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de Boer, Willem I. J.; Buskens, Erik; Koning, Ruud H.; Mierau, Jochen O.

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Neighborhood Socioeconomic Status and Health Care Costs: A Population-Wide Study in the Netherlands

Willem I. J. de Boer, MSc, Erik Buskens, MD, PhD, Ruud H. Koning, PhD, and Jochen O. Mierau, PhD


Objectives. To identify disparities in several types of insured health care costs in the Netherlands across neighborhoods with different socioeconomic statuses and to assess the room for improvement.

Methods. We used 2015 Dutch whole-population registry data to estimate the age- and gender-specific cost structure by neighborhood for total, specialist, pharmaceutical, and mental health care. Classifying neighborhoods by the quintile of their neighborhood socioeconomic status (NSES), we determined differences in observed and expected health care costs for several scenarios of NSES improvement.

Results. From low to high NSES, we found a clear downward gradient in health care costs. Total health care costs would drop by 7.3% if each neighborhood's cost structure was equal to that of the most affluent neighborhoods. The potential for cost reduction appeared highest for females, for age groups between 40 and 60 years, and for pharmaceutical care.

Conclusions. Low NSES is associated with relatively high health care costs, and represents considerable potential for cost savings in health care.

Public Health Implications. Our research suggests that policies aimed at improving the socioeconomic determinants of health locally may be pivotal in containing health care costs. (*Am J Public Health.* 2019;109:927–933. doi:10.2105/AJPH.2019.305035)

 See also Özdemir and Özdemir, p. 835, and Galea and Vaughan, p. 842.

A growing body of literature acknowledges the association between neighborhood socioeconomic conditions and many adverse health outcomes, including mortality,¹ self-rated health,² and quality of life.³ Poor health has, in turn, been related to high health care costs.⁴ Studies have shown that socioeconomic status and living in deprived neighborhoods increases not only the odds of poor health⁵ but also the odds of high-cost health care usage.⁶ However, few studies have researched the direct relationship between neighborhood socioeconomic status and health care costs. Asaria et al. have used hospital episode statistics to estimate the financial consequences of neighborhood socioeconomic differences in health care costs in the United Kingdom.⁷ They documented a substantial neighborhood socioeconomic gradient in hospital admissions and estimated that, if all neighborhoods had the same

number of (age- and gender-adjusted) admissions as the most affluent neighborhoods, annual cost savings would potentially be £4.8 billion (around US\$6.8 billion), or 11% of hospital services costs for the National Health Service. Taking a similar approach, the Public Health Agency of Canada⁸ estimated that the direct costs of the socioeconomic gradient amounted to Can \$6.2 billion (around US\$4.8 billion), or more than 14% of total annual costs on acute care hospitalizations, prescription medications, and outpatient visits. For the

United States, comparable patterns of health outcomes strongly associated with socioeconomic differences have been observed.^{9,10}

Thus far, research on the neighborhood socioeconomic gradient in health care costs has mainly involved case studies for specific health care categories, such as inpatient hospital costs¹¹ or prevalence of chronic diseases.¹² To the best of our knowledge, however, no study hitherto has provided a comprehensive, population-wide analysis of the cost implications of the neighborhood socioeconomic gradient in health. With this study, we aimed to add to the current state of research by including total health care costs (within insured health care), as well as the major care domains, with whole population data. Specifically, we analyzed the relationship between socioeconomic status of neighborhoods and pertinent health care costs while taking into account each neighborhood's age and gender structure.

The Netherlands has a statutory health insurance system, with obligatory private insurance, which the government regulates and subsidizes.¹³ Thus, 99.8% of the Dutch population has at least basic health insurance, granting access to health care. The health care market is organized in a system of regulated competition under the Health Insurance Act, through a privatized system of health insurers and health care providers.¹³ This system encompasses more than half of total health and care costs, including primary care, hospital

ABOUT THE AUTHORS

All of the authors are with the Faculty of Economics and Business, University of Groningen, Groningen, the Netherlands. Willem I. J. de Boer is also with the Institute of Sport and Exercise Studies, HAN University of Applied Sciences, Nijmegen, the Netherlands. Erik Buskens is also with the University Medical Center Groningen. Jochen O. Mierau is also with the Aletta Jacobs School of Public Health, University of Groningen.

