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Quantification of disparities in the distribution of lifestyle and metabolic risk factors, prevalence of non-communicable diseases and related mortality: the Belgian Health Interview Surveys 1997–2018

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ABSTRACT

Objectives Comprehensively measure the trends in health disparities by sociodemographic strata in terms of exposure to lifestyle and metabolic risks, and prevalence and mortality of non-communicable diseases (NCDs) during the last 20 years in Belgium.

Design Cross-sectional analysis of periodic national-representative health interview surveys and vital statistics.

Setting Population-based study of adult residents in Belgium between 1997 and 2018.

Participants Adults aged 25–84 years and resident in Belgium in the years 1997 (7256 adults), 2001 (8665), 2004 (9054), 2008 (7343), 2013 (7704) and 2018 (8358).

Main outcome measure Age-standardised prevalence rates of modifiable lifestyle risks (poor diet, smoking, excessive alcohol use and leisure-time physical inactivity), metabolic risks (high body mass index (BMI), blood pressure and cholesterol levels) and major NCDs (type 2 diabetes mellitus (T2DM), cardiovascular diseases (CVDs), cancer, asthma and chronic obstructive pulmonary disease (COPD)), with their relative health disparities across strata by age, sex, region of residence, nationality, education and income level, and according to high versus low engagement in the four lifestyle risks, calculated from a survey-weighted age-adjusted logistic regression.

Results Greater avoidable disparities were observed between extremes of education and income strata. The most marked disparities were found for exposure to lifestyle risks (except excessive alcohol use), prevalence of high BMI as well as T2DM, asthma and COPD, with disparities of daily smoking and COPD worsening over time. Still, NCD-specific mortality rates were significantly higher among men (except asthma), residents of Wallonia and Brussels (except cerebrovascular disease), and among the native Belgians (except T2DM and asthma). High engagement in lifestyle risks was generally observed for men, residents of the region Wallonia, and among lower education and income strata. This subgroup (20%) had a worse health profile as compared with those who had a low-risk lifestyle (25%), shown by prevalence ratios varying between 1.1 and 1.6 for metabolic risks, and between 1.8 and 3.7 for CVD, asthma and COPD.

Conclusions Improving population health, including promoting greater health equity, requires approaches to be tailored to high-risk groups with actions tackling driving root causes of disparities seen by social factors and unhealthy lifestyle.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The identification of the lower education and lower income groups as vulnerable within the Belgian population and the quantification of their health disparity gaps according to their root causes is essential to support equitable health promotion programmes and preventive strategies aiming at more health gains for all.

⇒ We used data of the Belgian Health Interview Surveys, the best available nationally relevant epidemiological evidence from Belgium over the last 20 years, to study disparities in health from lifestyle and metabolic risks to non-communicable disease outcomes.

⇒ From the sociodemographic sources of health disparities, only ageing, an inevitable part of life, poses an unavoidable risk factor for non-communicable diseases, and therefore, equitable health policies for Belgium should account for the general profile of the high-risk groups, as identified by this study, that is, residents with a non-Belgian origin, and the lower-education and lower-income groups.

⇒ The self-reported lifestyle, metabolic risks and prevalence of common non-communicable diseases were likely to be underestimates; as reporting of them is subjected to more than only their actual presence.

⇒ The cross-sectional survey design cannot rule out the possibility of 'reverse causation' where those with prevalent non-communicable disease did show to have less lifestyle risks.

INTRODUCTION

Chronic non-communicable diseases (NCDs), including type 2 diabetes mellitus (T2DM), cardiovascular diseases (CVDs), cancer and respiratory diseases, are the leading causes of morbidity and mortality in Europe with over 90% of all deaths attributed to NCDs, and 86% in Belgium.[1] The onset of NCDs is primarily driven by four major lifestyle risks: unhealthy diets, tobacco use, alcohol use and physical inactivity, all of which are modifiable.[2] These lifestyle risks are the main cause of the rising prevalence of metabolic risks such as high body mass index (BMI), high blood pressure (BP), hyperglycaemia and hypercholesterolaemia leading to the onset of NCDs and a major population health burden.[2]

Monitoring risks and disease prevalence in the population is essential for public health planning. It is particularly relevant for identifying health disparities and less favoured population subgroups, given the urgent need to address health equity, as acknowledged by WHO,[3 4] the European Union (EU)[4 5] and state members such as Belgium.[6 7] Variables such as age,[8] sex,[9] geographical region,[10] nationality[11 12] and socioeconomic status (SES)[10 13] are well-known indicators of health disparities at the population level, as characterised in the EU.[10] In Belgium, health disparities have been consistently monitored over the years for region and educational level, with overall less prevalent NCDs risks and outcomes for residents of Flanders and the higher educated.[14 15]

While these sociodemographic risk factors are non-modifiable (eg, age and sex) or difficult to change (eg, SES), other risk factors, such as lifestyle choices and associated metabolic conditions, offer an additional opportunity for NCD risk stratification. Such a risk stratification assessment is likely to be the most effective in primary care settings either using risk charts, like WHO CVD risk charts,[16] and/or clinical knowledge,[17 18] including an emphasis on the assessment of risk factors susceptible to be improved.[19] In particular, healthier lifestyle choices prior to diagnosis have been shown to be strongly associated with a lower incidence of multimorbidity of cardiometabolic diseases and cancer,[20] implying that lifestyle-based interventions can, when appropriately accounting for SES, indirectly address disparities in the pursuit of health equity. Lifestyle choices, however, tend to cluster, that is, most individuals engage in multiple lifestyle risks: poor diet, smoking, excess alcohol and physical inactivity,[21] with this accumulation of lifestyle risks having strong implications for living a longer life in good health.[22 23] Defining health disparities in terms of engagement to multiple lifestyle risks offers an additional perspective into identifying high-risk stratum for priority action. The comprehensive understanding of who is at risk and which lifestyle risks more frequently cluster would certainly support tailored health promotion programmes, aiming at more health gains.

