Sport as a medicine for health and health inequalities

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Chapter 5. Sport participation and socioeconomic inequalities in health care costs

How are sport and other lifestyle factors associated with socioeconomic differences in health care costs?[4]

Abstract

Objective: There is a strong socioeconomic gradient in health care costs. However, little is known about the role of lifestyle factors in the association between health care costs and socioeconomic status (SES). This study investigates variation in the association between lifestyle indicators and health care costs between and within neighborhoods with similar SES.

Methods: Using 2016 whole-population data for all 790 neighborhoods of the Netherlands, we estimated the association between neighborhood average health care cost performance (i.e., health care costs adjusted for population age and gender) and neighborhood socioeconomic status (NSES) and four lifestyle indicators – smoking, alcohol consumption, physical activity and sport club membership. Additionally, using regression analysis, we explored the multivariate relationship between average health care cost performance, NSES and lifestyle indicators.

Results: Neighborhoods with proportionally fewer smokers and more sport club members had significantly lower average health care costs. Remarkably, neighborhoods with more people who complied with the recommended maximum alcohol consumption had significantly higher health care costs. These findings were consistent within and between neighborhoods with different SES levels. Neighborhoods with more compliance with physical activity guidelines had lower health care costs. However, this relationship was inconsistent across different NSES levels, with the largest cost reductions found in the most deprived neighborhoods.

Conclusion: Our findings suggest that prevention policies aimed at reducing the number of smokers and increasing sport club membership may reduce health care costs across all NSES groups, while increasing compliance with physical activity guidelines may be effective mainly in low SES neighborhoods.

[4] Joint work with L.H. Dekker, R.H. Koning, G.Navis and J.O. Mierau. A condensed version of this chapter has been published in Preventive Medicine as De Boer et al. (2020).

5.1 Introduction

A large body of epidemiological and population health research addresses relationships between neighborhood characteristics and a myriad of health and economic outcomes (Chetty et al., 2016; Duncan & Kawachi, 2018) As such, neighborhood socioeconomic status (NSES) has been associated with adverse health outcomes, including chronic disease (Diez Roux, 2001; Picket & Pearl, 2001; Howard et al., 2016), mortality (Brown et al., 2013; Kim et al., 2018) and poor self-rated health and quality of life (Rocha et al., 2017). These associations are often cited to explain why health care expenditures are disproportionately high in neighborhoods with particular characteristics (De Boer et al., 2019).

However, while the socioeconomic gradient in health is one of the most consistent findings in epidemiological research (Stringhini et al., 2017; Bilal et al., 2019) a recent study found great variation in health care costs between neighborhoods with similar socioeconomic characteristics (De Boer et al., 2019). With global health expenditures on the rise (WHO, 2017), this finding warrants further exploration, as a better understanding of the complex relationship between NSES and health care expenditures may reveal pathways for future cost savings.

Health behaviors are a very plausible mediator of social inequalities in health. Factors such as physical activity, alcohol consumption and especially smoking are strongly socially patterned, while being simultaneously related to health outcomes (Lantz et al., 1998; Petrovic et al., 2018). Research shows that socially disadvantaged individuals are more likely to exhibit behaviors detrimental to their health. This could be due, for example, to material and financial constraints, a lesser appreciation of the benefits of health behaviors for longevity and difficulties in absorbing health promotion messages (Wardle & Steptoe, 2003; Pampel et al., 2010; Stringhini et al., 2011).

Nevertheless, the social patterning of neighborhoods is not uniform (Diez Roux & Mair, 2010). The complexities of these patterns may yield opportunities for intervention (Diez Roux & Mair, 2010). They also leave room to hypothesize a different role of lifestyle in influencing health care costs between areas with similar as well as different socioeconomic statuses. To date, the role of lifestyle determinants in influencing the effects of NSES on health care costs has not been examined.

