



Article

Is loneliness an undervalued pathway between socio-economic disadvantage and health?

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Abstract:

Loneliness is a growing public health issue. It is more common in disadvantaged groups, and has been associated with a range of poor health outcomes. Loneliness may also form an independent pathway between socio-economic disadvantage and poor health. Therefore, the aim of this study was to explore the contribution of loneliness to socio-economic health inequalities. These contributions were studied in a Dutch national sample (n = 445,748 adults [≥19 y.o.]) in Poisson and logistic regression models controlling for age, gender, marital status, migration background, BMI, alcohol consumption, smoking, and physical activity. Loneliness explained 21% of socioeconomic health inequalities between the lowest and highest socio-economic group in self-reported chronic disease prevalence, 27% in poorer self-rated health, and 51% in psychological distress. Subgroup analyses revealed that for young adults, loneliness had a larger contribution to socioeconomic gaps in self-rated health (37%) than in 80+-year olds (16%). Our findings suggest that loneliness may be a social determinant of health contributing to the socioeconomic health gap independently of well-documented factors such as lifestyles or demographics, in particular for young adults. Public health policies targeting socioeconomic health inequalities could benefit from integrating loneliness into their policies, especially for young adults.

Keywords: socioeconomic health inequalities, social determinants of health, SES, lifestyle, loneliness, the Netherlands

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1. Introduction

While average health and life expectancy in Western populations have been improving over the last few decades, not everyone in society has benefited equally. Health inequalities between and within countries still persist [1] and are a public concern from both an economic and social perspective. According to Dahlgren and Whitehead [2], the determinants of health have an individual (age, gender, genetic), lifestyle, social, as well as a socioeconomic dimension. The socioeconomic dimension is often described in terms of socioeconomic status (SES) and includes education, income and occupation. Research on SES health inequalities was started by the Black report [3] and the Whitehall [4] studies and studies have since reported that lower SES individuals tend to have poorer health [5, 6], unhealthier lifestyles [7, 8], and have higher risks for chronic diseases [9, 10].

As part of the social dimension, loneliness is a public health concern that is increasingly recognized in the context of poorer health [11, 12]. A growing number of people reporting to feel lonely has been documented around developed countries across the world. A cross-country study on loneliness and social isolation in the United States, the United Kingdom, and Japan reported that 22%, 23%, and 9% of the respondents felt lonely often or always, respectively. Loneliness is not limited to the elderly as some studies found that the majority of the lonely were under the age of 50 and were more likely single or divorced [13, 14]. Studies have shown that loneliness is correlated to mortality [11, 15], poorer physical [11, 16] and mental health [11, 17]. Lonely people were also more likely to engage in unhealthy behaviors [18, 19], and visit physicians [19, 20] and mental healthcare providers [20] more frequently. While loneliness is closely interlinked with other known determinants of health [19], to date the extent of its contribution to socioeconomic health inequalities in a general population remains unclear. Socio-economic gaps are commonly attributed to unhealthy lifestyles among disadvantaged groups while it is increasingly apparent that these factors alone cannot fully explain the observed inequalities [8, 21]. Quantifying the impact of loneliness in health inequalities after considering the combined effect of (clusters of) other social determinants might therefore present possibilities for better targeted public health policies.

We also hypothesize that the impact of loneliness on socioeconomic health inequalities may vary across population groups (e.g. age, marital, or migration status) in light of an age-normative life-stage perspective, different life circumstances, and priorities [14]. In other words, loneliness may have a different impact on persons of different ages, depending on what is considered as the 'norm' in society at different phases of life. Loneliness may interact differently with lower socio-economic status for divorced or widowed people [22], as well as persons with a migration background [23]. There is currently no consensus in the literature on whether females or males are more susceptible to experiencing loneliness and its impact on health [19] and health inequalities. Therefore, the aim of this study is to use a comprehensive national population sample in order to 1) assess the relative contribution of loneliness to the association between SES and chronic disease(s), self-rated health, and psychological distress, and 2) explore whether the contribution of loneliness to the socio-economic health gradient differs across population groups defined by age, gender, marital status, and migration background. Our findings should inform public health policies about the independent contribution of loneliness beyond the well-documented factors, in search of new modifiable social determinants to tackle the inequalities.