Correspondence should be sent to Willem I. J. de Boer, University of Groningen, Faculty of Economics and Business, Nettelbosje 2, 9747 AE, Groningen, the Netherlands (e-mail: w.i.j.de.boer@rug.nl). Reprints can be ordered at <http://www.ajph.org> by clicking the "Reprints" link.

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care, and pharmaceutical care. The remaining costs fall under different legislation and mainly concern long-term care and supplementary insured health care, such as dental care. Health care costs constitute about 11% of Dutch gross domestic product.

The complete data on annual insured health care costs make it possible to identify disparities in health care costs across neighborhoods with differing socioeconomic status in the Netherlands. Our research aimed to provide insights into the relationship between neighborhood socioeconomic status (NSES) and health care costs, while taking into account age and gender. By applying several policy simulations that involve improving NSES, we were able to estimate the potential savings in annual health care costs. Jointly, these scenarios provide guidance and justification for investment and for taking a broad socioeconomic policy perspective to curb rising health care costs.

METHODS

Vektis,¹⁴ the health care information center established by Dutch health care insurers, provided health care costs for 2015. Health insurance firms are required by law to provide their health care declaration data for risk equalization. Vektis harmonizes these data and makes them available for research and policy purposes. By design, these data cover all insured individuals (i.e., 99.8% of the population). Hence, our research was able to take advantage of what is for all intents and purposes full-population data.

In our analysis, we used data aggregated at the neighborhood level, defined by the first 3 digits of each postcode. In 2015, the Netherlands had 790 neighborhoods of roughly 21 000 inhabitants, on average. For each of these neighborhoods, the data included the number of insured years (1 insured year equals 1 person insured for all 365 days) and annual health care costs, disaggregated by 91 age groups (0, 1, 2, . . . up until age 89 years, plus age 90 years and older combined) and 2 gender categories (male and female).

In addition to total health care costs, we discerned 3 main components for further analysis: specialized, pharmaceutical, and mental health care. Specialized health care (comprising 52% of total health care costs)

included all medical-specialist care within hospitals including intramural medication, as well as extramural care by medical specialists. Pharmaceutical care costs (11%) included all pharmaceutical aid dispensed through public pharmacies, including fees and practice costs for pharmacists. Mental health care (8%) included treatment of basic mental health care, specialist mental care, and mental health care institutions. Apart from these 3 categories, total costs included other cost categories under the Health Insurance Act, such as primary, emergency, paramedical, and maternity care.

We obtained data on NSES from The Netherlands Institute for Social Research.¹⁵ Biannually, this institute publishes an NSES Score, which is derived from characteristics (education, income, and labor market status) of individuals in each neighborhood. In line with Public Health Agency of Canada⁸ and Asaria et al.,⁷ we ordered the 790 neighborhoods by NSES score and divided them into roughly equal-sized quintiles (with NSES1 the most deprived neighborhoods and NSES5 the most affluent). Table 1 shows the descriptive statistics of the data at the neighborhood level.

Following the method of Ferrer and Palmer,¹⁶ we decomposed the variance in health care costs between, as well as within, NSES quintiles. First, we estimated the socioeconomic gradient by regressing health care on dummy variables of each of the 5 NSES quintiles. Next, we simulated 4 scenarios for reducing the variation in socioeconomic status of neighborhoods both between and within NSES quintiles. In scenario 1, we estimated the impact of completely eliminating the socioeconomic

gradient by applying the national average cost structure to all neighborhoods. The term “cost structure” stands for average costs for the (91 × 2 =) 182 age-and-gender categories, which can be calculated at neighborhood, NSES-quintile, and national levels. In scenario 2, we simulated an improvement to the cost structure of the most-affluent NSES quintile for all neighborhoods. In addition to this somewhat utopian scenario, we considered 2 more-cautious scenarios. Scenario 3 estimates the impact of each neighborhood shifting up 1 NSES quintile on the socioeconomic ladder. The most realistic scenario, scenario 4, shows the impact of reducing the within-NSES quintile variation in health care cost by assigning the within-NSES quintile average health care cost structure to each neighborhood in that quintile with health care costs above the average.