To identify and quantify all relevant health disparities in Belgium, this study aims to provide a clear and comprehensive overview of the health status, from lifestyle risks to NCDs, by relevant population strata of socio-demographic factors as well as by engagement in multiple lifestyle risks, using nationally relevant epidemiological evidence from Belgium over the last 20 years.

METHODS

Data sources

Belgian Health Interview Surveys

The Belgian Health Interview Surveys (BHIS) is a cross-sectional study, conducted by Sciensano, carried out periodically every 4–5 years since 1997 and including approximately a sample of 10 000 participants per survey wave, representative of Belgian residents. Briefly, participants were selected from the Belgian national population register through a multistage stratified population sampling involving a geographical stratification according to the regions, and subsequently, a selection of municipalities within provinces, households within municipalities and a maximum of four respondents within households was applied. Data were collected through face-to-face interview at the participant's home covering demographics, specific diseases and conditions, and nutritional status, and a self-administered questionnaire covering more sensitive topics, such as health behaviours and lifestyle. Survey weights were designed and applied to ensure the representativeness of the sample in terms of age, sex and province. Further details on the BHIS are described elsewhere.[24–26]

The present analyses included adults aged between 25 and 84 years. Participants younger than 25 years were excluded from the analysis since a large proportion achieved their highest educational level by the age of 25, and aged 85 years and older since a large proportion of them are institutionalised and the surveys did not include these people. The final sample included 7256 adults in the year 1997, 8665 in 2001, 9054 in 2004, 7343 in 2008, 7704 in 2013 and 8358 in 2018.

Standardised procedures for mortality analysis

Standardised procedures for mortality analysis (SPMA), operational since the early 1990s, was developed by Sciensano with the aim to facilitate the use of vital statistics data for public health policy and scientific research.[27] From 1998 up to 2017, cause-specific mortality data were coded by the International Classification of Diseases (ICD)-10 using the initial cause of death only, and grouped by age, sex, region of residence and nationality. Data from 1998 were used as a proxy for the year 1997 so that cause-specific mortality could be coded using ICD-10 for all years included in the analyses, and similarly, data from 2017 as a proxy for the year 2018.

Patient and public involvement

As a secondary data analysis of the BHIS, this study did not involve patients/participants or the public in the design, conduct or dissemination plans.

Health outcomes measures

Lifestyle risks

Data on dietary habits, smoking status, alcohol consumption and physical activity were self-reported in the BHIS. Consumption of fruits (excluding juice) and vegetables (including salad and excluding potatoes or juice) was assessed based on questions related to their daily intake. A non-daily consumer was defined as a participant reporting, at the time of the interview, a frequency of 4–6 times a week or less. Similarly, daily consumption of sweet or salty snacks and sugar-sweetened beverages (SSBs) was assessed based on a consumption frequency of one serving or more a day. Current smoking was defined as smoking at least 100 cigarettes in lifetime and currently being a daily smoker. Alcohol consumption was assessed based on questions related to consumption frequency and the average number of drinks across weekdays and during weekends, and excess was defined as drinking more than 15 and 22 servings per week for women and men, respectively, following WHO indicators. For physical inactivity, a dichotomous categorical variable was created to differentiate between having sufficient physical activity and being at risk of physical inactivity during leisure time based on a description of the leisure time activities: hard training and competitive sports more than once week, jogging and other recreational sports or gardening at least 4 hours a week; jogging and other recreational sports or gardening at most 4 hours a week; walking, bicycling or other light activities at least 4 hours a week; walking, bicycling or other light activities at most 4 hours a week; or reading, watching TV or other sedentary activities, following WHO indicators.

Clustering of the lifestyle risks was summarised as a composite index (online supplemental table 1). Each lifestyle risk factor was scored from 1 to 5, with higher points indicating the highest risk, as follows: dietary risks (non-daily fruit, non-daily vegetables, daily snacks and daily SSBs, four present=5, three=4, two=3, one=2, none=1); smoking (current heavy smoker=5, current non-heavy/occasional smoker=4, former smoker quitting <10 years ago=3, former smoker quitting ≥10 years ago=2, never smoked=1); alcohol consumption (≥22 servings a week=5, 15–21=4, 8–14=3, 1–7=2, occasional drinkers/abstainers=1); physical inactivity (sedentary activities=5, leisure time sport <4 hour a week or light activities=3, intensive training or leisure time sport ≥4 hours a week=1). The index ranged from 4 to 20, and was for the analyses further categorised into high engagement (12–20) vs low (4–7). Lifestyle risk index was calculated for the years 2013 and 2018, as dietary data were not available for previous years.

Metabolic risks

BMI was calculated as self-reported body weight divided by self-reported body height squared, using BMI ≥25 kg/m^2 for overweight and ≥30 kg/m^2 for obesity. Information on prevalent high BP (systolic BP ≥140 mm Hg or diastolic BP ≥90 mm Hg) and high cholesterol levels (total cholesterol ≥190 mg/dL) was self-reported by providing participants with a list of clinical conditions for which they had to specify whether they had each clinical condition in the past 12 months.

Prevalence of NCDS

Similarly, data on the prevalence of NCDs were self-reported collected using a list of chronic diseases for which participants had to specify whether they had each chronic disease in the past 12 months. This study reported on the prevalence of T2DM (ICD-10: E11), myocardial infarction (ICD-10: I21–I22), coronary artery disease (ICD-10: I20), cerebrovascular disease (ICD-10: I60–I69), other serious heart diseases (ICD-10: I30–I52), cancer (ICD-10: C00–D49), asthma (ICD-10: J45–J46) and chronic bronchitis/chronic obstructive pulmonary disease (COPD) or emphysema (ICD-10: J40–44, J47).

