Younger and Dissatisfied? Relative Age and Life-satisfaction in Adolescence

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Abstract. This is the first study to investigate whether age gaps between classmates (that is, relative age) affect life-satisfaction gaps in adolescence. To this end, we analyse data from the multi-country Health Behaviour in School-Aged Children (HBSC) survey. We find evidence that relative age negatively impacts adolescents' life-satisfaction. A twelve-month age gap decreases life-satisfaction, rated on a 0-10 scale, by 0.3 points. This negative effect is consistent across countries. Finally, this negative effect does not decrease with the increase in absolute age.

Keywords: Relative age, adolescents, education, Europe, life-satisfaction

JEL-Classification: C26, I21, I31, Z13

1 Introduction

Does date of birth affect educational achievements and well-being in youth? Possibly, yes. Rather than due to some sort of astrological phenomenon, it would be due to the distance of the birthdate from the so-called *cutoff date*, the date that separates students in different grades[1] and determines maturity differences within a class.[2] Usually, these maturity differences consist of at most one year, as students born up to one year apart are grouped in the same class,[3] and there is evidence that this maturity gap jeopardizes human capital accumulation. In fact, the age difference between classmates, also known as "relative age," leads to gaps in perceived ability and performance, also known as "relative age effects" (RAEs, Barnsley & Thompson 1988). As a consequence, relative age negatively affects students' educational paths as well (Peña 2016; Liu & Li 2016; Navarro et al. 2015; Ponzo & Scoppa 2014; Bernardi 2014; Sprietsma 2010; Elder & Lubotsky 2009; Bedard & Dhuey 2006; Allen & Barnsley, 1993). Moreover, it causes gaps in non-cognitive abilities and well-being (Schwandt & Wuppermann 2016; Patalay et al. 2015; Zoëga et al. 2012; Mühlenweg et al. 2012; Dhuey & Lipscomb 2010; Mühlenweg 2010; Elder & Lubotsky 2009; Dhuey & Lipscomb 2008; Lien et al. 2005; Thompson et al. 2004).

Based on this literature, it is natural to hypothesize that—compared to their older peers—the youngest students in a class experience a low life-satisfaction, that is, a low subjective evaluation of life as a whole (De Neve & Oswald 2012). However, so far, no study has investigated whether relative age indeed affects life-satisfaction. The first contribution of our study fills this gap by investigating a representative sample of European adolescents.[4]

Abbreviations: RAEs, relative age effects; HBSC, Health Behaviour in School-Aged Children.

[1] In the entirety of this paper, the word "grade" refers to a particular school level, not to an exam mark.

[2] Under the assumption that within-class age gaps in youth are a good proxy for maturity differences between classmates.

[3] For instance, in Austria the cutoff date is September 1st, which implies that in the same grade there are students born from September 1st of year t to August 31st of year t+1.

[4] We use the term "adolescents" in sensu lato, which includes people who are between nine and nineteen years old (https://www.psychologytoday.com/basics/adolescence).

The study of the RAEs on adolescents' life-satisfaction is economically relevant for at least two reasons. First, life-satisfaction in adolescence is the best predictor of an adult's life-satisfaction and emotional health (Clark et al. 2018). Second, recent studies suggest that life-satisfaction might affect adolescents' success in education and labour market outcomes, both directly—through the effect on school performance (Zi et al. 2015; for a literature review, Lippman et al. 2014), and indirectly—by affecting the big five traits and self-esteem (Soto 2015; Specht et al. 2013; for a literature review, Lippman et al. 2014).

This paper provides a second original contribution to the relative-age literature and to the life-satisfaction literature. There has been a recent upsurge of studies that investigate the reasons why life-satisfaction decreases between the age of 10 and 16. Currently, some potential explanations for this phenomenon are the increase in school-related stress, the increase in depression, the innate optimism that turns into a more realistic world view, and body changes (Casas 2016; Currie et al. 2012; Goldbeck et al. 2007). The possible role of within-class age differences has so far been neglected, and our study poses to fill this gap in the literature.