The objective of the current study is to investigate variation in the association between lifestyle factors and health care costs both between and within neighborhoods with similar socioeconomic statuses. For this research we used whole-population data for the Netherlands. The research focuses on several lifestyle indicators: smoking, alcohol consumption and physical activity. The negative effects of smoking and alcohol consumption have been extensively demonstrated (Sturm, 2002; Evans & Stoddart, 1994). For physical activity the relationship with health and health care costs seems to be more complex, varying by type and context of physical activity. Research shows that occupational physical activity may have opposite health effects

compared to leisure time physical activity (Holtermann et al., 2012). In addition, Andersen et al. (2000) demonstrated that among all physically active individuals, those who participated in a sport experienced 50% less mortality than those who did not participate in a sport. The current research therefore includes two lifestyle indicators for physical activity: a general indicator for compliance with the Dutch guideline for sufficient physical activity and a more specific indicator for sport club membership.

Hence, our research investigates to what extent these four lifestyle indicators – smoking, alcohol consumption, getting sufficient physical activity and sport club membership – influence average health care costs and variation in those costs within, as well as between, neighborhoods with similar socioeconomic statuses.

5.2 Method

5.2.1 Data

Data on health care costs were provided by Vektis, an information center for Dutch health insurers (Vektis, 2018). Dutch law requires health insurers to provide detailed health care data to Vektis, which compiles this information and makes it available for research and public health policy. Here we investigate all health care costs that fall under the Health Insurance Act. This comprises all basic health care, including primary, hospital, pharmaceutical, mental health, dental and paramedical care (Vektis, 2018). All inhabitants of the Netherlands are required by law to purchase health insurance consistent with the Health Insurance Act; therefore these data cover almost the entire population of the Netherlands (i.e., 99.8%).

We used 2016 data at the neighborhood, or 3-digit postal code area. Each such neighborhood contains an average of about 21,000 persons. For each neighborhood, health care costs were available by gender and by age (0, 1, 2, etc. up to 89, with 90 years and older in one age category).

The dependent variable for our analysis was average health care cost performance (*AHCP*), defined as the difference between the observed average health care cost and expected average health care cost. We calculated the expected health care cost by multiplying the *national* average cost by the *neighborhood's* population size (the number of insured years), for each of the 182 (91 x 2) age and gender combinations. A positive value for *AHCP* indicates that the actual health care cost was higher than the expected cost based on the specific age/gender distribution of that neighborhood.

As independent variables, we considered the socioeconomic status for each neighborhood (*NSES*), as well as the four lifestyle indicators. The Netherlands Institute for Social Research (SCP) provided data on the socioeconomic status (SES) of all 4-digit postal code areas of the Netherlands (SCP, 2018), based on income, education and occupation of the

inhabitants. The SES data is constructed as a *z*-score with a normal distribution. It has a mean of zero, and ranges from -3.5 to 2.2, with higher values indicating more affluent neighborhoods. For our research, we aggregated the existing 4-digit postal code data into 3-digit postal code NSES values by calculating weighted (by population size) averages (SCP, 2018).

The following four lifestyle indicators were used in this research, with all being measured at the neighborhood level:

- *Smoking*. The percentage of people aged 19 and older who answered "no" to the question, "Do you ever smoke?" In this definition for current smoking status, the electronic cigarette was excluded. Data on e-cigarette use was not available at the neighborhood level, as it was not part of the survey we used.
- *Alcohol consumption*. The percentage of people aged 19 and older who complied with the 2016 Dutch recommendation to consume no more than one glass of alcohol on average per day.
- *Physical activity*. The percentage of people aged 19 and older who complied with the 2016 Healthy Exercise Guideline. This recommends that a person should do at least enough moderately intensive physical exercise to consume 200 kilocalories on a daily basis. The amount, frequency and intensity of the recommended exercise differ by age groups.
- *Sport club membership*. The percentage of the population that was a member of a sport club.

The first three lifestyle variables were derived from Statistics Netherlands (CBS) in cooperation with the Netherlands Institute for Public Health and the Environment (RIVM) and Municipal Health Services Netherlands (GGD). The CBS, RIVM and GGD conduct a population-wide, biannual survey of health and lifestyle ("Gezondheidsmonitor"; N = 457,000 in 2016) (CBS, 2016). From the findings of that survey, RIVM estimates these indicators for local areas (i.e., sub-neighborhoods) using a small-domain estimator model (Van de Kassteele et al., 2017). For our analysis, we aggregated local area data for 2016 to the neighborhood level.