NCDs-specific mortality

Using the predefined procedures accessible from SPMA, age-standardised mortality rates per 100 000 were retrieved using ICD-10 codes for T2DM (E10–E14), coronary artery disease (I20–I25), cerebrovascular disease (I60–I69), cancer (C00–D48), asthma (J45–J46) and chronic lower respiratory diseases (J40–J44, J47) were obtained with comparisons made by sex, region and nationality.

Population stratification

To describe potential health disparities across the Belgian population, the following sociodemographic determinants of health were selected: 10-year age group, sex, region of residence, nationality, education and income. Educational level was based on the highest level of education attained in the household and was recoded into three categories: low (primary education or less), intermediate (lower and higher secondary education) and high (higher education). Income level was based on the household's total available income and recoded into five quintiles. Additionally, the population was further stratified by lifestyle risk index: high versus low engagement in lifestyle risks, as an additional layer of potential health disparities.

Data analyses

Annual descriptive statistics were represented as weighted proportions of the characteristics of the survey participants as a whole per survey year. Age-standardised prevalence rates were computed by levels of the population stratification variables using direct standardisation with the Belgian population of 2018 as reference. Health disparities were calculated by direct comparison between population strata: age (oldest, that is, aged 75–84 years, vs youngest, that is, aged 25–34 years), sex (women vs men), region (Walloon vs Flanders, Brussels vs Flanders), nationality (non-Belgian Europeans vs Belgians, non-Europeans vs Belgians), educational level (low vs high), income (low vs high) and engagement in lifestyle risks (high vs low). The disparities by age for metabolic risk and NCD prevalence were mainly included to assess their

time trends, that is, narrowing disparities over time would suggest their onset occurred at a sooner age than before.

Health disparities were reported as prevalence ratios (PRs),widely known as relative risks, between the age-standardised prevalence between two levels of the population stratification variables; with the estimated PRs and their uncertainty (95% CI) calculated using a survey-weighted logistic regression model, and adjusting for age and using the STATA postestimation command adjrr.[28] The 20-year trend was tested by including an interaction term between time and the population stratification variable in the models, and p-values for this interaction term were reported. We only analysed outcomes for which at least 20 survey participants in any specific strata reported having the outcome of interest. Additionally, we measured health disparities by sociodemographic factors in absolute terms, using prevalence differences, commonly known as risk differences (RD), between two levels of the population stratification variables. To explore the role of individual lifestyle risks, independently of others, relative health disparities were estimated for having that lifestyle risk vs not (reference).

Clustering of lifestyle risks was described using Spearman's rank correlation coefficients (P) with p-values adjusted for multiple testing according to Sidak. Such clustering was quantified using prevalence odds ratios (ORs), as estimated from a survey-weighted generalised ordered logistic regression model using the gologit2 command in STATA with the autofit function that identifies the partial proportional odds model that appropriately fits the data,[29] with separate models for each lifestyle risk related to the other risks. To enhance interpretation of results, we only presented prevalence ORs and their 95% CI for the extremes, that is, estimates belonging to the comparisons between a score of 5 (high engagement in a lifestyle risk) versus 1 (low; reference), for having a higher score than 1 on the lifestyle risk of interest.

All analyses were conducted using STATA/SE V.16, and a p-value of 0.05 was considered as statistically significant with no adjustment for multiple comparisons for quantification of health disparities.

RESULTS

An overview of the general characteristics of the study population across the six available surveys is presented in table 1, including prevalence estimates for the lifestyle and metabolic risks, chronic diseases and NCD-specific mortality.

Relative health disparities by sociodemographic population strata

For all population strata, the relative health disparities were generally more pronounced for lifestyle risks and NCDs (figure 1; and online supplemental table 2).

Exposure to lifestyle risks was observed to be generally higher in young adults and among men (except for daily snacking and leisure-time physical inactivity), residents of Wallonia compared with those of Flanders (except for daily snacking), Belgian nationals (except for non-daily vegetables and leisure-time physical inactivity), the lower education and the lower income group (except for daily snacking and excessive alcohol use). Relative disparities in lifestyle risks were the largest for daily smoking by age (PR 0.22, 95% CI 0.13 to 0.36), educational level (PR 2.7 1, 95% CI 2.22 to 3.32) and income level (PR 2.96, 95% CI 2.29 to 3.81) as well as for non-daily vegetables by educational level (PR 2.03, 95% CI 1.76 to 2.35) and income level (PR 2.72, 95% CI 2.20 to 3.36). Over time, the health disadvantages in lifestyle risks were increasing for the lower education and lower income groups for daily smoking (figure 2A).

Moreover, the prevalence of overweight and obesity was observed to be significantly higher with advanced age groups, among men (only overweight), among residents of Wallonia, non-European residents, and the lower education and lower income groups, with significantly increasing disparities for the non-Europeans reaching a PR of 1.18 (95% CI 1.06 to 1.31) for overweight in 2018 (figure 2B). Disparities were the largest for obesity by educational level (PR 1.81, 95% CI 1.52 to 2.14), followed by income level (PR 1.65, 95% CI 1.27 to 2.14) and age (PR 1.64, 95% CI 1.19 to 2.25) as well as nationality (PR for non-Europeans: 1.36, 95% CI 1.03 to 1.77). A significantly higher prevalence of the metabolic risks of high BP and high cholesterol levels was observed for advanced age, men (only cholesterol levels), and the lower education and lower income groups, presenting for the low income groups an increase in the relative disparities of high BP up to a PR of 1.48 (95% CI 1.19 to 1.84) in 2018 (figure 2B).