2. Materials and Methods

This is a cross-sectional study of associations between the individual socioeconomic status, lifestyle-related factors, and loneliness with self-rated health, chronic disease, and psychological distress in the Netherlands for the year 2016.

Data and Sample

Data were obtained from two data sources: the Dutch Health Survey and Statistics Netherlands. The Health Survey is commissioned by the municipalities and the Ministry of Health, Welfare and Sport. In accordance to the Public Health Law, Dutch municipalities are required to assess local public health issues at least once every four years. In order to do so, the Health Survey is implemented in collaboration with Statistics Netherlands, the Public Health Service, and The Dutch National Institute for Public Health and the Environment (RIVM). The Health Survey runs once every four years nationwide for people aged 19 years and older. The survey includes questions about respondents' general physical and mental health, daily activities, lifestyle, social contacts, participation in voluntary work, informal care, family life, SES, housing and neighborhood conditions. Survey data is collected in a number of ways including either by paper and pencil, internet, or interviews by telephone or face-to-face. The response rate for the Health Survey was 40% in 2016 [24], with a total of 445,748 complete responses. These data have been previously

used to, for example, study the association of loneliness and healthcare costs in a nationally representative sample [20].

The data provided by Statistics Netherlands consisted of the administrative data collected from the Personal Records Database and the Dutch Tax and Customs Administration data for the entire Dutch population. The former is collected by municipalities and provides information on citizens' age, gender, and migration background. The latter provided annual income records for each individual and household. Based on the pseudo-anonymized personal social security codes, the Health Survey data were linked with the Personal Records Database and the Dutch Tax and Customs Administration data for people aged 19 years and older in the secured environment managed by Statistics Netherlands. After merging the Health Survey sample with the administration data, 445,748 responses were retained in our sample.

Measures

Dependent variables

Three outcome variables were used to operationalize health in this study, namely 'having a chronic disease', 'self-rated health', and 'psychological distress'. The operationalization and sources of variables are listed in Appendix 1, Table A1. The variable having at least one chronic disease was obtained from the question "Do you have one or more long-term diseases (expected duration 6 months or longer)" (answer options yes or no). The dichotomous variable 'having a chronic disease' was categorized as either none or at least one. Self-rated health was measured by the question "In general, would you say your health is ...". Answers were given on a five-point Likert scale with categories "excellent", "very good", "good", "fair" and "poor". The answer categories were dichotomized as "excellent, very good, good" or "fair, poor". Psychological distress was measured with the Kessler psychological distress scale (K10) [25]. The scores for these 10 questions were categorized as "none, low, or moderate" (scores between 10 and 29), or "high" (scores between 30 and 50) psychological distress [26].

Independent variables

Loneliness

Loneliness was based on the score for the 11-item de Jong-Gierveld scale [27]. Eleven statements are listed, based on various aspects of deprivation ("I wish I had a really close friend", "Often, I feel rejected", "I experience a sense of emptiness around me", "I miss having people around me") companionship ("It makes me sad that I have no company around me", "I feel my circle of friends and acquaintances is too limited"), sociability ("There is always someone around that I can talk to about my day to day problems"), and meaningful relationships (There are plenty of people that I can depend on if I'm in trouble", "There are enough people that I feel close to", "I can rely on my friends whenever I need them", "There are many people that I can rely on completely"). The statements are scored 'yes', 'more or less' or 'no'.

Confounders

Lifestyle-related variables included Body Mass Index (BMI), alcohol consumption, smoking, and physical activity, similar to previous research [28]. We controlled for the demographic variables age, sex, migration background, and marital status, and for mode of completing the survey. Proxies for socioeconomic status included the highest attained level of education, standardized household income quartile, and self-reported income adequacy. After running all analyses for the three SES proxies separately and finding similar results, one SES construct was created in order to present the associations for socioeconomic health inequalities. To combine the three SES variables into one SES construct, they were standardized into z-scores ($z(x) = \frac{x - \text{mean}(x)}{\text{standard deviation}(x)}$) e.g. [29] from the three z-scores, one overall mean score was calculated to represent the overall SES-construct, and was further divided into quartiles. The fourth quartile included persons with the highest SES and was taken as the reference group.