The Dutch National Olympic Committee (Nederlands Olympisch Comité * Nederlandse Sport Federatie; hereafter: NOC*NSF) provided the percentage of sport club members for each neighborhood (also at the 3-digit postal code level). NOC*NSF collects information on sport club membership, including members' home addresses, through the national sport federations. These data include all federations recognized by and associated with the NOC, except the sport fishing association. NOC*NSF divides the number of sport club members by the neighborhood population size to get the percentage of sport club members in each neighborhood.

In the Netherlands, some 60% of the population participates in a sport weekly, with almost half of sport participants being members of a sport club (NOC*NSF, 2018). Although being a member of a sport club does not itself imply physical activity, it is a leisure time indicator

that is associated with being physically active and adhering to a healthy lifestyle (Telford et al., 2016).

To make the results more intuitive, we used positive coding for the lifestyle variables; that is, higher values indicate healthier lifestyles. Our hypothesis is that a healthier lifestyle leads to lower health care costs. We thus expected each positively coded lifestyle indicator to be negatively related to *ACHP*. We analyzed data for 2016, the most recent year for which data was available for all variables.

5.2.2 Analysis

To analyze the role of lifestyle factors in the socioeconomic gradient of neighborhood health care costs, we first calculated Pearson correlations between the dependent variable and all independent variables. Next, we measured the associations with average cost performance (*AHCP*) for *NSES* and the lifestyle indicators, using four ordinary least squares regression models. The first model looks at the univariate relationship between *AHCP* and *NSES*, where dependent variable $ahcp_i$ represents the average health care costs performance, for each neighborhood i:

$$ahcp_i = \alpha + \beta_1 \, NSES_i + \varepsilon_i \,, \tag{5.1}$$

where, in this and the following equations, β_1 estimates the effect of the NSES-score on the health care costs performance. Next, we estimate the effect of a lifestyle indicator, e.g. *smoking*, on *AHCP* in equation (5.2), while equations (5.3) estimates the multivariate relationship of *AHCP* on *NSES* and *smoking*:

$$ahcp_i = \alpha + \beta_2 \, smoking_i + \varepsilon_i \,, \tag{5.2}$$

$$ahcp_i = \alpha + \beta_1 \, NSES_i + \beta_2 \, smoking_i + \varepsilon_i \,, \tag{5.3}$$

The second model estimates the relationship between *AHCP* and each of the lifestyle variables separately. The third model estimates a multivariate association between *AHCP* and *NSES* together with a lifestyle indicator.

To test whether *NSES* and the lifestyle indicators have independent effects on *AHCP,* the fourth model expands on the third model, including an additional interaction effect between *NSES* and the lifestyle indicator. So, in equation (5.4) an interaction effect of *NSES* and *smoking* is included*:*

$$ahcp_i = \alpha + \beta_1 \, NSES_i + \beta_2 \, smoking_i + \beta_3 \, NSES_i * smoking_i + \varepsilon_i \,, \tag{5.4}$$

In equations (5.2) and (5.3), β_2 estimates the effect of *smoking*. Naturally, the regressions are also run for the other lifestyle variables, where instead of *smoking, alcohol consumption, physical activity, sport club membership* can be read. The null hypotheses of our research are that both β_1 and β_2 are equal to zero (for all lifestyle indicators). Our alternative hypotheses are that a higher NSES is associated with a lower health care costs performance ($\beta_1 < 0$) and a healthier lifestyle corresponds to a lower health care costs performance ($\beta_2 < 0$, for all j). In equation (5.4), the interaction coefficient β_3 can be interpreted as the influence a lifestyle indicator has on the observed relationship between NSES and health care costs performance. Thus, the relationship between *AHCP* and a lifestyle factor is estimated as ($\beta_2 + \beta_3\ NSES_i$). Again the null hypothesis is that there is no such association ($\beta_3 = 0$). Here the alternative hypothesis is that lifestyle indicators do affect the relationship of NSES with costs ($\beta_3 \neq 0$).

