



Decreasing income inequality and adolescent emotional distress: a population-based case study of Icelandic adolescents 2006–2016

Arndis Vilhjalmsdottir¹ · Bart De Clercq² · Ragna B. Gardarsdottir¹ · Jon Gunnar Bernburg⁴ · Inga Dora Sigfusdottir³

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Abstract

Objectives In this study, we aim to test whether changes in community income inequality influence adolescent emotional distress. We take advantage of the unique combination of data and history available in Iceland. This affluent welfare society has experienced extreme shifts in income inequality, allowing us to test whether changes in community income inequality are related to changes in adolescent emotional distress.

Methods Combining adolescent survey data ($n = 24,107$) with tax registry data on 76 neighborhood communities, we used a multilevel approach to model the data as longitudinal in order to test whether changes in community income inequality are related to changes in symptoms of anxiety and depression among adolescents.

Results The results showed that, after adjusting for relevant individual and community covariates, decreases in community income inequality were associated with decreases in symptoms of anxiety among adolescents ($b = -0.367$, $p \leq 0.001$), but not with decreases in symptoms of depression.

Conclusions While the results provide a partial support for the income inequality thesis, we call for replications from other cultures and studies exploring the mediating role of social psychological processes.

Keywords Adolescents · Anxiety · Depression · Neighborhood communities · Income inequality · Change effects

Introduction

A recent rise in both income inequality (Piketty and Saez 2014) and emotional distress among younger cohorts (Kessler et al. 2007) has directed attention to whether and

how these trends are related in affluent societies (Hidaka 2012). The *income inequality thesis* (Wilkinson and Pickett 2017) holds that as the economic distance between the least and most affluent in a society increases, so does anxiety and depression among society members, *regardless* of their personal economic standing. While causal mechanisms remain unclear (Avendano and Hessel 2015), scholars (Wilkinson and Pickett 2017) have suggested that a high level of income inequality facilitates psychosocial dysfunction, in the form of unfavorable social comparison and

Arndis Vilhjalmsdottir and Bart De Clercq have contributed equally to this work.

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✉ Arndis Vilhjalmsdottir
arv5@hi.is

Bart De Clercq
b.declercq@ugent.be

Ragna B. Gardarsdottir
rbg@hi.is

Jon Gunnar Bernburg
bernbu@hi.is

Inga Dora Sigfusdottir
ingadora@ru.is

¹ Faculty of Psychology, University of Iceland, Oddi, 101, Reykjavík, Iceland

² Faculty of Medicine and Health Sciences, Department of Public Health, Academic Hospital, Ghent University, K3-4, De Pintelaan, 185, 9000 Ghent, Belgium

³ School of Business, Reykjavik University, Menntavegi 1, 101 Reykjavík, Iceland

⁴ Faculty of Social Science, University of Iceland, Oddi, 101, Reykjavík, Iceland

an erosion in social capital (social networks and trust), thus undermining emotional well-being. To substantiate this argument, some have pointed out how egalitarian societies tend to be more cohesive, supportive and healthier than more unequal societies (Islam et al. 2006; Wilkinson and Pickett 2007).

Historically, Iceland is an egalitarian country with an even income distribution. As may be seen in Fig. 1, this changes during the 2000s economic boom, and country-level income inequality rose to previously unseen levels. From 1997 to 2007, the country's Gini coefficient increased strongly—or by 52% (Olafsson and Kristjánsson 2013). Curiously, at approximately the same time, symptoms of anxiety and depression increased in the adolescent population (Sigfusdóttir et al. 2008). However, in the wake of the economic recession in 2009, income inequality was sharply reduced (see Fig. 1), mostly because of income reduction among top earners (Olafsson and Kristjánsson 2017). In 2012 Iceland's income distribution had reached its previous egalitarian level, albeit rising again slightly in 2014 (Olafsson and Kristjánsson 2017).

