 [1.3,4.7]	57 20.2 [14.9,26.7]	233 77.3 [70.8,82.8]			
TU	0	11 26.0 [12.6,46.1]	40 74.0 [53.9,87.4]			
MO	7 2.1 [1.0,4.6]	33 21.1 [12.9,32.5]	143 76.8 [65.6,85.2]			
SSA	6 6.4 [2.7,14.5]	30 58.4 [42.2,73.9]	24 35.2 [21.7,51.6]			
Women						
BE	3204 59.5 [57.7,61.2]	1618 29.2 [27.6,30.9]	704 11.3 [10.3,12.5]	3204 59.5 [57.7,61.2]	1618 29.2 [27.6,30.9]	704 11.3 [10.3,12.5]
FR/NL/GE/L	158 60.6 [51.7,68.8]	77 25.7 [19.2,33.5]	48 13.8 [8.6,21.4]	158 60.6 [51.7,68.8]	77 25.7 [19.2,33.5]	48 13.8 [8.6,21.4]
S-EUR	121 55.0 [46.5,63.1]	48 22.0 [15.8,29.6]	56 23.1 [17.0,30.6]	121 55.0 [46.5,63.1]	48 22.0 [15.8,29.6]	56 23.1 [17.0,30.6]
TU	<5 6.3 [2.2,16.7]	11 37.0 [20.3,57.6]	26 56.7 [36.8,74.7]	<5 6.3 [2.2,16.7]	11 37.0 [20.3,57.6]	26 56.7 [36.8,74.7]
MO	33 19.0 [12.4,28.0]	29 30.1 [19.9,42.9]	76 50.8 [38.6,62.9]	33 19.0 [12.4,28.0]	29 30.1 [19.9,42.9]	76 50.8 [38.6,62.9]
SSA	41 60.6 [45.1,74.1]	14 16.1 [8.3,29.0]	18 23.4 [13.2,37.9]	41 60.6 [45.1,74.1]	14 16.1 [8.3,29.0]	18 23.4 [13.2,37.9]

** FOBT: faecal occult blood test; CI: confidence interval; BE: Belgium, FR: France, NL: the Netherlands, GE: Germany, LU: Luxemburg, S-EUR: southern Europe, TU: Turkey, MO: Morocco, SSA: Sub-Saharan Africa*