Finally, we produced margins plots showing the marginal relationships between NSES and average health care cost performance for each lifestyle indicator. This is a visual depiction of the interactions in the final model. These margin plots include 95% confidence intervals.

5.3 Results

Table 5.1 shows the summary statistics for all variables at the neighborhood level. The statistics are unweighted. As a result, the mean of the average health care cost performance is not equal to zero (the weighted mean does equal zero). For completeness, the statistics for sex and age were added, since these variables were used to calculate the average health care cost performance for each neighborhood.

Table 5.1: Summary statistics (at 3-digit postcode level, unweighted, *n* = 790 neighborhoods)

Variable	Explanation	Mean	St. Dev.	Min	Max
AHCP	Average health care cost performance (in euros)	-84.14	244.05	-1,446.06	684.96
Sex	Females (%)	50.1	2.0	28.2	58.6
Age	Average age	42.2	2.9	22.7	58.4
NSES	Neighborhood socioeconomic status	0.0	0.8	-3.5	2.2
Smoking	Individuals not smoking (%)	79.9	3.2	65	86
Alcohol consumption	Individuals complying with the alcohol norm (%)	39.6	5.4	26	66
Physical activity	Individuals complying with healthy exercise guidelines (%)	49.8	4.5	35	66
Sport club membership	Individuals who are sport club members (%)	25.8	6.1	8	49

Table 5.2 shows the correlations between average health care cost performance, NSES and the four lifestyle indicators. We observe a significant negative association between NSES and health care cost performance ($p<0.001$). All but one of the lifestyle indicators shows a significant negative correlation with average health care cost performance. Only *alcohol consumption* has a positive (and significant) correlation with *AHCP*. Looking at the associations with NSES, *smoking*, *physical activity* and *sport club membership* all have positive correlations with *AHCP*, while *alcohol consumption* has a significant negative correlation with NSES. Among the lifestyle indicators, *sport club membership* shows a strong (absolute value>0.6) and positive correlation with smoking, while also having a strong negative correlation with *alcohol consumption*.

Table 5.2: Correlations between cost performance, NSES and four lifestyle indicators

	AHCP	NSES	Smoking	Alcohol consumption	Physical activity
NSES	-0.598***	1			
Smoking	-0.568***	0.620***	1		
Alcohol consumption	0.420***	-0.355***	-0.340***	1	
Physical activity	-0.266***	0.320***	0.116**	-0.462***	1
Sport club member	-0.573***	0.588***	0.685***	-0.639***	0.364***

Note: Significance: * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 5.3 presents the results of the models regressing *AHCP* on NSES and the lifestyle indicators. The first column shows the outcomes of the first model, with only NSES. Next, the outcomes of the second, third and fourth models are presented, separately for each lifestyle indicator.

The outcome of the first model demonstrates a significant negative association between *AHCP* and NSES. This confirms the finding from the correlation matrix (see Table 5.2). Similarly, from the second models it is clear that all lifestyle variables are significantly associated with *AHCP*. For *smoking*, *physical activity* and *sport club membership* a significant negative association was found between a healthy lifestyle and average health care cost performance. The coefficient for *smoking* is highest: neighborhoods with 1 percentage point more non-smokers had €38.51 lower health care cost performance per person on average. At the national level in the Netherlands, reducing the number of smokers by 1 percentage point could lead to an annual health care cost savings of some €650 million. This amount is equivalent to 1.6% of all insured health care. Similarly, in neighborhoods with a 1 percentage point higher sport club membership and where residents got enough physical activity, the health care cost performance per person was, respectively, €24.81 and €14.25 lower. This corresponds to a potential annual health care cost reduction of some €420 million (1.0%) for *sport club membership* and €240 million (0.6%) for *physical activity*. However, for *alcohol consumption* the coefficient is positive; that is,

neighborhoods with a 1 percentage point higher compliance with the alcohol norm had on average €16.18 higher health care cost performance per person.