What role could be played by relative age in the worsening of life-satisfaction in adolescence? The decrease in the importance of relative age, which occurs with the increase in absolute age, reduces various types of negative gaps that are owed to maturity gaps. For instance, with the increase in absolute age, performance gaps due to maturity gaps fall; thus, the oldest students in a class become disenchanted. The oldest students understand their superior performance in the earlier stages of their education was due—at least partly—to their greater maturity rather than greater talent, which might have a negative impact on their life-satisfaction. The symmetric situation might characterize the youngest students in a class for whom the reduction in performance gaps might have a less negative (or even positive) effect on their life-satisfaction. Based on this background, we expect that if there is an interaction effect between relative and absolute age, it is positive. This result would imply two things: (i) that students who are among the oldest in their class suffer a larger decrease in life-satisfaction in adolescence, (ii) negative gaps in terms of life-satisfaction may last.

Our investigation is conducted with data from the international survey, “Health Behaviour in School-Aged Children (HBSC).” As illustrated in the state of the arts provided by Casas (2016), this is currently the only survey that addresses adolescents, collecting life-satisfaction data for cross-country comparisons. Because of the possibility of conducting international comparisons, data from this survey allow us to obtain clear and externally valid results. In particular, the use of data from a large pool of countries allows us to purge the estimates of RAEs on life-satisfaction from season of birth confounders (i.e. unobservable climatic, environmental, sociocultural, and biological factors that affect students’ skills and well-being; Musch & Grondin 2001).

The policy implications of our study differ from that of some previous research (Ponzo & Scoppa 2014; Mühlenweg et al. 2012; Black et al., 2011; Grenet 2011; Mühlenweg & Puhani 2010; Mühlenweg 2010; Dhuey & Lipscomb 2010; Elder & Lubotsky 2009; Cascio & Schanzenbach 2007; Bedard & Dhuey 2006), which investigates the role of age differences between classmates as an instrument for age at school entry. More specifically, our econometric analysis may be interpreted as a reduced form of studies that investigate the so-called “Effects of Age at School Entry” (ASE, Mühlenweg et al. 2012). Our different approach leads to results that inform policy makers and scholars on the age-grouping system (Solli 2017; Larsen & Solli 2017; Pellizzari & Billari 2012; Barnsley & Thompson 1988), rather than on age at school entry.

The remainder of the paper proceeds as follows. Section 2 discusses the data and the descriptive statistics. Section 3 proceeds with the main analysis, while investigations of heterogeneous treatment effects by age and country are in Section 4. Section 5 summarizes the results, illustrates policy implications, and provides directions for future research.

2 Data and Descriptive Statistics

The purpose of this section is twofold. First, we discuss the main features of the HBSC survey data and of the data set preparation. Second, we discuss the variables used in the analyses and their main descriptive statistics.

2.1 Data

The HBSC survey is an international WHO collaborative study that explores the determinants of young people's health, well-being, and health behaviours. It is administrated by teachers to nationally representative samples of students between about 10.5 and 16.5 years of age, and it is conducted by means of standardized questionnaires.[5] In our research, we use the HBSC data from the 2001/2, 2005/6 and 2009/10 survey waves, as they are the most recent publicly available waves to contain information on adolescents' life-satisfaction.[6]

During the data set preparation process, we drop observations on students from some countries in two broad cases. First, the case when a precise cutoff date cannot be assigned to students, which may happen for three reasons: (i) since information on students' state or region is anonymized, we cannot investigate students from countries with multiple cutoff dates that vary by regions or states (the case of Germany, Canada, and the United States (US)); (ii) we cannot investigate students from countries where the cutoff date could not be retrieved (the case of Russia, Armenia and Turkey); (iii) when there is no information on students' day of birth, we cannot investigate students from countries with a cutoff that does not fall in the first day of the month (the case of Israel, Portugal and Romania). Second, the

[5] Currie et al. (2012), Roberts et al. (2010), Currie et al. (2009), Currie et al. (2008), and Currie et al. (2004) discuss in detail the survey's methodology and the main descriptive analyses of the data.
[6] There are five previous waves and one more recent wave; however, they are not freely accessible. We chose to utilize only the open-access data to grant transparency and replicability of our results.

case when information included in the data set is incomplete, which may happen for two reasons: (i) students' birthdate is missing, the case of Hungary, wave 2001 and Czech Republic, wave 2006; (ii) the life-satisfaction item is absent from the survey, the case of Malta. Information on these characteristics is fundamental to generating the independent variable of interest and to conduct robustness checks; more details on these two points are discussed below.