Statistical analyses

The relative risks for the adverse health outcomes were modelled in a series of logistic and robust Poisson regressions. The outcomes ‘chronic disease’ and ‘self-rated health’ were modelled in Poisson regressions with robust variance given so called ‘common outcomes’ (more than 10% cases). It is known that the Odds Ratios (OR) estimates by logistic regressions do not appropriately approximate the relative risks (RR’s) for such outcomes [30]. For the outcome ‘psychological distress’ (5% cases), logistic regressions were run. Per health outcome, four regressions were computed to assess the relationships between SES and health. Model 1 included the SES construct and demographic factors (age, gender, migration background, and marital status). Model 2, contained the SES construct, demographic factors, and lifestyle-related factors. Model 3, contained the SES construct, demographic factors, and loneliness. Finally, in model 4, all factors were included. All models were adjusted for mode of survey completion (paper, internet, phone and face-to-face) and accounted for complex survey design through survey weights. The contributions of factors were assessed by comparing the relative risk and odds ratios, and their percentage change ($((\frac{OR_{Model\ 1} - OR_{Model\ X}}{OR_{Model\ 1} - 1}) \times 100)$ where X is 2, 3, or 4) as done in previous studies [31-33]. This method has been shown to result in similar findings as the counterfactual framework approach [33]. The interactions between the SES construct and (1) age, (2) gender, (3) migration background, and (4) marital status were tested to check whether the association of loneliness and the SES health gradient was different between subpopulations. Missing data were imputed by means of Multiple Imputation by Chained Equations (MICE, 5 imputations, $n = 445,748$) [34]. For the subgroup analyses, interaction effects were tested between the SES construct and age, gender, migration background and marital status. For significant interaction effects, stratified models were run. The significance level was set at $\alpha = 5\%$. Analyses were performed in Stata 16 [35].

3. Results

3.1 Descriptive statistics

The mean (SD) age was 59.4 (16.9) years and 56% of the sample was female. Dutch-born respondents represented 88% of the sample, 9% of the respondents had a western-migration background and 4% a non-western migration background. The majority of the participants was married or lived together (73%), 11% of the respondents was single, 10% was divorced and 7% was widowed. Almost 40% of the people included in the sample reported having at least one chronic disease, 26% rated their overall health as fair or poor, and 5% of the respondents was at a high risk of experiencing psychological distress. Some loneliness was reported by 34% of the participants, 5% reported severe, and 3% very severe loneliness (see Table 1). Respondents from lowest SES quartiles reported worse physical and mental health, unhealthier lifestyles, and were lonelier compared to higher SES quartiles (Appendix 1, Table A2). The descriptive statistics per health outcome are listed in Appendix 1, Table A3. Respondents with at least one chronic disease, poorer self-rated health, or high risk for psychological distress were more often ((very) severely) lonely compared to their healthier counterparts.

Table 1. Sample characteristics (n = 445,748)

Sample Characteristics	N (%)	
Age	19-40	68,434 (15.4%)
	41-64	142,790 (32.0%)
	65-80	192,640 (43.2%)
	81+	41,884 (9.4%)
Gender	Male	204,095 (45.8%)
	Female	241,653 (54.2%)

Migration background	Dutch-born	389,298 (87.3%)
	Western background	38,445 (8.6%)
	Non-western background	18,005 (4.1%)
Marital status	Married/co-habitant	313,285 (70.9%)
	Single	45,853 (10.4%)
	Widowed	30,593 (6.9%)
	Divorced	51,877 (11.7%)
Education	Primary school	30,981 (7.5%)
	Lower vocational	138,947 (33.5%)
	Middle vocational/ secondary	125,981 (30.4%)
	Higher vocational/ university	118,985 (28.7%)
Household income quartile	0-25%	64,825 (14.6%)
	26-50%	122,251 (27.5%)
	51-75%	125,196 (28.1%)
	76-100%	132,739 (29.8%)
Self-reported income adequacy	Inadequate, major concerns	12,367 (3.0%)
	Inadequate, some concerns	43,640 (10.5%)
	Adequate, minor concerns	146,380 (35.1%)
	Adequate, no concerns	215,147 (51.5%)
SES Construct	Q1, lowest SES	103,316 (25.1%)
	Q2	102,502 (24.9%)
	Q3	103,322 (25.1%)
	Q4, highest SES	102,697 (24.9%)
Physical activity	Sufficient	288,523 (70.1%)
	Insufficient	122,855 (29.9%)
Body Mass Index (BMI)	Underweight (<18,5)	5,410 (1.3%)
	Normal (18,5-25)	190,365 (44.8%)
	Overweight (25-30)	164,653 (38.8%)
	Obese (30>)	64,431 (15.2%)
Alcohol consumption	Never	47,286 (11.4%)
	Regular consumption	335,675 (80.9%)
	Excessive	32,256 (7.8%)
Smoking	Never smoked	170,859 (40.6%)
	Former smoker	181,412 (43.2%)
	Current smoker	68,163 (16.2%)
Chronic disease	None	261,977 (59.9%)
	At least one	175,086 (40.1%)
Self-rated health	Fair, bad	125,043 (28.4%)
	(very) good, excellent	315,079 (71.6%)
Psychological distress	No or low risk	411,536 (95.1%)
	High risk	21,362 (4.9%)
Mode of survey completion	Paper	221,433 (49.7%)