The third model includes both NSES and the lifestyle indicators as covariates. The signs of all coefficients in the third model are similar to those found in the first and second models. The associations between *smoking* and *sport club membership* with health care cost performance are negative and significant (p<0.001). However, combined with NSES, the association of *physical activity* with *AHCP* is not significant (p=0.147). *Alcohol consumption* again has a significant positive coefficient.

The fourth model presents interaction terms for NSES and the lifestyle indicators. A significant interaction term means that the effect of NSES on *AHCP* differs for neighborhoods with different levels of the lifestyle indicator. In other words, the marginal effect of the lifestyle indicator differs for neighborhoods with different levels of NSES. For the lifestyle indicators *smoking*, *alcohol consumption* and *sport club membership,* individual coefficients for NSES and the lifestyle indicators are, again, significant. However, the interaction effects are not significant, which suggests that NSES and each lifestyle indicator has an independent effect on *AHCP*. Only for *physical activity,* the interaction term is significant (p<0.001) and positive (+4.35). This implies that the association between *AHCP* and NSES was greater in neighborhoods where more people complied with the minimum exercise guideline.

Table 5.3: Regression results on average health care costs performance (dependent variable) for NSES and 4 lifestyle indicators

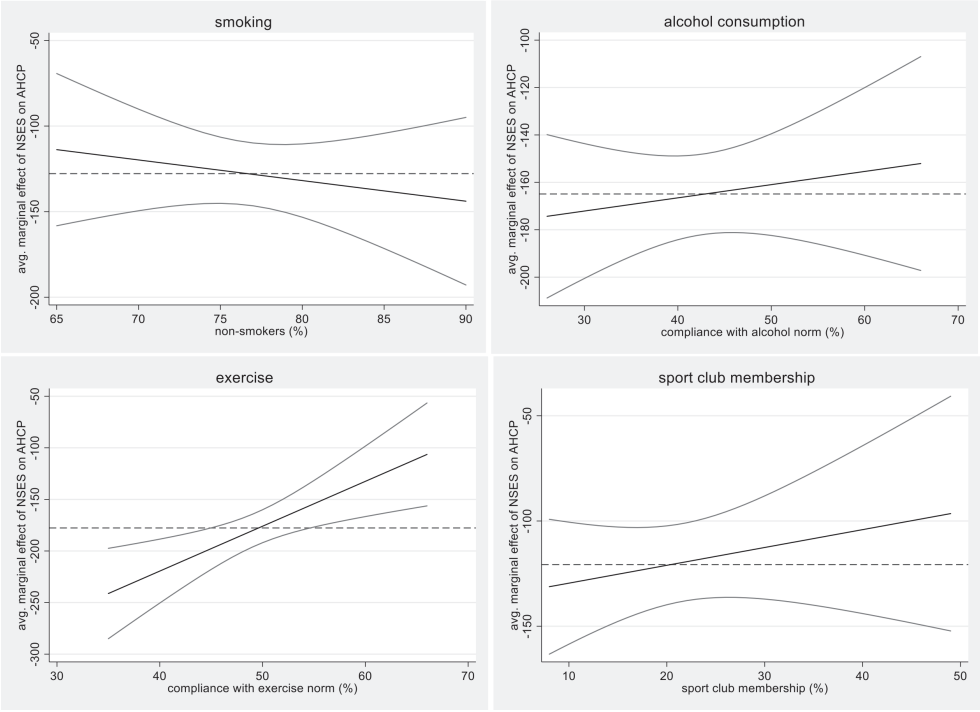
		smoking			alcohol consumption			physical activity			sport club member		
	(1)	(2)	(3)	(4)	(2)	(3)	(4)	(2)	(3)	(4)	(2)	(3)	(4)
NSES	-182.1 ***		-127.8 ***	-35.4 ***		-164.9 ***	-188.8 ***		-177.7 ***	-393 ***		-120.7 ***	-138.0 ***
	(7.87)		(9.30)	(135)		(8.73)	(40.0)		(8.01)	(71.9)		(9.38)	(23.2)
Lifestyle factor		-38.51 ***	-19.87 ***	-20.2 ***	16.18 ***	5.46 ***	5.77 ***	-14.25 ***	-2.30	-1.19	-24.81 ***	-13.53 ***	-13.49 ***
		(2.95)	(2.27)	(2.21)	(1.50)	(1.32)	(1.53)	(2.62)	(1.75)	(1.70)	(1.10)	(1.22)	(1.23)
NSES * Lifestyle factor				-1.20			0.56			4.35 ***			-0.848
				(1.75)			(0.91)			(1.45)			(0.98)
constant	-28.97 ***	3,020 ***	1,537 ***	1,564 ***	-667.2 ***	-251.2 ***	-263.1 ***	720.3 ***	87.81	25.97	581.7 ***	297.9 ***	294.4 ***
	(6.99)	(236)	(181)	(176)	(62.4)	(54.7)	(62.6)	(133)	(88.3)	(86.5)	(29.4)	(31.67)	(31.5)
R^2	0.519	0.435	0.588	0.589	0.199	0.537	0.537	0.089	0.521	0.529	0.467	0.599	0.599