Finally, since "relative age" refers to the difference in age between students in the same class, we exclude students from classes that are not properly identified. In particular, after close scrutiny of the data set, we note that classes with extreme sizes—either very small or very large—are likely assigned an improper class-identifier. For instance, in some schools, the same identifier is clearly assigned to different classes in different grades, so RAE data from these classes are meaningless. To reduce the probability of treating students from different classes and grades as if they belong to the same class, we trim the sample using standard boundaries: we exclude students from classes that are in the 95th percentile or above of the class size distribution (i.e. more than 33 students) and students from classes that are in the 5th percentile or below of the class size distribution (i.e. fewer than 8 students).[7]

Our final sample is composed of 379,524 students from 32 countries. While Table O.1 in the Online Appendix A provides the number of observations by country and wave, Table O.2 lists the country-specific cutoff dates, which have been retrieved from different sources listed in Table O.3.

2.2 Outcome Variable: Life-satisfaction

The outcome variable of our analyses is life-satisfaction, a subjective evaluation of life as a whole. This is measured in the HBSC survey by means of the Cantril ladder (Cantril, 1965), which is a scale ranging from 0 to 10 to indicate the worst and best possible level of life-

[7] Also robustness checks that included these classes would be meaningless.

satisfaction.[8] This scale has been psychometrically demonstrated to be valid, reliable, and sensitive. It is probably the most quoted scale on life-satisfaction and it is particularly suitable for international comparisons (see Cases, 2016, for a discussion on the state of the art literature).

Table 1 shows that, as usual, the distribution of subjective life-satisfaction is left-skewed: on average, adolescents declare to enjoy a life-satisfaction of about 7.6.

Table 1. Descriptive statistics. Source: HBSC data.

Variables	N	Mean	Standard deviation
Life-satisfaction	363,009	7.600	1.895
Relative age	368,588	0.321	0.453
Female	379,524	0.508	0.500
Age	379,524	13.543	1.651
Both parents at home	377,431	0.753	0.431
Low socioeconomic status	379,524	0.211	0.408
Medium socioeconomic status	379,524	0.403	0.490
High socioeconomic status	379,524	0.387	0.487
Season-of-birth	379,524	5.482	3.358

2.3 Independent Variable of Interest: Relative Age

Our explanatory variable of interest is a proxy for relative age, which measures the difference between the age (in months) of the oldest regular student in a class and student *i*. By "regular student" we mean that the student is in the right class based on her age and on the country cutoff date.[9] For regular students, this measure should range between 0 (i.e. student *i* is the oldest regular student in the class) and 12 months (i.e. there is one full year difference between student *i* and the oldest regular student in the class).

[8] The students are shown the picture of a ladder. The best possible life score (10) is positioned at the top of the ladder, while the worst possible life score (0) is positioned at the bottom of the ladder. The students are asked, "In general, where on the ladder do you feel you stand at the moment?" (Cantril 1965).

[9] Fumarco and Baert (2018) provide an illustrated description of how the combination of information on students' month and year of birth (their own and that of their classmates) and the country-specific cutoff date allows the identification of regular students.

Past studies within RAE literature consider the role of relative age as a mechanism that leads to the age at school entry effect (ASE). In many studies (Ponzo & Scoppa 2014; Mühlenweg et al. 2012; Black et al. 2011; Grenet 2011; Mühlenweg & Puhani 2010; Mühlenweg 2010; Dhuey & Lipscomb 2010; Elder & Lubotsky 2009; Cascio & Schanzenbach 2007; Bedard & Dhuey 2006), the authors use expected age at school entry as an instrument for age at entry; thus, the explicit goal of these studies is to investigate the effect of age at entry on a specific outcome, such as educational performance. Differently, by operationalizing relative age as we do—which is in the spirit of the reduced form adopted in the above studies, we take the path in the first studies on this topic (e.g. Allan & Barnsley 1993; Barnsley & Thompson 1988), which focuses on the age-grouping system.[10]

Table 1 shows that this variable for relative age is right skewed. In fact, its mean is 0.321, which corresponds to about three months and 27 days difference—assuming 30 days per month, suggesting the possible presence of (at least) some non-regular students. In general, for non-regular students, there could be either a negative relative age (this is the case of, for instance, retained or redshirted students who are older than expected) or a relative age that is larger than 12 (this is the case of, for instance, students who skipped a grade or entered school earlier). Table O.4 in the Online Appendix shows that 10% of students in the sample are older than expected—we call them "Older students" for brevity, while 4% of students are younger than expected—we call them "Younger students" for brevity. This table also reports the percentage of students who are in classes composed only of regular students.