Internet	223,657 (50.2%)
Face-to-face	428 (0.1%)
Telephone	230 (0.01%)

Mean (sd)

Loneliness 3.1(2.9)

SES Construct: combination of education, household income quartile and self-reported income adequacy. Self reported variables: education, income adequacy, physical activity, BMI, alcohol consumption, smoking, loneliness, marital status, chronic disease, and self-rated health. Registry data variables: age, gender, migration background, and household income quartile

3.2 Socioeconomic status, lifestyle, and loneliness

The results of models 1-4 indicate that people with lower SES had higher odds to report presence of at least one chronic disease, poor self-rated health, and a high risk for psychological distress (Table 2 and Figure 1). The differences between the SES groups were largest for psychological distress, followed by self-rated health and chronic disease. That is, individuals in the lowest SES quartile have 8.93 [95%CI 8.16-9.77] higher odds to report psychological distress, 3.26 [3.17-3.35] odds to report poor health, and 1.75 [1.72-1.79] odds to have at least one chronic disease. The RR's and OR's remained statistically significant for all SES quartiles in the complete model (model 4, adjusted for age, gender, migration background, marital status, SES, lifestyle-related factors, and loneliness). For example, for the lowest SES quartile (Q1) the OR for high risk of psychological distress was 4.09 [3.72-4.51], for self-rated health the RR was 2.28 [2.21-2.34] and for chronic disease the RR was 1.45 [1.42-1.48], (Table 2).

When chronic disease was the outcome, the RR for the lowest vs highest SES group decreased by 21% with the addition of loneliness and 40% when the model was adjusted for lifestyle-related factors and loneliness (Table 2). Similarly, for self-rated health, the RR for individuals in the lowest SES quartile reduced by 27% with the addition of loneliness. With both lifestyle-related factors and loneliness, the RR for the lowest (vs highest) SES group reduced by 43%, from 2.73 to 2.28. For psychological distress, loneliness accounted for a 51% reduction of OR for the lowest vs highest SES group. Together, loneliness and lifestyle resulted in a reduction of 61% (Table 2, Figure 1, and Appendix 1 Table A4). As a robustness check we ran our models with each of the SES variables separately, which yielded similar results, see Appendix 2, Tables B1-B4.

Table 2. Associations between socioeconomic groups and the three health outcomes, adjusted for demographic factors, lifestyle, and loneliness (n = 445,748).