In each of the 4 scenarios, we calculated the differences between a neighborhood’s observed health care costs and the costs if the cost structure of the given scenario were to be applied to that neighborhood. In a simulated scenario, we multiplied the neighborhood’s observed population structure (i.e., the number of insured years for each age-and-gender category) with the cost structure of the given scenario (e.g., for scenario 1, the national average costs for each age-and-gender category). We then determined the absolute and relative potential cost reduction by calculating the differences between the observed and the simulated costs for each neighborhood and NSES quintile. We performed this analysis separately for all 4 health care costs. To analyze differences between groups (such as NSES quintiles), we performed analysis of

TABLE 1—Descriptive Statistics, Dutch Health Insurance Population (at Neighborhood Level): The Netherlands, 2015

Variable	Mean (SD)	Median (Range)
Insured years	21 066.22 (19 990.12)	14 800.92 (23.00–147 868.40)
Gender: % female	50.05 (2.49)	50.37 (30.13–54.85)
Neighborhood socioeconomic status, index score	−0.03 (0.83)	0.06 (−3.45–2.22)
Total health care costs per insured year, €	2 308.32 (318.38)	2 318.22 (1 095.24–3 216.90)
Specialist health care costs per insured year, €	1 226.63 (158.88)	1 231.95 (549.29–1 787.94)
Pharmaceutical costs per insured year, €	258.70 (44.12)	258.07 (91.07–431.71)
Mental health costs per insured year, €	150.75 (70.78)	133.51 (0.00–661.98)

Note. The sample size was n = 790. The 2015 annual Euro to US dollar conversion rate was 1.11 (€1 = \$1.11).

variance and *t* test, boxplot, and regression analysis, with Stata/SE version 15.0 (Stata-Corp LP, College Station, TX).

RESULTS

Table 2 shows the average total health care costs for each neighborhood and NSES quintile. A clear socioeconomic gradient in health care costs can be observed: with every subsequent NSES quintile, average costs decline by about €100 (see also boxplots of Figure A, available as a supplement to the online version of this article at <http://www.ajph.org>). One-way analysis of variance test showed that average costs differ significantly ($P < .001$) across NSES quintiles.

Scenario 1 applies the national average cost structure to each neighborhood. Table 2 shows the relative difference between observed and expected outcomes (see also Table A). Again, the negative socioeconomic gradient is visible. While the lowest NSES quintile incurred 10% (€249) more costs than expected, the highest NSES quintile incurred 8% (€170) less than expected.

Table 2 shows results for eliminating the socioeconomic gradient completely by assigning the age-and-gender-specific average health care costs of the highest NSES quintile to each neighborhood (scenario 2). For each of the other quintiles, health care costs decline, with the greatest change being achieved in the lowest-NSES group (16% per year). Aggregating over the different cost

reductions provides a total potential decrease in annual health care costs of 7.3% (€2.8 billion) of total insured health care costs.

The outcomes of scenario 3 are shown in Table 2. If neighborhoods were to reach the cost structure of the next NSES quintile, a savings of 3.6% (€1.4 billion) of total insured health care costs would be achieved.

Table 2 shows the outcomes of a decrease in health care costs of the neighborhoods that have costs above the average of their own NSES quintile to match that average within-NSES quintile cost structure (scenario 4). In total, 306 (out of 790) neighborhoods, or about 8.6-million insured years, had health care costs above their within-NSES quintile average. The potential reduction in total health care costs equals 2.4% of total insured health care cost (€958 million), or 4.6% of the costs for these neighborhoods alone. The cost-saving potential was quite evenly distributed over the NSES quintiles. In addition, within NSES quintiles, we also observed a negative relationship between health care costs and NSES.