Standard errors in parentheses (* p<0.1, ** p<0.05, *** p<0.01)

Figure 5.1 shows the interaction effect of the lifestyle indicators on the relationship between NSES and *AHCP*, with confidence intervals. Additionally, the dashed lines show the effects of NSES on *AHCP* independent of the lifestyle indicators (as in the third model). The figures show a downward slope for *smoking* and an upward slope for *alcohol consumption, physical activity* and *sport club membership*. An upwards slope indicates that neighborhoods with a healthier lifestyle would profit less – i.e., have a smaller drop in average health care cost performance – from moving up the socioeconomic ladder than neighborhoods with less healthy

lifestyles. For *physical activity*, in neighborhoods with a low level of compliance with the physical activity guideline the marginal effect of NSES on *AHCP* is below the dashed line, as is the confidence interval. This means that the marginal effect of NSES on *AHCP* is significant for *physical activity*. In other words, an improvement of NSES in neighborhoods with low adherence to the exercise norm would reduce *AHCP* more than in neighborhoods where compliance with the exercise norm is high. For all other lifestyle indicators, the confidence interval includes the original estimate of the NSES at all levels of the lifestyle indicator. Hence, for these lifestyle indicators, the marginal effect of NSES on *AHCP* is not significant. An alternative but equivalent interpretation of the foregoing results is that increasing the rate of compliance with the exercise norm would reduce health care costs more in low SES neighborhoods than in high SES neighborhoods (see Figure S1 in Supplement).

Figure 5.1: Margin plots showing the interaction effect of a lifestyle indicator on the relationship of NSES with average health care cost performance, for four lifestyle indicators, with confidence intervals (2016)



Note: Values on the horizontal axes represent the lifestyle factor. Those on the vertical axes represent the marginal effect of NSES on *AHCP*; that is, the effect of moving up one standard deviation on the NSES scale on average health care cost performance. The dotted horizontal lines represent the effect of NSES on *AHCP* without the interaction effect

5.4 Discussion

The outcomes of our research confirm that health care costs are negatively associated with smoking (Xu et al., 2015) and insufficient physical activity (Pratt et al., 2000). While other research shows that lifestyle factors and socioeconomic characteristics are independently related to, for example, perceived health (Molarius et al., 2006) and health outcomes (Lantz et al., 1998; Petrovic et al., 2018), our findings show a similar association for average health care cost, particularly for smoking and sport club membership. Remarkably, this finding does not hold for getting sufficient physical activity. This indicates that health effects may indeed vary for different types of physical activity. We did find that lifestyle effects sometimes differ for different NSES levels. Earlier research suggests that the health effects of physical activity can be different depending on whether physical activity occurs during work or in leisure time, and whether it is in the context of practicing a sport (Andersen et al., 2000). Unfortunately for the current study, no neighborhood-level data were available detailing types of physical activity.