The NCD prevalence was significantly higher with advanced age, among men (except for cancer, asthma, chronic bronchitis, COPD or emphysema), among residents of Wallonia and Brussels (except for CVD and cancer), among the low educated (except for CVD and cancer) and the lower income groups (except for CVD), with over 20 years' time reducing disparities in age for asthma and in Brussels for cancer, but worsening disparities by income levels for chronic bronchitis, COPD or emphysema (figure 2C). Relative disparities in NCD prevalence were the largest for T2DM by nationality (PR for non-Europeans: 2.20, 95% CI 1.51 to 3.22) and by income (PR 2.11, 95% CI 1.36 to 3.27) as well as for chronic bronchitis, COPD and emphysema.

The NCD-specific mortality rates were significantly higher among men (except for asthma), residents of Wallonia and Brussels as compared with those of Flanders (except for cerebrovascular disease), and among the native Belgians (except for T2DM and asthma).

Absolute health disparities by sociodemographic population strata

Measuring this on an absolute scale did not alter conclusions (online supplemental table 3). Similarly, when using absolute differences, health disparities were the

Table 1 Characteristics (weighted %) of the Belgian population, aged 25–84 years, according to survey year

No of individuals	Year of the survey						P trend*
	1997	2001	2004	2008	2013	2018	
	7256	8665	9054	7343	7704	8358	
	(%)	(%)	(%)	(%)	(%)	(%)	
Sociodemographic factors							
Age groups							<0.001
25–34 years	26.1	20.6	19.8	18.8	18.5	19.1	
35–44 years	21.0	19.5	19.1	18.3	17.1	15.7	
45–54 years	20.1	19.4	19.6	20.2	20.4	19.2	
55–64 years	15.7	16.9	17.5	19.0	20.1	21.4	
65–74 years	12.1	14.8	15.9	13.8	14.1	15.4	
75–84 years	4.9	8.8	8.9	9.9	9.9	9.2	
Sex, men	49.7	48.4	48.3	48.2	48.8	48.6	0.236
Region of residence							0.650
Flanders	57.8	58.4	58.3	58.8	57.6	56.7	
Brussels	10.7	9.9	10.0	10.3	10.7	10.1	
Wallonia	31.6	31.7	31.7	30.9	31.7	33.2	
Nationality							<0.001
Belgians	90.8	93.2	92.0	91.4	89.4	88.6	
Non-Belgian Europeans	5.6	4.6	5.0	5.9	6.4	6.6	
Non-Europeans	3.5	2.2	2.9	2.7	4.2	4.8	
Educational level							<0.001
Low	33.7	37.2	33.5	28.8	24.1	29.1	
Intermediate	32.5	30.2	30.8	32.7	33.5	32.0	
High	33.8	32.5	35.7	38.5	42.4	48.4	
Income level							<0.001
Quintile 1	20.4	20.2	19.4	17.9	16.6	11.8	
Quintile 2	19.7	19.0	18.9	17.8	17.0	15.1	
Quintile 3	22.2	19.6	20.0	21.3	21.0	19.9	
Quintile 4	19.6	20.8	19.9	16.8	21.0	25.9	
Quintile 5	18.1	20.4	21.8	26.2	24.2	27.3	
Lifestyle risks†							
Dietary risks							
No daily fruits					43.9	44.1	0.810
No daily vegetables					20.4	23.2	0.004
Daily snacking					37.0	34.5	0.027
Daily SSBs					22.6	19.8	0.008
Daily smoking	25.1	23.5	23.4	20.5	19.2	16.1	<0.001
Excessive alcohol use	7.1	9.7	9.0	8.2	6.8	6.2	<0.001
Leisure time physical inactivity	35.1	36.8	28.1	29.4	28.2	29.0	<0.001
Metabolic risks†							
Overweight, BMI ≥25 kg/m^2	45.4	48.8	48.1	50.9	51.7	52.7	<0.001
Obesity, BMI ≥30 kg/m^2	12.1	13.6	14.2	15.1	15.2	17.4	<0.001
High blood pressure	12.9	16.7	17.8	18.6	19.2	20.5	<0.001
High cholesterol					19.1	20.2	0.334
NCD prevalence†							

Continued

Table 1 Continued

No of individuals	Year of the survey						P trend*
	1997	2001	2004	2008	2013	2018	
	7256	8665	9054	7343	7704	8358	
	(%)	(%)	(%)	(%)	(%)	(%)	
Type 2 diabetes mellitus	3.3	4.0	5.0	4.9	6.4	6.9	<0.001
Cardiovascular diseases					4.6	5.3	0.203
Myocardial infarction				0.8	1.1	0.8	0.845
Coronary heart disease				2.4	1.5	1.3	<0.001
Heart disease					2.3	3.5	0.002
Cerebrovascular disease	0.9	0.7	0.8	1.2	1.0	0.9	0.766
Cancer	1.5	1.9	1.4	2.5	2.3	2.8	0.001
Asthma		4.8	4.4	4.3	4.5	5.7	0.071
Chronic bronchitis/COPD or emphysema		6.5	6.3	4.3	4.3	4.4	<0.001
NCD-related mortality rates (per 100 000) attributed to							
Diabetes	19.3	16.7	17.1	16.4	12.8	10.6	0.024
Coronary artery disease	159.5	137.4	124.2	92.9	67.5	55.9	0.009
Cerebrovascular disease	90.0	79.2	73.4	60.5	48.1	42.8	0.009
Cancer	378	351	330	324	303	274	0.060
Asthma	4.63	3.96	2.33	1.34	1.25	0.87	0.009
Chronic bronchitis/COPD or emphysema	64.5	54.7	50.2	46.9	43.1	38.0	0.009