Cost Categories

Costs and cost-saving potentials differ considerably over the cost categories. While total health care costs were more than 10% higher in NSES1 as compared with the national average (scenario 1), this number was considerably less for specialist care (6.6%; Table B, available as a supplement to the online version of this article at <http://www.ajph.org>). By contrast, for pharmaceutical

care and especially mental health care, these differences were much higher: 17% and 23% for NSES1, respectively. The Bonferroni test showed that, with the exception of specialist care, average costs drop significantly when moving upward on the NSES quintile ladder. However, the differences between NSES4 and NSES5 were not significant for any of the cost categories. Table 3 shows the relative difference between observed and expected costs in the scenario that shows the cost-saving potential (scenario 2) and the most realistic scenario (scenario 4) for total, specialist, pharmaceutical, and mental health care.

There are large differences between the cost groups when it comes to the potential cost savings if each neighborhood were to have the NSES5 cost structure (scenario 2). This is especially the case for NSES1 in pharmaceutical care and mental health, with potential cost reductions of 27% and 34%, respectively. The relationship between deprivation and health care costs is mainly positive for most cost types (greater deprivation means higher costs). However, for mental health care, the fourth quintile (NSES4) would have had 5.6% higher costs with the cost structure of NSES5. A similar pattern is visible for scenario 3 (Table B).

Scenario 4 paints a different picture, as within-NSES-quintile improvements show similar-sized cost-cutting potentials across the NSES groups. Relative cost-saving potentials in this scenario are higher for mental health (11.6%) and pharmaceutical care (4.5%) than for total health care (2.4%).

TABLE 2—Real and Expected Average Total Health Care Costs and Potential Savings for 4 Scenarios: The Netherlands, 2015

NSES Quintile ^a	No. of Neighborhoods	Insured Years	Observed Average Costs, €	Cost Saving			
				Scenario 1, %	Scenario 2, %	Scenario 3, %	Scenario 4, %
NSES1	112	3 346 924	2 554	9.8	16.3	7.3	2.4
NSES2	153	3 301 725	2 469	2.6	9.7	4.2	2.3
NSES3	170	3 331 801	2 350	-1.7	5.7	2.8	2.5
NSES4	184	3 335 400	2 250	-4.7	2.9	2.9	2.6
NSES5	171	3 326 467	2 159	-7.9	0.0	0.0	2.5
Total	790	16 642 317	2 356	0.0	7.3	3.6	2.4

Note. NSES = neighborhood socioeconomic status. The scenarios show the relative potential cost savings (i.e., the percentage difference between the simulated health care costs in each of the 4 scenarios and the observed costs). In scenario 1, the health care cost structure for each neighborhood is equal to that of the national average. In scenario 2, costs are equal to that of the most-affluent NSES quintile. In scenario 3, costs are equal to that of the next NSES category. In scenario 4, each neighborhood's costs are held to at most the within-NSES-quintile average. The 2015 annual Euro to US dollar conversion rate was 1.11 (€1 = \$1.11).

^a1 = most deprived to 5 = least deprived.

TABLE 3—Cost Effects of Scenarios 2 and 4 for Total, Specialist, Pharmaceutical, and Mental Health Care: The Netherlands 2015

NSES Quintile ^a	Total Health Care, %	Specialist, %	Pharmaceutical, %	Mental Health, %
Scenario 2				
NSES1	16.3	10.9	21.1	25.1
NSES2	9.7	6.2	8.6	12.8
NSES3	5.7	4.0	5.8	-0.1
NSES4	2.9	3.0	0.8	-5.9
NSES5	0.0	0.0	0.0	0.0
Total	7.3	4.9	7.9	8.1
Scenario 4				
NSES1	2.4	3.0	4.5	8.1
NSES2	2.3	2.7	3.8	11.8
NSES3	2.5	3.0	4.7	13.3
NSES4	2.6	2.7	3.9	12.4
NSES5	2.5	3.0	5.3	14.1
Total	2.4	2.9	4.5	11.6

Note. NSES = neighborhood socioeconomic status. In scenario 2, costs are equal to that of the most-affluent NSES quintile. In scenario 4, costs are held to at most the within-NSES average.

^a1 = most deprived to 5 = least deprived.