[10] Although irrelevant to this study, we additionally suggest that this operationalization of relative age could be useful when using panel data sets. In fact, while the date of birth and school entry age are fixed characteristics in time—and thus they would be cancelled out by means of the "within transformation"—the age difference between the oldest regular student in the class and student *i* may change in time, because the oldest regular student—and thus her age—may change for several reasons. For instance, students may change class when they pass from primary to middle school and then to high-school. As another example, consider the case of students of Italian technical high schools: in the third year, students are re-grouped in different classes based on the specialization they have chosen (e.g. electronic, mechanic, hydraulic). In these cases, with enough variation across time in the difference between the age of the oldest regular student in a class and student *i*, the within transformation would not eliminate relative age so its effect could be estimated.

The presence of non-regular students—an issue sometimes referred to as the problem of within-class heterogeneous ages (Peña 2016; Sprietsma 2010; Bedard & Dhuey 2006)—gives rise to a possible bias in the estimates of RAEs. For instance, it would not be possible to tell whether differences in life-satisfaction were driven by relative age or by the fact that the student has been retained; in fact, being older gives some advantages, but retention could lead to stigma. We conduct two types of robustness checks that take care of this issue: (i) one where we restrict the sample to regular students (ii) and one where we instrument relative age.

The correlations matrix in Table 2 suggests that relative age is positively associated with life-satisfaction. This correlation is statistically significant at 10% and goes in the opposite direction of what was initially hypothesized: relatively young adolescents (i.e. the youngest regular students) report a higher life-satisfaction. However, this should not come as a surprise: a large within-class age gap comes with a low absolute age for student *i*, which the literature suggests to be associated with higher life-satisfaction.[11] Therefore, as explained in the next section, it is fundamental to control for absolute age in our econometric analyses.

Table 2. Pairwise correlations. Source: HBSC data.

	Pairwise correlations								
Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1 Life-satisfaction	1								
2 Relative age	**0.019**	1							
3 Female	**-0.050**	**0.037**	1						
4 Age	**-0.182**	**-0.183**	**-0.003**	1					
5 Both parents at home	**0.119**	**0.031**	**-0.011**	**-0.037**	1				
6 Low socioeconomic status	**-0.126**	**-0.035**	**0.033**	**0.019**	**-0.089**	1			
7 Medium socioeconomic status	**-0.007**	-0.001	**0.010**	-0.001	**0.009**	**-0.424**	1		
8 High socioeconomic status	**0.112**	**0.030**	**-0.038**	**-0.016**	**0.065**	**-0.410**	**-0.652**	1	
9 Season-of-birth	**-0.008**	**0.218**	**0.003**	**-0.046**	0.001	0.001	0.001	-0.002	1

Note: Correlations in bold are statistically significant at least at the 10% significance level.

[11] Correlations between life-satisfaction and relative age at a country-level confer similar insights; this table can be provided upon request.

2.4 Control Variables

The analyses in this study account for various students' characteristics. Most importantly, we account for the student's absolute age and its squared term to capture non-linear returns, since adolescents' life-satisfaction tends to decrease in time (Casas 2016; Currie et al. 2012; Goldbeck et al. 2007), without controlling for the adolescents' characteristics, estimates of RAEs would be positively biased, as is suggested in Table 2. Additionally, in later stages of the analysis, this variable is interacted with the independent variable of interest to investigate whether the decrease in life-satisfaction in adolescence changes with changes in relative age. We include students' gender as well because past studies find evidence that female adolescents tend to enjoy lower levels of life-satisfaction than male peers (Moksnes & Espnes 2013; Goldbeck et al. 2007); this variable equals 1 for female students and 0 for male students, the reference group. We additionally control for basic family structure, that is, whether the student lives with both parents, since there is evidence that the presence of both parents at home positively impacts children's life-satisfaction (Kwan 2008; Zullig et al. 2005; Sastre & Ferrière 2000; Demo & Acock 1996).[12] Additionally, we account for family socioeconomic status (SES), which is derived from multiple items and is constructed according to the HBSC guidelines (Currie et al. 2008). This variable ranges between 0 (low socioeconomic status, the reference group) and 2 (high socioeconomic status). Although intuitively one would expect a positive effect of household income on adolescents' life-satisfaction, the direction of such an effect is still a matter of debate (Crede et al. 2014).[13]

Our analyses also account for the effects of unobservable birthday characteristics, known as "season-of-birth" effects. The variable for season of birth is proxied by the month

[12] However, this information on family structure is imperfect, as it neglects qualitative measures of (i) the relationship between parents and (ii) and the parents' relationship with their offspring.