*P trend calculated using the p value of corrected weighted Pearson χ^2 statistic for sociodemographic factors, the p-value of the time term in a survey-weighted logistic regression for lifestyle and metabolic risks and NCD prevalence, and the p-value of Mann-Kendall trend test for NCD-related mortality rates.
†Self-reported prevalence of lifestyle and metabolic risks and NCDs.
BMI, body mass index; COPD, chronic obstructive pulmonary disease; NCD, non-communicable disease; SSBs, sugar-sweetened beverages.

most pronounced for age, education and income strata, with the highest disparities seen for lifestyle and metabolic risks, but not for prevalent NCDs related to their low prevalence in the general population. In particular, absolute disparities in lifestyle risks were the largest for dietary risks by age (RD non-daily fruit: −25%, 95% CI −31% to −19%; RD daily SSBs: −20%, 95% CI −25% to 16%), by income (RD non-daily vegetables: 24%, 95% CI 19% to 29%) as well as for leisure-time physical inactivity by age (RD 22%, 95% CI 15% to 28%), by education (22%, 95% CI 17% to 26%) and income (22%, 95% CI 16% to 28%) and for daily smoking by income (RD: 21%, 95% CI 16% to 28%). Moreover, large absolute disparities for overweight were observed for age (RD: 21%, 95% CI 15% to 27%), sex (RD: −14%, 95% CI −17% to −11%), nationality (RD for non-Europeans: 9.2%, 95% CI 3% to 16%), educational level (RD 17%, 95% CI 13% to 21%), and income level (RD: 11%, 95% CI 6% to 17%), while lower than 5% for other metabolic risks and NCD prevalence, except for income groups (RD high BP 8.1%, 95% CI 3.4% to 13%; RD high cholesterol: 7.0%, 95% CI 2.3% to 12%; chronic bronchitis, COPD or emphysema: 9.1%, 95% CI 6.2% to 12%) and for non-European and diabetes (RD 7.5%, 95% CI 2.5% to 13%).

Clustering of lifestyle risks

One-fifth was engaged in multiple lifestyle risks of poor diet, smoking, excessive alcohol use and physical inactivity, while one-fourth reported an overall healthy lifestyle (online supplemental table 4). High engagement in multiple lifestyle risks was most frequent among men (65%), residents of Wallonia (37%), the lower education (62%) and the lower income strata (17%) with their multiple risks mainly characterised by non-daily intakes of fruit (76%), daily snacking (43%), current smoking (69%) and physical inactivity (61%), but no distinct pattern of alcohol consumption.

Belgian residents with at least one dietary risk were slightly more likely to be physically inactive, heavy smokers, and heavy drinkers, with former or current smokers also more likely to be heavy drinkers and physically inactive, but heavy drinkers less likely to be physically inactive (online supplemental table 5). The odds of having at least one dietary risk was higher for heavy smokers (OR 3.17; 95% CI 2.54 to 3.95; table 2), and for the physically inactive (OR 1.45; 95% CI 1.24 to 1.69). Similarly, the odds of being a former or current smoker was higher when having four dietary risks (OR 2.84; 95% CI 1.87 to 4.25), for heavy drinkers (OR 4.75; 95% CI 3.61 to 6.25) and