We found that greater compliance with the alcohol norm was associated with higher average neighborhood health care costs. This contradicts other research which points to many adverse health effects of (excessive) alcohol consumption (Bouchery et al., 2011; Wood et al., 2018). Indeed, evidence is ambivalent about the health effects of moderate alcohol consumption (Bouchery et al., 2011; Fernandez-Sola, 2015). Our findings in this regard support the hypothesis that moderate alcohol consumption can have health benefits, such as lower incidence of cardiovascular events and mortality (Fernandez-Sola, 2015). Other research suggests that the prevalence of excessive drinking may not be related to educational level (Van Oers et al., 1999). Often, deprived neighborhoods have higher proportions of current drinkers (i.e., those presently consuming an alcoholic beverage), while also having lower weekly alcohol consumption rates (Brenner et al., 2015). In the Netherlands, statistics show that while lower educated men under the age of 65 consume most alcohol, alcohol use among women is highest for the highest educated group, for all age groups (RIVM, 2017). Future research investigating the remarkable relationship between alcohol consumption and health care costs that we found would be very welcome, including looking at the effects of using different thresholds for “excessive” drinking.

Our analysis had several limitations. First of all, while we used rich, whole-population data, our data included only health care costs covered under the Dutch Health Insurance Act. Although this coverage is broad, including all basic health care, it may nonetheless have missed some direct and indirect health-related expenses stemming from, for example, general practitioner care, hospital care and pharmaceuticals. Secondly, in our study we analyzed lifestyle indicators for smoking, alcohol consumption and physical activity, but we omitted a fourth potentially important lifestyle factor: nutrition. Unfortunately, no data on nutrition was available at the neighborhood level. As a healthy diet can have positive health effects, future studies may wish to take diet into account (Lenoir-Wijnkoop et al., 2013; Kiefte-De Jong et al.).

Thirdly, because our study focused on the neighborhood level, the findings may not be fully be transferable to policies and interventions aimed at the individual level. However, research shows that neighborhood characteristics can affect the physical health of individuals (Loh et al., 2016). Fourthly, because of the unique characteristics of the Dutch health care system and Dutch society (e.g., the country's rather egalitarian socioeconomic structure and large sport club membership), the outcomes of this research may not be fully generalizable to other countries. However, because of the scope of this research, we believe that the findings provide valuable insights, as would similar investigations in other countries. Additionally, because we used a cross-sectional approach, the socioeconomic gradients in health care costs that we found represent associations, and are not necessarily indicative of causal relationships between NSES, lifestyle factors and health care costs. Future research could look in more detail at the effects of NSES and lifestyle factors on specific types of health care costs.

5.5 Conclusion

From our correlations and regression analyses, we can conclude that, at the neighborhood level, a higher percentage of non-smokers, persons getting enough physical activity and sport club members are all associated with significantly lower health care costs. Accounting for age and gender, but not differences in NSES, neighborhoods with 1 percentage point less smokers, more sport club members and getting enough physical activity had on average €39, €25 and €14 less annual health care costs per person, respectively. Surprisingly, neighborhoods with a higher compliance with the alcohol norm also had significantly higher health care costs. One percentage point less alcohol users was associated with €16 higher average costs. Moreover, our regression analysis showed that the associations for smoking, sport club membership and alcohol consumption were both additional to (consistent coefficient signs in models 3 and 4) and independent of (no significant interaction coefficient in models 4) a neighborhood's socioeconomic status. Hence, the lifestyle indicators smoking and sport club membership seem to be complementary to NSES in explaining variations between neighborhoods in health care costs. For physical activity, the findings differ. When NSES was added to the equation (in model 3), physical activity was no longer significantly associated with health care costs. However, the significant and positive interaction between NSES and physical activity in estimating health care costs (model 4) implies that in neighborhoods with less compliance with the exercise norm, NSES has a stronger marginal effect on average costs.