	Model 1 (SES)	Model 2 (SES + lifestyle-related factors)		Model 3 (SES + loneliness)		Model 4 (SES + lifestyle-related + loneliness)	
Chronic disease (RR)	RR/OR (95%CI)		% reduction		% reduction		% reduction
Q1 lowest SES	1.75 (1.72-1.79)	1.58 (1.55-1.61)	23%	1.59 (1.55-1.62)	21%	1.45 (1.42-1.48)	40%
Q2	1.30 (1.27-1.32)	1.22 (1.20-1.25)	27%	1.24 (1.21-1.26)	20%	1.17 (1.15-1.20)	43%
Q3	1.14 (1.11-1.16)	1.10 (1.07-1.13)	29%	1.11 (1.09-1.14)	21%	1.08 (1.05-1.11)	43%
Q4 highest SES	Ref	Ref		Ref		Ref	
Self-rated health (RR)							
Q1 lowest SES	3.26 (3.17-3.35)	2.73 (2.65-2.81)	23%	2.64 (2.57-2.72)	27%	2.28 (2.21-2.34)	43%
Q2	2.01 (1.94-2.07)	1.83 (1.78-1.89)	18%	1.81 (1.76-1.87)	20%	1.68 (1.63-1.73)	33%
Q3	1.46 (1.41-1.51)	1.39 (1.34-1.43)	15%	1.39 (1.35-1.44)	15%	1.33 (1.29-1.38)	28%
Q4 highest SES	Ref	Ref		Ref		Ref	
Psychological distress (OR)							
Q1 lowest SES	8.93 (8.16-9.77)	7.29 (6.64-7.99)	21%	4.87 (4.43-5.34)	51%	4.09 (3.72-4.51)	61%
Q2	3.24 (2.94-3.57)	2.94 (2.67-3.25)	13%	2.29 (2.07-2.53)	42%	2.12 (1.91-2.34)	50%
Q3	1.85 (1.67-2.05)	1.75 (1.58-1.94)	12%	1.58 (1.42-1.76)	32%	1.51 (1.36-1.68)	40%
Q4 highest SES	ref	ref		ref		ref	

RR: Risk Ratio, OR: Odds Ratio, CI: Confidence Interval, all OR's significant at p-value<0.01, SES 220
 construct: combination of standardized z-scores ($z(x) = \frac{x - \text{mean}(x)}{\text{standard deviation}(x)}$) for education, house- 221
 hold income, and income adequacy. All models are adjusted for age, gender, migration background, 222
 marital status and mode of survey completion. RR and OR percentage reduction was calculated as: 223
 $(\frac{\text{OR}_{\text{Model1}} - \text{OR}_{\text{Model2}}}{\text{OR}_{\text{Model1}} - 1}) \times 100$. 224

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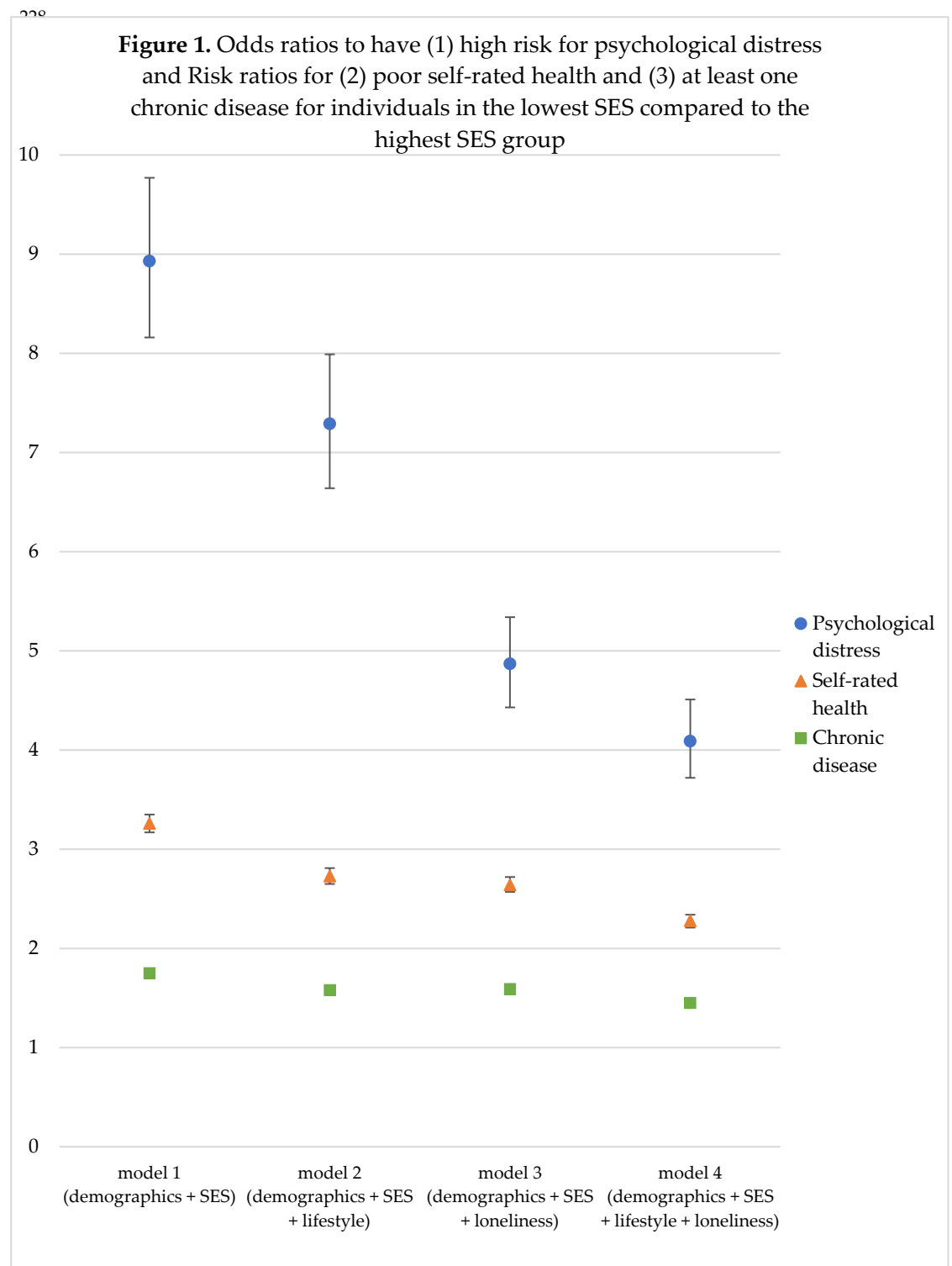