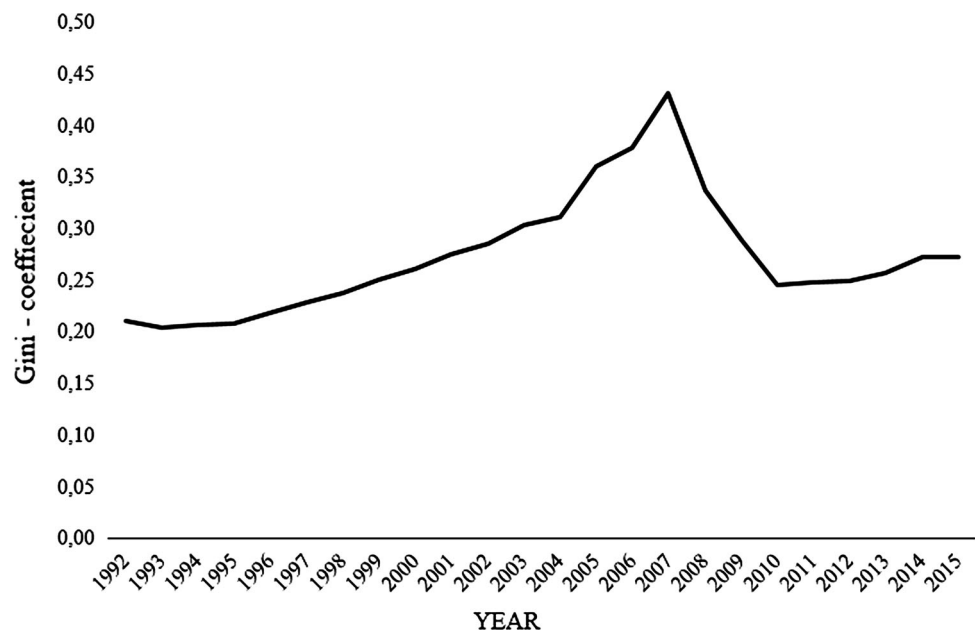
Because the global increase in income inequality for the past three decades has provided the broader context for most studies testing the income inequality thesis, they have assumed both an increase in income inequality and ill-health (Kondo et al. 2012; Hu et al. 2015). For example, although several country-level studies have established that income inequality is related to health and well-being in adolescents (Elgar et al. 2015, 2016), no study has tested the inverse claim inherent in the income inequality thesis, that a *reduction* in income inequality indeed produces *better* health outcomes, thus validating the claim. The

dramatic shifts in income inequality in Iceland, in combination with available population data on Icelandic adolescents, provides a unique natural laboratory (Craig et al. 2012) to test the inverse implication of the income inequality thesis.

In this study, we aim to link the shifts in income inequality in Iceland, to changes in adolescent emotional distress. We do this by applying the income inequality thesis to adolescents in the neighborhood context. We focus on adolescents within neighborhood communities for two reasons. First, adolescence is a formative time period for emotional well-being throughout the life-course (Kessler et al. 2007; Graber and Sontag 2009). Second, income inequality in the neighborhood community may be more relevant for adolescents than income inequality at a larger societal scale (Pabayo et al. 2016), due to their sensitivity to social comparison (Blakemore and Mills 2014), awareness of social hierarchy and stigma (McLoyd et al. 2009; Flanagan et al. 2014), and dependence on the neighborhood social context (Leventhal et al. 2009).

Although cross-national studies have linked income inequality with psychological symptoms among adolescents (Elgar et al. 2015, 2016), few have explored how income inequality in the neighborhood community may relate to adolescent anxiety and depression. Apart from two cross-sectional studies linking high community income inequality to emotional distress among Icelandic adolescents (Vilhjálmsdóttir et al. 2016, 2018b), we know of only one other study addressing the association of community income inequality and adolescents' symptoms of depression. That study (Pabayo et al. 2016) found that income inequality was related to depressive symptoms among

Fig. 1 The trajectory of income inequality in Iceland from 1995 to 2007, as measured using the Gini coefficient. Figure is based on numbers from Olafsson and Kristjánsson (2017)



adolescent girls in a restricted sample of 38 neighborhood communities in Boston.

Two out of the three studies (Pabayo et al. 2016; Vilhjalmsdottir et al. 2016) assessed only one dimension of emotional distress, as a single indicator of depression, or as a cluster of anxiety and depression symptoms. Unfortunately, this practice does not advance science by pinpointing specific pathways between income inequality to various indicators of emotional distress (Kawachi and Subramanian 2014). Support for this practice, however, is found in the third study (Vilhjalmsdottir et al. 2018b) which showed the associations between income inequality and adolescent emotional distress may, indeed, be contingent on the type of emotional distress—and on the time-point measured.

Still, these studies (Pabayo et al. 2016; Vilhjalmsdottir et al. 2016, 2018a) do not address change in income inequality or change in adolescents' symptoms of anxiety and depression over time. Longitudinal studies—assessing simultaneous shifts in income inequality and adolescents symptoms of anxiety and depression—are needed in order to test the association between trends in income inequality and trends in adolescent emotional outcomes (Pabayo et al. 2016), and to substantiate whether reducing income inequality is beneficial to population health (Avendano and Hessel 2015).