We performed linear regressions of standardized health care costs on dummy variables for each NSES quintile (see “regression analysis” in the Appendix for explanation and Table D for regression outcomes, available as supplements to the online version of this article at <http://www.ajph.org>). Figure 1 shows the predicted standardized health care cost difference from the benchmark NSES3. All cost categories have a negative slope, implying that a higher NSES quintile is associated with lower-than-expected health care costs. The slope is steepest for pharmaceutical costs. The curve for mental health care shows an upward slope at the end, indicating that NSES4 performs relatively better than NSES5 (although this difference is not statistically significant).

Effects of Gender and Age

Differentiating the scenarios by age revealed the typical upward sloping profile of health care costs over the life cycle, with a peak in health care costs for women during childbearing years (Figure B, available as a supplement to the online version of this article at <http://www.ajph.org>). Concerning the NSES quintiles, we observed that the most-deprived neighborhoods almost consistently displayed higher health care costs over the life cycle. Table C (available as a supplement to

the online version of this article at <http://www.ajph.org>) shows the potential total impact of reducing the socioeconomic gradient in health care costs for scenarios 2, 3, and 4 (by definition, the impact of scenario 1 equals zero). For scenario 2, the total cost reduction was 8.0% for females (€1.7 billion) and 6.4% for males (€1.1 billion). This relative potential decreases to 3.6% for both genders in scenario 3. By contrast, the potential for health cost savings within NSES quintiles (scenario 4) is relatively higher for males (2.7%) than for females (2.3%).

Differentiating by age groups, those aged 41 to 50 years and 51 to 60 years had the highest saving potential in relative terms, and in absolute terms for those aged 51 to 60 years. The potential for these age groups was more than 10% for scenario 2 and 3.5% for scenario 4. By contrast, the potential for adolescents (aged 11 to 20 years) was just 1.4% and 1.6%, respectively.

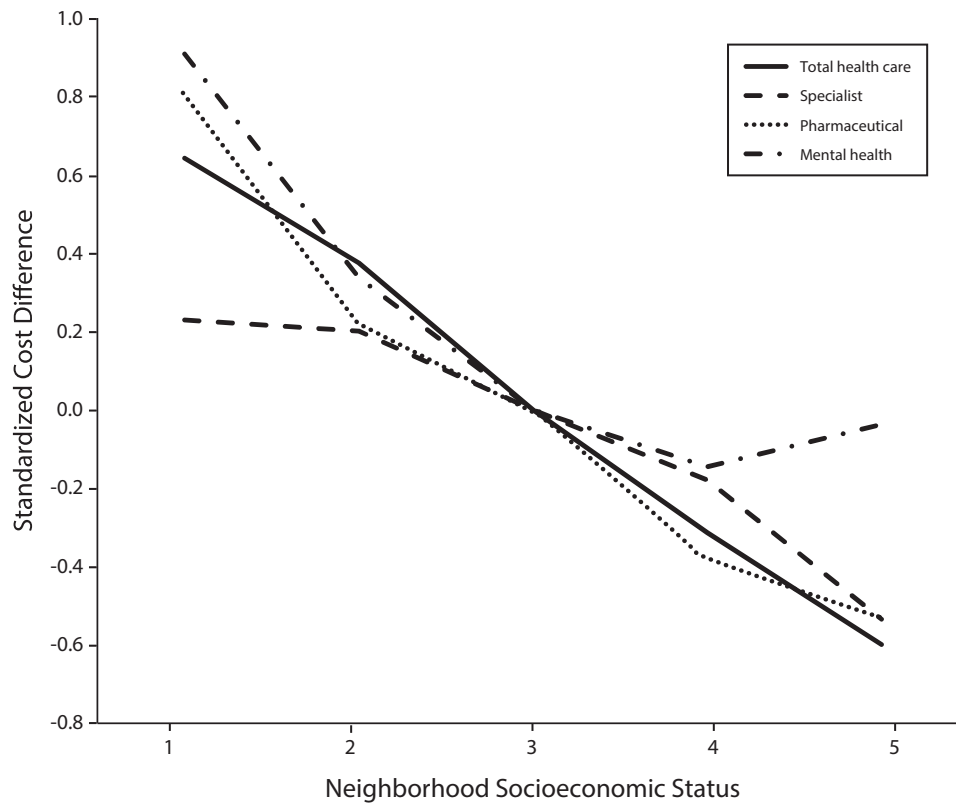
DISCUSSION

In this article, we demonstrated a clear socioeconomic gradient for insured health care costs with full-population data from the Netherlands. We discerned a substantial negative relationship between socioeconomic