Figure 1. Odds ratios to have (1) high risk for psychological distress, (2) poor self-rated health and (3) at least one chronic disease for individuals in the lowest SES group compared to the highest SES group.

Fig. 1 OR's (95%CI) (lowest SES group [Q1] vs highest SES group [Q4]) in model 1 (demographic and SES factors), model 2 (demographic, SES factors, and loneliness), and model 3 (demographic, SES, lifestyle factors and loneliness) for psychological distress (blue), self-rated health (orange), and chronic disease (green).

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3.3 Analyses in age and gender strata's

To assess whether sub-group analyses were warranted, interactions effects were tested between SES and age, gender, migration status and marital status for all three outcomes. Interaction effects between SES and all four demographic factors were significant when chronic disease or self-rated health were an outcome. For psychological distress, interactions with age, gender, and migration status were observed. For gender and migration status, the direction and magnitude of the SES gradient as well as the relative role of lifestyles and loneliness remained similar compared to the general population (Appendix 1, Table A4 and A5). Loneliness had a slightly larger role in explaining the socioeconomic health gradient in singles (24% for chronic disease and 31% for self-rated health) and divorced respondents (24% and 29%), compared to married (21% and 27%) and widowed respondents (22% for both outcomes), (Appendix 1, Table A7). For the youngest age group (19-40 years old), loneliness was relatively more important in explaining socio-economic differences in self-rated health and psychological distress, compared to older adults. When accounting for loneliness, the difference between the lowest and highest SES group in self-rated health reduced by 37% among young adults vs 16% in the 80+ age category. For psychological distress, this difference was reduced by 55% and 27% for the youngest and oldest age group, respectively. See Table 3 for the results of model 3 (loneliness) in the complete sample and the four age groups, and Appendix 1 Table A7 for the results of all age groups in all models.

Table 3. Associations for complete sample and four age groups with the three health outcomes, adjusted for demographic factors, SES, and loneliness (model 3).