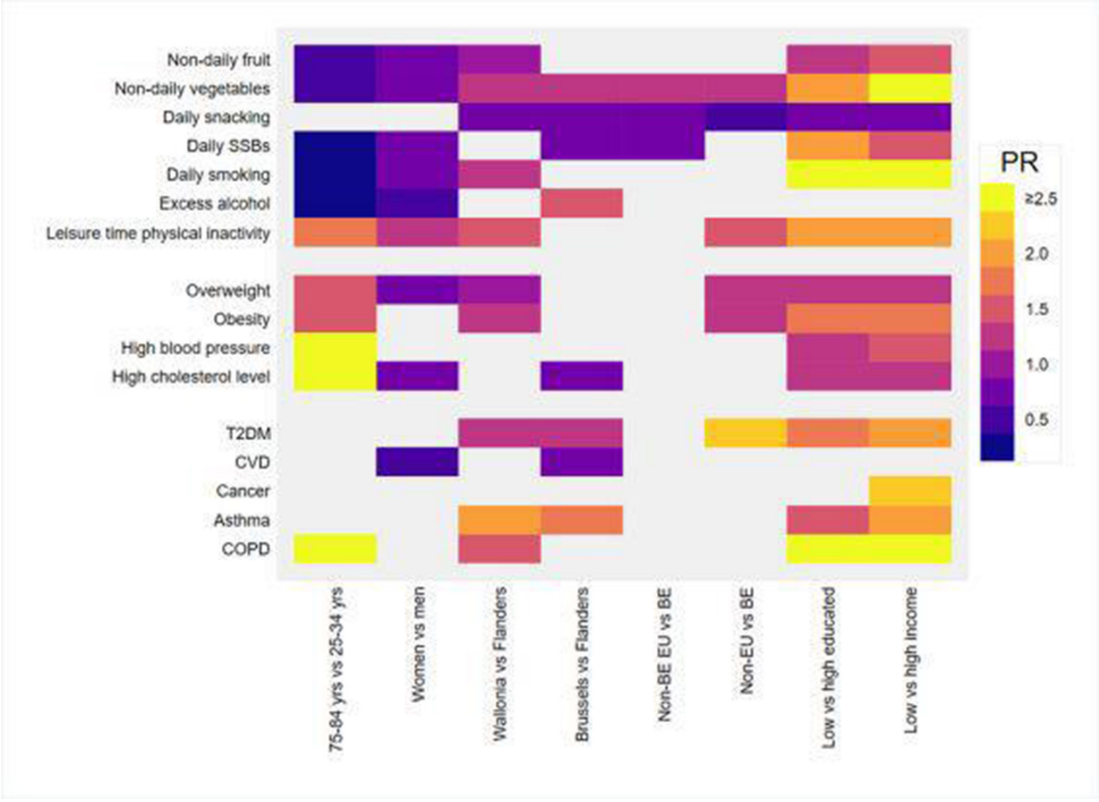

Figure 1 Heatmap of the relative health disparities, expressed in age-standardised prevalence ratios between distal groups, from lifestyle and metabolic risks to non-communicable diseases according to sociodemographic strata in 2018 in Belgium. Colours depicted the strength of the disparity with the more yellow representing a higher prevalence of poor health in the index group as compared with the reference group, and the more blue a higher prevalence of poor health in the reference group as compared with the index group. Empty boxes represents the non-significant estimates or the non-estimable estimates because too few cases. COPD, chronic obstructive pulmonary disease, also including chronic bronchitis, emphysema in the present analyses; CVD, cardiovascular disease; EU, European Union; PR, prevalence ratio; SSBs, sugar-sweetened beverages; T2DM, type 2 diabetes mellitus.

for the physically inactive (OR 1.39; 95% CI 1.18 to 1.64). The odds of being a frequent (at least weekly) drinker was only higher for heavy smokers (OR 2.45, 95% CI 1.95 to 3.08). Lastly, the odds of being at most light physically active was higher for heavy smokers (OR 2.17; 95% CI 1.73 to 2.72), but lower for heavy drinkers (OR 0.60; 95% CI 0.46 to 0.78).

The prevalence of metabolic risks and NCDs were higher among individuals with high engagement in multiple lifestyle risks (table 3). In 2018, relative disparities were significantly varying between 1.13 (95% CI 1.02 to 1.25) and 1.56 (95% CI 1.29 to 1.87) for metabolic risks, and between 1.75 (95% CI 1.12 to 2.72) and 3.69 (95% CI 2.18 to 6.28) for CVD, asthma and COPD, with only high cholesterol levels significantly higher in 2018 than in 2013. Focusing on individual lifestyle risks, the prevalence of high BMI, T2DM and CVD was more frequently reported for abstainers/occasional drinkers and the non-physically active, independently of age, sex and other lifestyle risks, with the prevalence of T2DM also more frequently reported when having none dietary risks, and of CVD and COPD more frequently for former and current smokers (online supplemental table 6).

DISCUSSION

Using nationally representative data of Belgium, we identified the population strata where health disparities are present, and we traced the evolution of these disparities over 20 years. Older age, lower education and lower income strata were the most affected by unfavourable health. For the latter two strata, we also observed a greater prevalence of engagement in multiple lifestyle risks, with their disparities worsening over time. Multiple lifestyle risks were also more prevalent in men, and the region of Wallonia. Still, NCD-specific mortality rates were significantly higher among men (except for asthma), residents of Wallonia, and Brussels (except for cerebrovascular disease), and among native Belgians (except for T2DM and asthma).

The socioeconomic distribution of health as reported in this study corroborates earlier surveillance findings from western countries, including Belgium,[14 15] as operationalised by highest educational attainment. The inverse education-health gradients are a long-lasting universal phenomenon in Europe with widening disparities for common chronic diseases,[30] self-assessed health[31] and mortality.[32] Following earlier observations,[33] results of this