Hence, in this study, we aim to use population-based observational data from Icelandic adolescents and neighborhood communities from 2006 to 2016 to gauge the relationship between income inequality and emotional distress. Specifically, we test whether the marked *decrease* in income inequality within Icelandic neighborhood communities from this time period is related to a *decrease* in symptoms of anxiety and depression among adolescent.

Methods

Data collection

Individual data came from a repeated cross-sectional survey, Youth in Iceland (YiI), conducted by The Icelandic Center for Social Research and Analysis (www.rannsoknir.is) in the years 2006, 2009, 2012, 2014 and 2016, according to protocol described elsewhere (Kristjansson et al. 2013). The YiI survey includes all adolescents in Iceland attending the compulsory ninth and tenth grades of secondary public schools (15 and 16 y.o.). Table 1 shows population numbers of both schools and students and gives a simple overview of our sampling strategy. Valid answers were obtained from 80% to 83% of the five cohorts. It is unclear why responses are missing from about 20% of the students. They may have been absent at the time when the

survey was conducted in their school or their parents may have prohibited their participation. Unfortunately, because of a complete lack of information on those missing students, imputation of missing values was not possible. Still, a participation rate of 80% and over is unusually high in school-based surveys (Weitzman et al. 2003).

Students who did not belong to the community population were excluded from the analysis, as their school attendance did not correspond to their residence (5485 students). These excluded students may be classified into two groups: 1) those who live in rural areas, and have to commute to other municipalities to attend school, or 2) those who may have been transferred to other schools for personal reasons. The first group of students ($n = 2444$) does not belong to our population of interest, because they live in rural areas that can hardly be regarded as meaningful neighborhood communities. However, the second group of students ($n = 3041$) may contribute to a systematic dropout bias in the analyses since the causes of them not attending their neighborhood school may correlate with the characteristics of their neighborhood. But, because of complete lack of information on where they actually live, any modeling of neighborhood characteristics in relation to their emotional distress is futile.

In order to ensure that only neighborhoods with meaningful and consistent neighborhood boundaries were included in our analysis, we restricted our analysis to schools participating in all five waves of YiI, containing 10 or more respondents on all waves (Raudenbush and Sampson 1999; Aminzadeh et al. 2013) (or 14 schools). In this process, we excluded private schools, which have no assigned school district, schools for the severely disabled, and schools that had during this period merged with others to form new school communities, altogether 46 schools containing 6097 students. This process resulted in valid data from 24,107 students obtained over the five time-points in 76 neighborhood communities. Missing individual data, ranging from 0.1% to 2.3%, were deleted when running the analyses.

Neighborhood community measures for all years were developed in collaboration with Statistics Iceland (<http://statice.is/>), a government agency that collects population demographic data and income data based on tax records of all Icelanders by their registered address (based on the national registry; www.skra.is). Because public school attendance in Iceland is highly correlated with neighborhood community residency, we used an institutional approach (Chaskin 1997) defining neighborhood communities as household addresses assigned to each public school, regardless of if they contained a public school attending student.

Table 1 Population of adolescents attending the 9th and 10th grade of elementary school, the participation rate of schools and students in the Youth in Iceland surveys, and the number of students used in the final analyses in the Icelandic data from the years 2006, 2009, 2012, 2014 and 2016

	2006	2009	2012	2014	2016
<i>Population of Icelandic adolescents attending the 9th and 10th grade of elementary school</i>					
All students enrolled in the 9th and 10th grade (N)	9278	9241	8710	8468	8488
Student participation rate [n, (%)]	7430 (80)	7514 (81)	7267 (83)	6998 (83)	7079 (83)
Students attending their neighborhood school [n, (%)]	6326 (86)	6397 (86)	5983 (84)	5728 (83)	5770 (85)
All schools containing 9th and 10th grade (N)	141	144	147	142	147
School participation rate [n, (%)]	129 (91)	140 (97)	145 (99)	130 (92)	145 (99)
<i>Included in the final analysis (n)</i>					
Meaningful school neighborhoods	76	76	76	76	76
Students in final analysis [n (%)]	5335 (58)	5082 (55)	4686 (54)	4560 (54)	4444 (52)
Mean number of respondents per school (n)	70.20	66.87	61.66	60.00	58.47
Standard deviation	50.61	45.12	38.72	37.88	40.24
Range of respondents	13–286	11–261	13–199	10–213	12–233