RR/OR (95%CI) [% reduction]	Complete sample (n = 445,748)		Age group 19-40 (n = 68,434)		Age group 41-64 (n = 142,790)		Age group 65-80 (n = 192,640)		Age group 81+ (n = 41,884)	
Chronic disease (RR)										
Q1 lowest SES	1.59 (1.55-1.62) 21%		1.83 (1.72-1.95) 27%		1.73 (1.68-1.79) 22%		1.27 (1.25-1.30) 21%		1.10 (1.06-1.15) 29%	
Q2	1.24 (1.21-1.26) 20%		1.29 (1.20-1.37) 26%		1.29 (1.25-1.33) 17%		1.08 (1.06-1.10) 27%		1.00 (0.96-1.04)	
Q3	1.11 (1.09-1.14) 21%		1.12 (1.05-1.20) 25%		1.15 (1.11-1.19) 12%		1.01 (0.99-1.04)		0.99 (0.95-1.03)	
Q4 highest SES	Ref		ref		ref		ref			
Self-rated health (RR)										
Q1 lowest SES	2.64 (2.57-2.72) 27%		2.95 (2.70-3.23) 37%		2.96 (2.83-3.09) 28%		2.11 (2.05-2.18) 20%		1.53 (1.46-1.61) 16%	
Q2	1.81 (1.76-1.87) 20%		1.88 (1.71-2.06) 27%		1.90 (1.81-1.99) 18%		1.56 (1.51-1.61) 14%		1.29 (1.22-1.35) 9%	
Q3	1.39 (1.35-1.44) 15%		1.43 (1.29-1.58) 19%		1.43 (1.36-1.50) 12%		1.25 (1.21-1.29) 14%		1.17 (1.10-1.23) 6%	
Q4 highest SES	Ref		ref		ref		ref			
Psychological distress (OR)										
Q1 lowest SES	4.87 (4.43-5.34) 51%		3.92 (3.32-4.61) 55%		5.83 (5.09-6.67) 51%		5.18 (4.48-5.98) 40%		4.95 (3.86-6.33) 27%	
Q2	2.29 (2.07-2.53) 42%		2.06 (1.73-2.47) 64%		2.52 (2.18-2.91) 40%		2.32 (2.00-2.70) 32%		2.72 (2.11-3.51) 18%	
Q3	1.58 (1.42-1.76) 32%		1.49 (1.24-1.79) 36%		1.64 (1.41-1.90) 29%		1.66 (1.40-1.96) 27%		1.65 (1.22-2.23) 21%	
Q4 highest SES	ref		Ref		ref		ref		ref	

RR: Risk Ratio, OR: Odds Ratio, CI: Confidence Interval, SES construct: combination of standardized z-scores ($z(x) = \frac{x - \text{mean}(x)}{\text{standard deviation}(x)}$) for education, household income, and income adequacy. All models are adjusted for gender, migration background, marital status and mode of survey completion. RR and OR percentage reduction was calculated as: $(\frac{OR_{Model1} - OR_{Model2}}{OR_{Model1} - 1}) \times 100$. RR's and OR's with $p < 0.05$ are in bold.

4. Discussion

The aims of this study were to 1) assess the relative contribution of loneliness to the association between SES with chronic disease, self-rated health, and psychological health and 2) explore whether the interplay between loneliness, socio-economic status, and health is different across population subgroups by age, gender, migration background, and marital status. We observed that loneliness can further explain the socio-economic gradient in health, independent of lifestyle, demographic and migration background. Our findings could inform public health policies about the independent contribution of loneliness beyond the well-documented factors, in search of new modifiable social determinants to tackle inequalities. Importantly, in young adults the role of loneliness in socio-economic health inequalities was more pronounced compared to older people. To our knowledge, our study is the first to quantify the relative contribution of loneliness to socio-economic gradients across a range of important health outcomes.

Public health policies aiming to reduce the health gradient could benefit from recognising loneliness as a potential pathway from socio-economic disadvantage to poor health. So far, the EU public health policy focuses on reducing the health gap by promoting healthy lifestyles in terms of nutrition, physical activity, alcohol, tobacco, and drug consumption, without specifically mentioning loneliness or other social factors [36]. In 2013, Mackenbach et al. assessed the 10 major contributors to health gains with the aim to evaluate the European public health policies, and loneliness was not considered among the major contributors [37]. In the Netherlands, policies that have been introduced in the past decades to reduce socioeconomic health inequalities were mostly focused on lifestyle, with an emphasis on individual responsibility [38]. One of the most recent health policies, the National Prevention Agreement, focuses on three major lifestyle factors; smoking, overweight, and excessive alcohol consumption [39]. The UK appears to be one of the few countries integrating loneliness in public health policy-making for the general population, with a Minister for Loneliness appointed in January 2018, and its first cross-government loneliness strategy in October of that year.