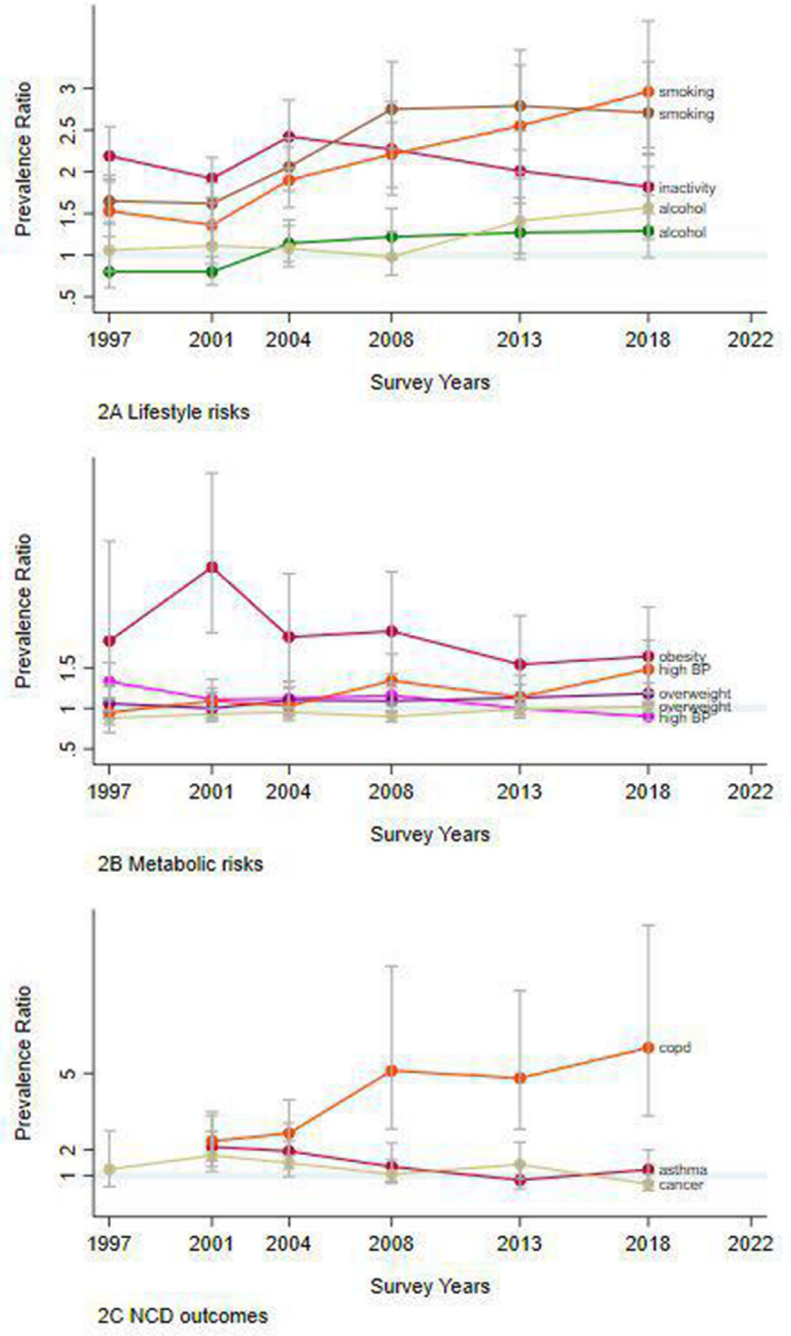

Figure 2 Significant 20-year time trends in the relative health disparities, expressed in age-standardised prevalence ratios (PRs) between distal groups calculated from periodic national-representative health interview surveys, from lifestyle risks to non-communicable diseases according to sociodemographic strata, from 1997 until 2018 in Belgium. 75–84 vs 25–34 years; Women vs men; Wallonia vs Flanders; Brussels vs Flanders; Non-Belgian Europeans vs Belgians; Non-Europeans vs Belgians; Low vs high educated; Low vs high income group. Grey horizontal gridline indicate the null-value, that is, no disparity between index and reference group. Omitted from the graphs are the significant 5-year changes in relative health disparities for diet (ie, a widening gap for non-daily vegetables and daily snacking in the Belgians as compared with the non-Europeans, for non-daily fruits and vegetables in the low income group as compared with high income group), and for high cholesterol and cardiovascular disease (ie, both reversing the relative disparities between Brussels and Flanders, with in 2018 higher prevalence in Flanders). (A): lifestyle risks; (B): metabolic risks; (C): non-communicable diseases. COPD, chronic obstructive pulmonary disease; CVD, chronic obstructive pulmonary disease; EU, European Union; SSBs, sugar-sweetened beverages; T2DM, type 2 diabetes mellitus.

study also confirmed that at present engagement in lifestyle risks remained more frequent for the low educated, and because of the mediating role of health illiteracy, that is, insufficient knowledge, motivation and competence to make appropriate health decisions, likely to persist.[34 35] Using education as a single indicator of socioeconomic

Table 2 Clustering of lifestyle risks in the Belgian population, aged 25–84 years, in 2013 and 2018*

Clustered with		Dietary risks	Smoking	Excessive alcohol use	Physical inactivity
		At least one dietary risk	Former or current smoking	At least weekly drinking	At most lightly active
Diet	ρ (p value)				
	No dietary risks		Reference	Reference	Reference
	Four dietary risks		2.82 (1.87; 4.25)	0.94 (0.61; 1.45)	1.08 (0.58; 2.00)
Smoking	ρ (p value)	0.160 (<0.001)			
	Never smoked	Reference		Reference	Reference
	Heavy smokers	3.17 (2.54; 3.95)		2.45 (1.95; 3.08)	2.17 (1.73; 2.73)
Alcohol	ρ (p value)	0.003 (0.998)	0.189 (<0.001)		
	Abstainers/occasional	Reference	Reference		Reference
	Heavy drinkers	1.03 (0.83; 1.28)	4.75 (3.61; 6.25)		0.60 (0.46; 0.78)
Physical inactivity	ρ (p value)	0.122 (<0.001)	0.071 (<0.001)	–0.128 (<0.001)	
	Very active	Reference	Reference	Reference	
	Sedentary	1.45 (1.24; 1.69)	1.39 (1.18; 1.64)	0.36 (0.30; 0.43)	

*Clustering described using ρ, Spearman's rank correlation coefficient with p-value adjusted for multiple testing according to Sidak, and quantified using prevalence ORs with 95% CIs for the extremes, that is, estimates belonging to the comparisons between high engagement in a lifestyle risk versus low engagement (reference), for having a higher score than one on the lifestyle risk of interest.

position at the individual level, however, captures only the knowledge-related assets of the socio-economic stratification, disregarding the full understanding of the existing health disparities by ranks in a society.[36] In our study, health disparities by education resemble well those by income, though slightly more pronounced for income. This suggests that both the social and financial resources provided by education and income, respectively, play a key role in a healthy lifestyle, and thereby delaying the onset of metabolic conditions and NCDs.