status and health care costs, with health care costs in the lowest socioeconomic neighborhoods being more than 10% higher than expected, based upon national averages, and those in the most prosperous neighborhoods being 8% less than expected. Simulations show that if each neighborhood's cost structure was equal to that of the most affluent quintile of neighborhoods, health care costs would drop by 7.3%. Interestingly, if the neighborhoods with above-average costs within each NSES quintile just dropped back to the average in that quintile, total health care costs could still be reduced by 2.4%.

Our findings confirm the negative socioeconomic gradient for health care costs that others have found for more specific cost categories,^{7,8} but the sizes of the effects (i.e., the relative cost-saving potential) are more modest. This could be attributable to the fact that we were using full-population data (without a selection bias) or to specifics of Dutch society and its health care system. Our research shows that the highest savings would be achieved by improving socioeconomic conditions and outcomes, which is consistent with the findings on actual⁹ and perceived health in the United States.^{2,16} Future research should consider the mechanisms that relate low NSES to higher costs. Perhaps the neighborhood socioeconomic gradient in health care costs is a reflection of relatively poorer lifestyles, as smoking¹⁷ and heavy drinking¹⁸ are generally found to be more prevalent among persons with a lower socioeconomic status.

Analysis for 3 large cost categories revealed that, by moving up on the NSES ladder, high relative cost reductions in pharmaceutical and mental health care may be achieved, but much less so in specialist care. Because low socioeconomic status is more associated with mental disorders¹⁹ and chronic diseases,²⁰ for example, these may provide an explanation for higher mental and pharmaceutical health care costs. Meanwhile, stress is more common in the highest-socioeconomic status groups,²¹ which could offer an explanation for the U-shaped curve in mental health care costs. Ideally, future research should expand to other types of health care costs, including primary health care, which has many direct and indirect linkages to other types of care, and zoom in on deeper levels of health care,



Note. This figure shows the standardized (i.e., the values on the y-axis show the difference to the benchmark in terms of standard errors) differences between neighborhood socioeconomic status (NSES) quintiles in health care costs, with NSES1 the most deprived neighborhoods and NSES5 the most affluent. The middle NSES quintile (NSES3) serves as the benchmark.

FIGURE 1—Standardized Differences in Health Care Costs Between Neighborhood Socioeconomic Status Quintiles: The Netherlands, 2015

such as specific treatments and the consumption of medicine. Currently, the possibilities for this research are restricted because of availability of data, as well as the compensation structure (for primary care) in the Netherlands. The limited data available on primary care indicate similar trends that would need explicit and additional study.

Females account for a relatively large portion of total health care cost differences between the NSES quintiles, while inequality within NSES quintiles is relatively higher among males. Importantly, neighborhood socioeconomic differences seem to contribute to comparatively large health cost effects for persons aged between 40 and 60 years but are relatively limited for younger persons (younger than 20 years). This age pattern confirms earlier research on socioeconomic status and general health outcomes²² and may reflect the fact that noncommunicable diseases, for example, are more prevalent at an early age in lower-socioeconomic status

classes.²³ Hence, the occurrence of the (perceived) burden of noncommunicable diseases may also take place much earlier. However, age-specific outcomes should be treated with caution, as they could reflect age- as well as cohort- or period-specific characteristics.

Limitations

Our analyses are not without limitations. First of all, although we used rich, full-population data, these data only included insured health care costs. These make up about 50% of total health care costs, and it is unclear if a socioeconomic gradient will also be present in the remaining care costs.

Second, we measured only the direct costs of health care, and could not assess the impact of the indirect and intangible costs of ill health. As highlighted by Mackenbach et al.,²⁴ indirect and intangible costs of health also display a socioeconomic gradient,

indicating that our estimates are best viewed as lower bounds.