Number of schools containing 9th and 10th grade may vary as rural schools may vary in their inclusion of higher grades and number of children registered between years. Number of schools may also vary as school district boundaries change between years, for example through merging of public schools

Individual-level measures

We measured adolescents' emotional distress with 12 items from the multidimensional Hopkins Symptom Checklist-90 (SCL-90) (Derogatis et al. 1974). The SCL-90's shorter forms (e.g., SCL-5 and SCL-10), performing nearly as well as the full version (Strand et al. 2003), have frequently been used to screen for emotional problems in Nordic populations (Veijola et al. 2003). Moreover, prior research among Icelandic adolescents have found the current measures of anxiety and depression symptoms to be valid (Sigfusdóttir et al. 2004, 2008) and time invariant for the time period of 2006 to 2016 (Thorisdóttir et al. 2017). Symptoms of *anxiety* (e.g., nervousness or feeling tense) were measured with a mean scale of three items, $\alpha = .75-.82$. Symptoms of *depression* (e.g., being sad or having little interest in doing things) were measured with the mean of nine items, $\alpha = .89-.92$. Both measured frequency of symptoms during the past week ranging from 1 'almost never' to 4 'often'. Because both scales were positively skewed they were logarithmically transformed, also allowing for an interpretation in percentage change.

We accounted for demographic characteristics and composition within communities (Oakes 2004; Avendano and Hessel 2015) by including several individual-level covariates. First, in the absence of a direct measure of family income, we included adolescent *family deprivation*, measured with the mean of four items, $\alpha = .75-.80$, assessing the frequency of the adolescent's parents inability to pay for basic necessities (Bernburg et al. 2009b) ranging from 1 = 'almost never' to 5 = 'almost always'.

Second, we include *gender* as a dichotomous variable by coding 0 = 'male', and 1 = 'female', and age as some students may have started their elementary education earlier than others, or have been transferred between grades. Third, we included *family disruption* as a dichotomous variable by coding 1 'the respondent does not live with both parents' and 0 if otherwise. Fourth, *Icelandic spoken at home* was used as a proxy measure for immigrant status, where yes was coded as '0' and '1' if no.

Community-level measures

Because our aim was to measure a *change in income inequality*, we created an index measuring an increase in community income equality (or a reversed income inequality measure). Based on tax records of households belonging to the public school communities we created a quintile ratio by dividing the mean disposable equivalized income, including capital gains, of the 20% lowest income households with that of the 20% highest-income households in the community (a 20/80 ratio). The higher the value of the index, the *lower* the level of income inequality. We assume a 1-year time lag between income equality and emotional distress outcomes on the grounds that any cause must precede its outcome in time. Hence, the equality index is calculated based on tax returns for a given year (i.e., tax returns over 12 months) which in turn corresponds to emotional outcomes measured in the following year (e.g., the value of the equality index in the year 2005 corresponds to anxiety and depression measures in 2006).

Households are defined as individuals sharing the family number assigned to them by Statistics Iceland, or sharing an address. Moreover, adults under the age of 30 who have already obtained their own family numbers (as Icelanders automatically do at the age of 18) but still share a registered address with their parents, were assigned to their former households family number (i.e., their parents family number). In addition and with the aim of only including active community members in the tax data (i.e., people who actually live in the community), individuals likely to be living elsewhere than in the neighborhood community, such as students living abroad and diplomats, were excluded. We believe that this procedure developed in collaboration with Statistics Iceland both reflects Icelandic households as a realistic economic unit during the time period 2006 to 2016, and adolescents' economic reality in their neighborhood community.

We accounted for community-level confounders following previous community research among adolescents (Sampson et al. 1997; Bernburg et al. 2009a, b). First, we included the *capital area location* of the school neighborhood, coded 1 for 'school neighborhoods in the capital area', and 0 for 'schools located outside the capital area'. Second, we account for a neighborhood community *mobility rate* calculated as the proportion of individuals who have a different residential address from the year before. Third, we created a community *concentrated disadvantage index* (CDI) with a factor score of three variables tapping on economic and social disadvantage; (1) the logarithm of the positively skewed median equivalized disposable income of all households belonging to the community, (2) proportion of single-parent households, and (3) proportion of immigrants in the community (Sampson et al. 1997). All registry-based community-level data was matched with the individual level data in such a way that a community measure from a given year (e.g., 2005) corresponded with individual level data from a following year (e.g., 2006).