Table 3 Prevalence (weighted %) of and relative disparities (age-standardised prevalence ratios) in health from metabolic risks to NCDs according to the level of engagement in multiple lifestyle risks for the Belgian population, aged 25–84 years*†

	2013		2018		Relative difference		
	High	Low	High	Low	2013	2018	P change‡
Metabolic risks							
Overweight, BMI ≥25	52.3	43.8	54.5	46.0	1.10 (0.97; 1.24)	1.13 (1.02; 1.25)	0.649
Obesity, BMI ≥30	14.4	10.6	20.2	13.2	1.36 (1.01; 1.83)	1.56 (1.22; 1.98)	0.328
High blood pressure	17.6	15.4	20.1	16.9	1.12 (0.87; 1.42)	1.29 (1.06; 1.57)	0.305
High cholesterol levels	19.3	16.7	23.8	16.3	1.11 (0.88; 1.39)	1.56 (1.29; 1.87)	0.020
NCDs							
T2DM	4.3	3.8	5.9	5.3	1.07 (0.65; 1.75)	1.22 (0.83; 1.79)	0.619
CVD	6.0	2.2	5.1	2.7	2.53 (1.39; 4.60)	1.94 (1.21; 3.12)	0.488
Cancer	1.6	1.5	2.8	1.9	1.31 (0.61; 2.81)	1.83 (0.89; 3.73)	0.468
Asthma	5.2	4.8	6.6	4.1	1.06 (0.59; 1.88)	1.75 (1.12; 2.72)	0.260
COPD	7.9	1.6	7.4	2.1	5.54 (3.03; 10.1)	3.69 (2.18; 6.28)	0.406

*Engagement in multiple lifestyle risks was summarised in a composite index of four lifestyle risk factors: diet, smoking, alcohol and physical inactivity (see online supplemental table 1), with each of them scored from 1 to 5, and higher points indicating lifestyle risk present for diet (ie, non-daily fruit and vegetables, and daily snacking and sugar-sweetened beverages), smoking (ie, a heavy smoker), alcohol (ie, excessive alcohol use), physical inactivity (ie, sedentary leisure-time activities). The index ranged from 4 (minimal engagement in lifestyle risks) to 20 (maximal engagement), and was further categorised for the analyses into high engagement in lifestyle risks (12–20) vs low (4–7).
†Adjusted for age and sex.
‡The p-value of time×strata interaction term in a survey-weighted age-adjusted logistic regression model.
BMI, body mass index; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; NCDs, non-communicable diseases; T2DM, type 2 diabetes mellitus.

We used the most simple absolute and relative measures of disparities in health to illustrate the existing disparities in Belgium, and in this way avoid the value-laden of an arbitrary choice. Our findings might be limited by participants' self-reporting. Reporting risks and diseases is subjected to not only the actual presence of it, but also participant-related characteristics like health knowledge, ability to recall, willingness to report, and in case of health problem, frequency of contact with physician and disadvantages experienced in everyday life. This shortcoming of self-reports has been acknowledged by the first Belgian Health Examination Survey (BELHES), conducted for the first time by Sciensano in 2018.[37] Early findings of the BELHES showed that one-third of the population suffers from high BP, half from high cholesterol levels and one-tenth from T2DM, while according to the self-reports only 15%, 20% and 6%, respectively.[38] This potential bias might differentially affect our population strata, with a misclassification likely to occur to a larger extent in the most disadvantaged group, leading to an underestimation of the true disparity. Besides, our findings provide a general profile of the high-risk groups, and therefore, cannot be directly extrapolated to all individuals belonging to certain strata, for example, within the low educated prevalence of risks and outcomes might differ not only by age group and sex,[30] but also by background psychosocial factors, such as marital status, household composition, social support and job strain, that may operate in the pathway between socio-demographic factors and NCD outcomes.[39] Furthermore, this study could not address the differential mortality by SES indicators because of the impossibility of individual linkage of census data with the most recent BHIS, as previously done.[40]

In cross-sectional studies, there is a potential bias for reverse causality bias, potentially explaining our contraintuitive finding of a higher reported T2DM prevalence when having none dietary risks and being abstainers/occasional drinker, since among those with T2DM around 60% of them followed a diet for this condition, as also inquired by the BHIS. While excessive alcohol use (ie, drinking very high amounts of alcohol weekly) is a well-recognised risk factor for NCDs, the light-to-moderate levels of alcohol consumption remain controversial.[41] In fact, zero consumption is nowadays ever more regarded as the consumption amount fitting a healthy lifestyle, since estimated protective effects for some health conditions at low levels are outweighed by increased risks of other health-related harms, including cancer.[42]

Our study implies that over a wide range of risk and health indicators important population strata to target are the elderly, the low educated, the low income strata and the immigrants, of which only the former is an unfortunately unavoidable disparity difficult to argue to be unjust.[43] Narrowing the disparities by socioeconomic position and nationality should be the focus of health policy programmes, likely with interventions based on the principles of proportionate universalism,[44] that is, a universal action with a targeted intervention component tailored to tackle the driving root causes either simultaneously or sequentially, with due consideration to the upstream determinants of health that may lie outside the health sector (eg, illiteracy, unemployment, the barrier to healthcare consumption).[45]

CONCLUSION

In conclusion, health status is not only a product of individual choice but also related to the population strata where a person belongs to, with this defined particularly by the socio-demographic factors influencing lifestyle. In addition, the tendency of lifestyle risks to cluster strengthens the need for health promotion programmes that tailor multiple targets and aim at reaching the socioeconomic disadvantaged for narrowing health disparities.

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Patient consent for publication Not applicable.

Ethics approval The consecutive Belgian Health Interview Surveys have been approved by the Privacy Commission and the Ethical Committee of Ghent University Hospital, which guarantees that the survey procedures are in line with the privacy legislation, and participants gave informed consent before taking part. The current study obtained ethics approval from the Institutional Review Board of the Institute of Tropical Medicine, Antwerp, Belgium (1366/20).

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Data availability statement Data are available in a public, open access repository. Data may be obtained from a third party and are not publicly available. Data of the Health Interview Surveys, conducted by Sciensano, are not publicly available, but access to data is possible through request to the Privacy Commission. More information can be retrieved via https://his.wiv-isp.be/SitePages/Home.aspx. Also, publicly available datasets were utilized in this study: Standardised Procedures for Mortality Analysis – Belgium (SPMA), developed by Sciensano, accessible via https://spma.wiv-isp.be/SitePages/Home.aspx.

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