[13] Class size is thought to be negatively related to school achievements (Krueger 2003). One could thus expect it to be related to life-satisfaction, too. For this reason, it was also included in early stages of the investigation, but no statistically significant effect was found in any model specification. This variable has thus been dropped from the analyses.

of birth within the calendar year (henceforth, calendar month) and ranges between 0 (January, the reference month) and 11 (December). Season-of-birth effects capture unobservable birthday characteristics that do not depend on maturity differences, but that may cause performance gaps between students born in different periods of the year. If left unaccounted for, season-of-birth effects could cause biased estimates. For instance, in the US, people born at the end of the calendar year are usually among the oldest in their class and thus enjoy maturity advantages on their classmates. At the same time, they are more likely to have disadvantageous family backgrounds (Buckles & Hungerman 2013). Therefore, for these students, season-of-birth effects counterbalance their advantageous higher maturity—at least partly.[14] In order to avoid any bias, our econometric analyses control for season-of-birth.

Although there is some correlation, relative age does not overlap with calendar month. This is due to one main reason: the presence of variation in the cutoff date among the countries in the sample. While the calendar year goes from January to December for every country, the "grouping-year" is country specific. The grouping-year starts with the country-specific cutoff date and finishes with the month that immediately precedes the cutoff date;[15] thus, it is the year based on which students are grouped in classes.

As can be seen from the pairwise correlations in Table 2 and in line with the literature, female and older adolescents tend to enjoy lower levels of life-satisfaction, while SES seems to have a positive effect. Moreover, although statistically significant at the 10% level, the correlation between calendar month and relative age is lower than 0.3, which qualifies as a negligible correlation (Hinkle et al. 2003).[16]

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[14] Other examples of season-of-birth effects are discussed in Fan et al. (2017), Quesada and Nolasco (2017), Rietveld and Webbink (2016), Clarke et al. (2016), Ramírez and Cáceres-Delpiano (2014), Currie and Schwandt (2013), Lokshin and Radyakin (2012), Bound and Jaeger (2001), and Musch and Hay (1999).

[15] For instance, in Austria, the cutoff date is September 1st, which implies that in the Austrian grouping-year, September (in year t) is the first month while the last month is August (in year t+1).

[16] While for illustrative purposes the calendar month is reported in the table in its discrete form, the analyses will use a set of dummies—one dummy per month—to capture non-linear effects.

Additionally, all of the analyses include fixed-effects for school and wave. We can use them simultaneously because, although the data set is cross-sectional, one fourth of the schools have participated in the survey in more than one wave.

Finally, one could argue that we should introduce age at school entry at least as a control variable; however, we do not do that for two reasons: (i) similar to relative age, it is endogenous and, among other things, (ii) school fixed-effects capture information on expected age at school entry.

2.5 Instrumental Variable: Expected Relative Age

In the robustness check conducted with two-stage least squares (2SLS), we instrument relative age with expected relative age. This variable is represented by the month of birth within the grouping-year (henceforth, academic month) and proxies the relative age that students would have if they were regular students. The expected relative age variable ranges between 0 and 11, with 0 being the month that starts the cutoff date and 11 the month that precedes the cutoff date. A very similar instrument has been used in Datar (2006), who uses the time—measured in days—between the children's birthday and the kindergarten school cutoff date. This is a similar approach adopted by Ponzo and Scoppa (2014), Mühlenweg et al. (2012), Black et al. (2011), Grenet (2011), Mühlenweg and Puhani (2010), Mühlenweg (2010), Dhuey and Lipscomb (2010), Elder and Lubotsky (2009), Cascio and Schanzenbach (2007), and Bedard and Dhuey (2006), who use expected age at school entry as an instrument for age at school entry.

3 Results

This section is composed of three subsections. Firstly, we report the results from the main analyses, and secondly, we discuss the results from the robustness checks. Thirdly, we conduct heterogeneity analyses with two purposes: (i) the investigation of whether RAEs on life-satisfaction vary with absolute age and (ii) the investigation of RAEs at a country level.