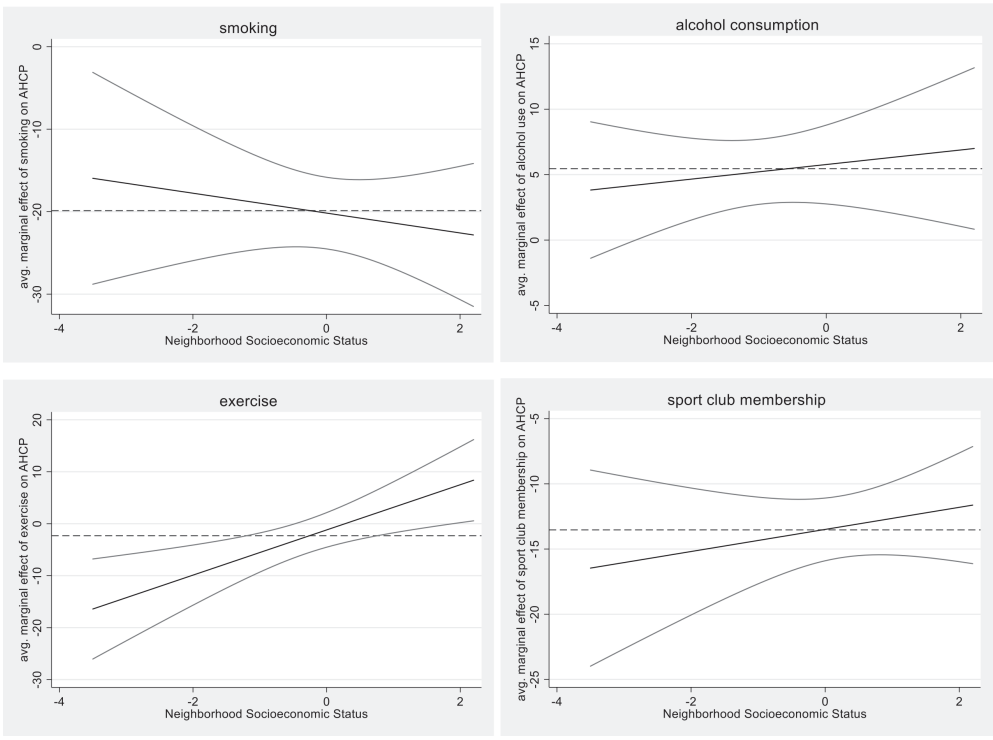
Our findings suggest that policies aiming at increasing the number of non-smokers and sport club members would be beneficial in reducing health care costs for all neighborhood socioeconomic levels. Increasing the percentage of persons getting enough physical activity in general may only be effective in low socioeconomic status neighborhoods. Physical activity policies would be advised to focus on increasing physical activity particularly via sport club

membership and perhaps also through other leisure time activities, such as by removing or diminishing (financial) barriers to participate in such activities for low income groups. In the Netherlands, local policies aimed at increasing youth sport club membership seem to be successful in reducing socioeconomic differences in sport club participation. Future research could focus on other lifestyle factors, such as nutrition, as well as on the differential effects of several types of physical activity, including physical activity in the context of work or as a means of transportation (e.g., commuting by foot or by bicycle) and practicing a sport outside the context of a sport club. To investigate the causal relationship between lifestyle factors, socioeconomic characteristics and health care costs, future research could furthermore look at individual data or take a longitudinal approach.

Appendix

An alternative interpretation of the results for the interaction term (β_3 in equation (5.4)) is to look at how the relationship between a lifestyle indicator and average health care costs performance changes with different levels of NSES. This is visualized in Figure A3.1 below.

Figure A3.1: margins plots showing the interaction effect of NSES on the relationship of a lifestyle indicator with average health care costs performance, for 4 lifestyle indicators, with confidence intervals (2016)



Note: the x-axis shows the value of NSES, the y-axis shows the marginal effect of a lifestyle factor on *AHCP*, i.e. what the effect is of moving up one percentage point on the scale of the lifestyle indicator on the average health care costs performance. The dotted horizontal line shows the effect of lifestyle indicator on *AHCP* without the interaction effect (β_2 in equation (5.3)).