Finally, because the economic turmoil in Iceland went hand in hand with changes in the societal context (Bernburg 2016), we included the *survey cycle*, coded from 1 indicating the survey cycle in 2006 to 5 denoting 2016, to account for simultaneous but unrelated time-trends. Finally, we included a quadratic term as *survey cycle*² to account for other nonlinear trends that may share the same trajectory as income inequality (Fairbrother 2014).

Statistical analysis

We use a novel method for modeling comparative survey datasets which allows for the separation of the time-invariant community characteristics from time-varying characteristics. This technique developed by Fairbrother (2014) aims to answer the question whether the

relationship observed between income inequality and emotional distress is the same over time, as it is cross-sectionally, by group mean centering community-time income inequality while controlling for the mean of community income inequality over the time (and other community characteristics regarded as confounders). This entails that all community-level variables (level 3) are grand mean centered (centered means of the period under study), while the community-by-years variables (level 2) are group mean centered and thus measured as standard deviations from the community's overall mean at different time-points. At the community level (level 3), four covariates have constant values during the study period: capital location of the community, average level of concentrated disadvantage, average mobility rates and average level of equality. At the community-by-year level (i.e., the period level or level 2), the equality variable indicated how much the community's income equality deviated from the community average of the time period 2006 to 2016 at each of the five time-points (i.e., 2006, 2009, 2012, 2014 and 2016) in terms of standard deviations (Fairbrother 2014). Thus, the coefficient for this variable indicates the percent change in anxiety and depression for a one unit standard deviation increase in equality from the overall community mean over the time period under study. All analyses are conducted using HLM7 software (Raudenbush et al. 2011).

Results

Table 2 provides a descriptive overview of the datasets used in our analyses. First we observed that the development of the income distribution seems to be slightly U-shaped. That is, income inequality decreased from 2005/2008 to 2011, but rises again in 2014. Second, anxiety and depression trajectories are also U-shaped, with the adolescent cohort in 2012 reporting the fewest symptoms of both anxiety and depression.

Before proceeding to multilevel analyses (results shown in Tables 3 and 4), we first checked whether there was a significant difference between communities in adolescent anxiety and depression. The results of empty intercept-only models (models 1 and 5) showed that most of the community-level variance in symptoms of anxiety and depression was between communities-years, with the 3rd level (community level) variance only significant for depression ($\chi^2 = 143.066$, $p \leq 0.001$), with the intra-class correlation (ICC) showing that about 2.1% and 2.2% of the variance of anxiety and depression was located at the community level (Merlo et al. 2005).

While we assume that a multilevel approach is appropriate, any estimation of the effect of changes in community income inequality can only be reliably done by first

Table 2 Descriptive overview of both community and student characteristics used in the final analyses in the Icelandic data from the years 2006, 2009, 2012, 2014 and 2016

Measures/year	2006		2009		2012		2014		2016	
Continuous variables	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Individual-level variables										
Log anxiety	0.51	0.39	0.49	0.39	0.41	0.40	0.44	0.43	0.49	0.45
Log depression	0.47	0.37	0.46	0.36	0.43	0.38	0.45	0.40	0.50	0.41
Household deprivation	1.34	0.59	1.40	0.64	1.39	0.64	1.35	0.62	1.31	0.57
Age	15.48	0.53	15.51	0.52	15.50	0.51	15.49	0.51	15.49	0.52
Dichotomous variables (0. 1)										
	Percent									
Female	0.51	0.50	0.51	0.50	0.51	0.50	0.52	0.50	0.50	0.50
Family disruption	0.29	0.45	0.28	0.45	0.28	0.45	0.29	0.45	0.30	0.46
Icelandic spoken at home	0.09	0.29	0.12	0.32	0.11	0.31	0.13	0.33	0.15	0.35
Neighborhood-level variables										
Residential mobility	0.19	0.11	0.18	0.05	0.14	0.03	0.15	0.03	0.16	0.03
CDI (factor score)	0.13	0.98	0.18	0.99	0.16	1.00	0.21	1.00	0.22	0.99
Equality index (20/80)	0.22	0.06	0.22	0.06	0.28	0.04	0.28	0.05	0.27	0.05
Dichotomous variables (0.1)										
	Percent									
Capital location	0.47	0.50	0.47	0.50	0.47	0.50	0.47	0.50	0.47	0.50

ruling out bias due to composition of people within communities and the effect of relevant community-level covariates (Oakes 2004; Avendano and Hessel 2015). The results of such benchmark models for anxiety and depression (see models 2 and 6 in Tables 3, 4) showed that after accounting for demographic composition and community-level covariates there still remains a significant period level variance in both symptoms of anxiety ($\chi^2 = 719.484$, $p \leq 0.001$) and depression ($\chi^2 = 650.036$, $p \leq 0.001$). Next we added changes in income inequality, and change covariates, to the equation (models 3 and 7), which showed that as income inequality decreased (from the overall mean in a given community) symptoms of anxiety decrease significantly ($b = -0.580$, $p \leq 0.001$), while no significant changes are found in symptoms of depression ($b = -0.123$, $p = 0.232$).