Current national policies that do target loneliness focus on mainly elderly populations [40]. One of the strengths of this study is that the large sample allowed us to explore differences between subpopulations and revealed the relative importance of loneliness in the context of health inequalities in the youngest age group. If elderly populations might to some extent be more acceptant of feelings of loneliness as part of their life phase, in line with the age-normative perspective [14], younger aged low SES groups may struggle more with loneliness in their overall well-being. This could imply that public health policies targeting loneliness may benefit from expanding the target group to include younger adults. The UK strategy is not focused on older age groups only as, for example, it also aims to embed loneliness into primary and secondary school classes. By 2023, all General Practitioners in the UK will refer lonely or socially isolated patients to 'community activities and voluntary services' [41]. While the effects of these policies remain to be seen, evidence points at potential benefits of integrating social factors into public health agenda's to offer opportunities to level socioeconomic inequalities in diverse population groups.

While this study accounted for loneliness to help further explain socio-economic inequalities beyond demographic and lifestyle factors, part of the health gap still remains. The risk ratios between the lowest and highest SES group remained 1.45 for chronic disease, 2.28 for self-rated health, and 4.09 for psychological distress. Other individual (e.g. genetic) and environmental factors (e.g. housing or neighbourhood environment) [42] could explain socioeconomic health differences further. Future research should explore the role of loneliness in the context of these other individual and environmental factors on the pathway from socioeconomic disadvantage to poor health.

Our findings should be interpreted in a view of a few limitations. First, the cross-sectional design hinders drawing any causal inferences. Future research with longitudinal design is warranted to explore the causal relationships and direction of the relationships

between loneliness, SES and health. Second, the Health Survey might suffer from selection bias, as the most socially disadvantaged individuals tend not to participate in survey research [43]. Despite deliberate oversampling of disadvantaged groups by the Health Survey, only 12,8% of the respondents belonged to the lowest income quartile. Similarly, only 12,1% of the respondents had a migration background as opposed to the national average of 22,1% in 2016 [44], possibly because the Health Survey is administered in Dutch only. Though the analyses used weighted data to balance out underrepresented groups, the associations of loneliness and SES health inequalities reported in this study is likely a conservative estimate. Third, the presence of at least one chronic disease as an outcome has a limitation in a sense that it does not distinguish the type of the disease. Different types of chronic diseases may be associated differently with SES, lifestyle-related factors, and loneliness. For example diabetes, respiratory, and cardiac diseases may be more related to SES and lifestyle-related factors, whereas mental diseases may be more strongly related to SES and loneliness. In this study, socioeconomic health inequalities were more pronounced in psychological and self-rated health compared to the presence of chronic disease(s) which may be attributed to the fact that self-rated health and psychological health are a more sensitive proxy to well-being than the presence of at least one chronic condition. These differences remain to be explored in future research.

5. Conclusions

In conclusion, our findings revealed that loneliness contributes to socioeconomic inequalities on top of demographic and lifestyle-related factors. While current public health policies tend to focus predominantly on lifestyle and address loneliness specifically in elderly populations, our results suggest that public health policies may benefit from more integrated approaches. In addition to lifestyle interventions, tackling loneliness, especially for youth, has the potential to reduce socioeconomic health inequalities.

Supplementary Materials: Table A1: Categories, operationalization, and sources of dependent and independent variables. Table A2: Percentages of adverse outcomes by SES quartile. Table A3: Percentages of adverse lifestyle behaviors and loneliness by health outcome. Table A4: Associations between demographic and socio-economic, lifestyle-related factors, loneliness, and health outcomes for males and females. Table A5: Associations between demographic and socio-economic, lifestyle-related factors, loneliness, and self-rated health for different migration groups. Table A6: Associations between demographic and socio-economic, lifestyle-related factors, loneliness and health outcomes for different marital status groups. Table A7: Associations between demographic and socio-economic, lifestyle-related factors, loneliness, and health outcomes for different age groups. Table B1: Associations between education, demographic, lifestyle-related factors, loneliness, and health outcomes. Table B2: Associations between household income quartile, demographic, lifestyle-related factors, loneliness and health outcomes. Table B3: Associations between income adequacy, demographic, lifestyle-related factors, loneliness and health outcomes. Table B4: Associations between SES, demographic, lifestyle-related factors, loneliness, and health outcomes.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The dataset was provided by Statistics Netherlands and the Dutch Public Health Services. Requests to access these datasets should be directed to Statistics Netherlands, microdata@cbs.nl. Results are based on calculations by researchers from Maastricht University using non-public microdata from Statistics Netherlands.

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