Third, because we used data aggregated at the neighborhood level, this may lead to an ecological inference fallacy (Simpson's paradox), and we may have over- or underestimated the socioeconomic gradient at less-aggregated levels. Our analysis shows, however, that a negative socioeconomic gradient was present between as well as within NSES quintiles. Future research may look deeper into the role of subpopulations on these gradients.

Fourth, because we used a cross-sectional approach, the socioeconomic gradients in health care costs that we found are associations and not necessarily indicative of a causal relationship between NSES and health care costs. However, applying Hill's criteria, we are confident that the outcomes are strong, consistent, and coherent, and therefore a causal relationship may be considered plausible. We performed robustness checks on

NSES with average household income and the average property value as alternative measurements, which showed results similar to our analysis (see “Sensitivity analysis using alternative socioeconomic status measurements” in the Appendix, available as a supplement to the online version of this article at <http://www.ajph.org>). Our results also showed that, although Bhavsar et al.²⁵ argued that neighborhood socioeconomic variables may not add information to explain socioeconomic differences in health outcomes, these variables can be very valuable, at least in the absence of individual data. Indeed, individual data would have been preferable and may in future research yield more precise estimates and insights.

We further acknowledge that the relationship between the socioeconomic environment and health outcomes is not simple, direct, or monocausal. Moreover, it is likely that several bidirectional mechanisms are at work here, as has been suggested by others.²⁶

Finally, because of the unavailability of detailed data, our analysis does not take into account mortality. Low-SES groups tend to have a higher mortality rate. We addressed this issue indirectly by keeping the population structure for each neighborhood constant. However, mortality also has an influence on the cost structure, and future analysis should, ideally, incorporate mortality rates.

Future research needs to focus on elucidating the general and regional specifics of the socioeconomic gradient in health care costs and understanding the underlying mechanisms. Knowledge of these mechanisms provides essential information on the type of policies that may be developed to achieve the cost reductions indicated by our analysis. Future research could test hypotheses that local characteristics, such as access to green and recreational areas²⁷ or sports facilities,²⁸ along with lifestyle characteristics, such as nutrition and physical activity, affect health care costs.

Public Health Implications

Curbing ever-increasing health care costs is an important public health goal. Our research suggests that, in line with other research,^{12,29} improving socioeconomic conditions, public policies, and facilities in neighborhoods is likely to contribute to this goal, especially for

the most deprived areas. In addition, the within-NSES-quintile potential for cost reductions suggests that local characteristics and more locally focused policies may decrease health care costs for deprived as well as affluent neighborhoods. It would seem, however, that a national public policy should start with the most-deprived neighborhoods (NSES1), because these areas have the highest potential for health gain and cost savings.

Our analysis indicates that health and health care costs should become a more integral part of socioeconomic policies and vice versa. Effective strategies need to take into account a neighborhood's population and social structure. In addition, differences in potential cost gains between age groups may signal a generational effect, which may have implications for future health care cost developments between socioeconomic groups, as others have suggested for specific health indicators.³⁰

Our research provides a clear indication that taking a broad view of future policies aimed at curbing health care costs, and either directly or indirectly decreasing the socioeconomic gradient in health and subsequent cost of care, is required. As such, there obviously is no “cure” or intervention to alleviate the socioeconomic status of an individual or neighborhood. Yet, this is no reason not to claim that our results provide clear support for the development of policies that address socioeconomic status-associated disparities in health.

To conclude, while not having presented experimental evidence about interventions that were designed to reduce health differences associated or mediated by socioeconomic status, we have been able to present strong arguments for developing integral approaches focused on target populations. This development would require solid theoretical underpinning as well as appropriate confirmatory research. **AJPH**

CONTRIBUTORS

W. I. J. de Boer conceptualized the study, conducted the analyses, and wrote the article. J. O. Mierau conceptualized the study and wrote the article. E. Buskens and R. H. Koning conceptualized the study and provided feedback on the article.

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CONFLICTS OF INTEREST

No authors have any personal, commercial, political, academic, or financial interests to disclose.

HUMAN PARTICIPANT PROTECTION

No protocol approval was necessary as the research conducted did not involve human participants.

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