Finally, in order to rule out the spurious association of the decrease in community income inequality with a decrease in adolescent anxiety, we added time both as a linear and quadratic term. By adding time, the relationship between a decrease in income inequality and a decrease in symptoms of anxiety is reduced by 37%, but remains significant ($b = -0.367$, $p \leq 0.01$). In the final models (models 4 and 8) the *proportion* of variance located at the community level (or the intra-class correlation) is 1.3% for symptoms of anxiety and 1.4% for depression. Hence, the differences in the intra-class correlation between the intercept-only models and the final models show that the final models explain 40% of original community-level variance in symptoms of anxiety and about 38% in symptoms of depression found in the intercept-only model.

Discussion

Our study is the first to test whether a decrease in income inequality is related to a decrease in symptoms of anxiety and depression among adolescents, as the income inequality thesis suggests (Wilkinson and Pickett 2017). The results support the general notion that inequality is linked to emotional distress by showing that as income inequality decreases within neighborhood communities, symptoms of anxiety also decrease across adolescent cohorts. Although we do not provide a full mediation test, the reduction in the strength of the association between the decrease in income inequality and the decrease in anxiety indicates that this link may be partly mediated by time-varying societal or individual factors.

The crux of the income inequality thesis is that as income inequality increases, status importance increases and social capital deteriorates, which in turn may lead to feelings of social anxiety, exclusion and detachment, implying the mediating mechanism via societal or individual processes (Wilkinson and Pickett 2017). While a recent study among Icelandic adolescents failed to find support for the mediational role of social capital in the community income inequality—emotional distress link (Vilhjálmsdóttir et al. 2016), another study among Icelandic adults found that during the sharp rise in income inequality in the mid-2000s, status differences became more salient to Icelanders (Oddsson 2016). The increased awareness of class division may have elicited status related comparison and worries that were later reduced as the income distribution returned to its' usual low levels. While we are unable to address adolescent *perception of status*

Table 3 Fixed and random parameters of predictors of log anxiety in pooled data of adolescents in the Icelandic data from the years 2006, 2009, 2012, 2014 and 2016

	Model 1			Model 2			Model 3			Model 4		
	<i>b</i>	SE	Sig.	<i>b</i>	SE	Sig.	<i>b</i>	SE	Sig.	<i>b</i>	SE	Sig.
Fixed parameters												
Intercept	0.470	(0.004)	***	0.468	(0.004)	***	0.467	(0.004)	***	0.467	(0.004)	***
<i>Level 3 (communities)</i>												
Capital location				− 0.011	(0.009)		− 0.009	(0.009)		− 0.009	(0.009)	
Mobility rate				− 0.035	(0.030)		− 0.030	(0.032)		− 0.029	(0.032)	
Concentrated disadvantage				− 0.002	(0.005)		− 0.003	(0.004)		− 0.003	(0.005)	
Equality index (20/80 ratio)				− 0.005	(0.073)		0.001	(0.073)		− 0.001	(0.073)	
<i>Level 2 (period)</i>												
Change in mobility rate							0.149	(0.097)		0.052	(0.088)	
Change in concentrated disadvantage							0.006	(0.016)		0.010	(0.016)	
Change in equality (20/80 ratio)							− 0.580	(0.122)	***	− 0.367	(0.127)	*
Survey cycle										− 0.107	(0.014)	***
Survey cycle ²										0.018	(0.002)	***
<i>Level 1 (individuals)</i>												
Household deprivation				0.099	(0.005)	***	0.099	(0.005)	***	0.100	(0.005)	***
Female				0.220	(0.005)	***	0.220	(0.005)	***	0.221	(0.005)	***
Age				0.026	(0.006)	***	0.026	(0.006)	***	0.026	(0.006)	***
Family disruption				0.028	(0.006)	***	0.028	(0.006)	***	0.027	(0.006)	***
Icelandic spoken at home				0.013	(0.010)		0.014	(0.010)		0.014	(0.010)	
	σ^2	SD	Sig.	σ^2	SD	Sig.	σ^2	SD	Sig.	σ^2	SD	sig
Random parameters												
Level 3 (community) variance	0.000	(0.014)		0.000	(0.003)		0.000	(0.014)	*	0.000	(0.020)	***
Level 2 (community by year) variance	0.003	(0.058)	***	0.003	(0.058)	***	0.003	(0.050)	***	0.002	(0.039)	***
Level 1 (student) variance	0.167	(0.409)		0.149	(0.386)		0.149	(0.386)		0.149	(0.386)	
ICC	0.021			0.022			0.018			0.013		

The table reports unstandardized coefficients; *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$

ICC = variance at both higher levels (community + community by year) = $(\sigma^2_{\text{community}} + \sigma^2_{\text{community by year}}) / (\sigma^2_{\text{community}} + \sigma^2_{\text{community by year}} + \sigma^2_{\text{individual}})$

due to lack of suitable measures, other research has suggested that subjective status may predict adolescent anxiety and depression better than absolute markers of household income or social status (Quon and McGrath 2015). We suggest that future research should address how the societal income distribution influences adolescents' perceptions of their socioeconomic status, and how their status perceptions, in turn, affect their emotions.

In contrast to research findings based on US samples (Pabayo et al. 2016), we did not find that changes in the level of income inequality were linked to changes in depression. Although the differences in results could be due to differences in country characteristics, a possible alternative explanation is that income inequality may simply have a more immediate impact on anxiety than on

depression. That is, income inequality may be a direct source of status related anxiety, while it may impact depression via systematic hampering of goal attainment (e.g., because of material deprivation) (Kawachi and Subramanian 2014). Hence, as income inequality and great status differences are set over time, they become a structural characteristic of a society. Thus, adolescent depression, because of frustration and lack of control associated with low social mobility, may simply take more time to develop (Graber and Sontag 2009). This is arguably not the case in the historically egalitarian and socially mobile Iceland. In other words, the relationship between income inequality and depression may depend on the duration of high levels of income inequality within a nation. This is in line with Kondós and his collaborators (Kondo et al. 2012)

Table 4 Fixed and random parameters of predictors of log depression in pooled data of adolescents in the Icelandic data from the years 2006, 2009, 2012, 2014 and 2016

	Model 5			Model 6			Model 7			Model 8		
	<i>b</i>	SE	Sig.	<i>b</i>	SE	Sig.	<i>b</i>	SE	Sig.	<i>b</i>	SE	Sig.
Fixed parameters												
Intercept	0.471	(0.005)	***	0.467	(0.004)	***	0.467	(0.004)	***	0.467	(0.004)	***
<i>Level 3 (communities)</i>												
Capital location				− 0.014	(0.008)		− 0.014	(0.008)		− 0.014	(0.008)	
Mobility rate				− 0.030	(0.035)		− 0.029	(0.036)		− 0.028	(0.036)	
Concentrated disadvantage				0.002	(0.004)		0.002	(0.004)		0.002	(0.004)	
Equality index (20/80 ratio)				0.075	(0.070)		0.077	(0.070)		0.075	(0.070)	
<i>Level 2 (period)</i>												
Change in mobility rate							0.082	(0.059)		0.030	(0.053)	
Change in concentrated disadvantage							0.001	(0.017)		− 0.002	(0.016)	
Change in equality (20/80 ratio)							− 0.126	(0.105)		− 0.050	(0.119)	
Survey cycle										− 0.085	(0.013)	***
Survey cycle ²										0.015	(0.002)	***
<i>Level 1 (individuals)</i>												
Household deprivation				0.135	(0.005)	***	0.135	(0.005)	***	0.136	(0.005)	***
Female				0.199	(0.005)	***	0.199	(0.005)	***	0.199	(0.005)	***
Age				0.028	(0.006)	***	0.028	(0.006)	***	0.028	(0.006)	***
Family disruption				0.054	(0.005)	***	0.054	(0.005)	***	0.053	(0.005)	***
Icelandic spoken at home				0.062	(0.009)	***	0.062	(0.009)	***	0.061	(0.008)	***
	σ^2	SD	Sig.	σ^2	SD	Sig.	σ^2	SD	Sig.	σ^2	SD	sig
Random parameters												
Level 3 (community) variance	0.001	(0.030)	***	0.000	(0.013)		0.000	(0.013)	*	0.000	(0.019)	**
Level 2 (community by year) variance	0.002	(0.049)	***	0.002	(0.048)	***	0.002	(0.048)	***	0.001	(0.037)	***
Level 1 (student) variance	0.145	(0.380)		0.124	(0.352)		0.124	(0.352)		0.124	(0.352)	
ICC	0.022			0.020			0.019			0.014		

Notes: the table reports unstandardized coefficients; *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$

ICC = variance at both higher levels (community + community by year) = $(\sigma^2_{\text{community}} + \sigma^2_{\text{community by year}}) / (\sigma^2_{\text{community}} + \sigma^2_{\text{community by year}} + \sigma^2_{\text{individual}})$

suggestion that future researchers testing the income inequality thesis may need to pay more attention to how long income inequality has persisted in the society, and to the time lag between income inequality and the proposed outcome.

Strengths and limitations

While we have focused on the case of Icelandic adolescents, the work represents a unique ‘natural experiment’. The period studied was characterized by a strong decrease in income inequality, following the bursting of an economic bubble created by neoliberal fiscal policies (Olafsson and Kristjansson 2013). Combining individual level population-based survey data and community-level

household demographic and tax registry data spanning 10 years allows a high degree of confidence in data validity. Hence, we believe that the data truly represent the Icelandic adolescent population during this time, and changes in the Icelandic socioeconomic reality.

Also, the structure of Icelandic neighborhood communities is quite homogenous compared to larger social units such as countries or states. For example, apart from containing an elementary public school, a typical Icelandic community has a primary healthcare center which is organized and run by the state (Haraldsdóttir et al. 2014), which entails that the provision of healthcare is the same across all neighborhoods in Iceland. This homogeneity of the state-run healthcare organization serves as a control for neighborhood differences in emotional distress due to

systematic differences in healthcare provision which may correlate with income inequality and adolescent emotional distress (Chen and Gotway Crawford 2012). Still, selection bias may be an issue in our study for two reasons. First, we note that because families choose where they live, this can lead to differences between those exposed to income inequality and therefore can explain any association. Second, valid data was obtained from 80% of the population. There could be differences in the characteristics of those not present at school on the day of data collection which we were unable to observe, and those who were, which may explain the observed association.

However, the tight coupling of student school attendance with their residential neighborhood provides an ideal operational definition of what constitutes as a meaningful neighborhood community (Chaskin 1997). By accounting more thoroughly for both individual- and community-level composition than in previous research on the income inequality thesis (Avendano and Hessel 2015), we believe we have truly partitioned out the effect of changes in income inequality within neighborhood communities on emotional distress.

We caution that although we find support for the change effect of income inequality *within* neighborhood communities, we did not find differences in adolescents' symptoms of anxiety according to levels of income inequality *between* communities. This may be because of the homogeneity of Icelandic neighborhood communities, evident in a low community variance at the community level. Although low disparities between neighborhood communities in terms of indicators of adolescents' outcomes are typical (Bernburg et al. 2009a; Pabayo et al. 2016; Vilhjalmsdottir et al. 2016), it should be noted that when differences between communities are so small, the role of community-level properties like income inequality is limited. Still, according to Liska (1990) the theoretical importance of a significant community variance should not be overlooked for two reasons. First, despite the small proportion of variance located at the community level, the community variable that explains it, may provide an important conceptual link between the individual and the context. Hence, the observed contextual effects in this study may be applicable to societies where the community-level variance is larger, for example in the USA (Pabayo et al. 2016). Second, although community level qualities may only explain a small proportion of the total variance, they frequently do so for a range of individual outcomes. Thus, decreases in income inequality over time may also be related to other distress related adolescent outcomes (e.g., substance abuse and delinquent behavior).

Conclusion

While the income inequality thesis implies that a decrease in income inequality should reduce people's emotional distress, no study has tested this directly. Using population data, this study supports the hypothesis by showing that a decrease in community income inequality is related to a decrease in anxiety among adolescents. Future research should address possible mediators, such as adolescents' perceptions of their social status which may underpin their anxiety. Finally, we call for studies addressing the change effect of income inequality over time across societies which differ in cultural values and norms.

Compliance with ethical standards

Conflict of interest The authors declare no conflicts of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The Youth in Iceland surveys were conducted anonymously and approved by the Icelandic Data Protection Authority (www.personuvernd.is). Parents were informed about the survey and given the opportunity to withdraw their children from participation. All community-level data were prepared by Statistics Iceland and delivered in aggregated form and can therefore not be traced back to individual households. This research received funding from The Icelandic Centre for Research (Grant No. 152601-052).

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