3.1 Main Analyses

We conduct our analyses with an ordinary least square (OLS) regression model as in other studies on the RAEs (e.g. Zweimüller 2013; Grenet 2011; Robertson 2011; Sprietsma 2010; Kawaguchi 2009; Dhuey & Lipscomb 2008; Lawlor et al. 2006). The outcome variable, life-satisfaction, is measured on a 0-10 scale and is standardized to a z-score as in Mühlenweg et al. (2012).[17]

We choose OLS for two reasons. First, OLS allows for greater flexibility compared to non-linear models (e.g. ordered logit or probit models); it is better suitable for robustness checks and heterogeneity analyses, where we use a large number of fixed effects, we include an interaction term, and we use the two-stage least squares model. Second, OLS does not rely on the often-unfulfilled assumption of ordinal models (Williams 2008), that is, the proportional odds assumption (also known as parallel lines assumption), which establishes that the odds cannot vary with different levels of the outcomes variable.

Throughout our analyses, we correct the standard errors for clustering at a class level to account for the possibility that the variance of the error term varies by class.[18] The estimated RAEs on standardized life-satisfaction are reported in Table 3.

Table 3. Relative age on standardized life-satisfaction. Source: HBSC data.

Variables	Life-satisfaction	Life-satisfaction	Life-satisfaction	Life-satisfaction
	(1)	(2)	(3)	(4)
Relative age	0.003***	-0.003***	-0.004***	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)
Age		-0.110***	-0.106***	-0.107***
		(0.002)	(0.002)	(0.002)
Age squared		0.009***	0.010***	0.010***
		(0.001)	(0.001)	(0.001)

[17] OLS on the untransformed variable could not be used because OLS assumes that: (i) each category is an equal distance apart; (ii) predicted values might lie outside of the boundaries of the outcome (i.e. 0-10); (iii) predicted values might lie between categories (i.e. fractional values do not represent any existing category).

[18] We repeat all of the analyses in this paper with a similar model specification where we control for average age of regular students obtained without student *i* and define the relative age variable as the difference between the average age of regular students and student *i*. The overall results are similar and can be provided upon request.

Female			-0.083***	-0.083***
			(0.004)	(0.004)
Both parents at home			0.228***	0.228***
			(0.004)	(0.004)
Medium socioeconomic status			0.198***	0.198***
			(0.005)	(0.005)
High socioeconomic status			0.337***	0.337***
			(0.006)	(0.006)
Fixed effects				
School	X	X	X	X
Wave	X	X	X	X
Season-of-birth				X
N	352,399	352,399	344,009	344,009
R-squared	0.044	0.067	0.094	0.094

Note: Life-satisfaction is standardized to a z-score. Age is centered. Standard errors clustered on class are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

The estimates in Table 3 provide a number of interesting insights. In column (1), we regress adolescents' life-satisfaction only on relative age, school, and waves' fixed-effects. As noted in Section 2.4, without controlling for absolute age, the estimates for RAEs on life-satisfaction are positively biased: life-satisfaction tends to decrease in time and in adolescence; thus, the youngest students in a class would tend to enjoy higher levels of life-satisfaction because of their lower absolute age.

In column (2) we insert (centred) age and its square. Now, the effect of relative age becomes negative and remains consistently so throughout the paper: in the remainder of the main analyses, in multiple robustness checks, and in heterogeneity analyses. In this second column, we observe that a one-month increase in relative age decreases life-satisfaction by 0.003 standard deviations, which implies that a twelve-month increase in relative age (i.e. the theoretical maximum age gap between regular students in the same class) decreases life-satisfaction by 0.036 standard deviations, corresponding to 0.072 points on a scale from 0 to 10.[19] An increase by one year in the absolute age decreases life-satisfaction by 0.107 standard deviations.

[19] Derived from: estimated RAEs (i.e. -0.003) multiplied by 12 and by the standard deviation of life-satisfaction from Table 1 (i.e. 1.895).

In column (3), we add other basic demographic characteristics: a dummy variable for being female, dummy variables for having both parents at home and for family socioeconomic status—the reference group is that of students from a family with low socioeconomics status. The RAEs on life-satisfaction increase from 0.003 to 0.004 standard deviations. Moreover, as expected, we observe that female adolescents are characterized by lower levels of life-satisfaction, and having both parents at home has a positive association with life-satisfaction. Finally, an increase in a family's socioeconomic status seems to have a positive association. Most of the estimates in these three columns are statistically significant.

In column (4), we add season of birth fixed-effects, but the RAEs on life-satisfaction do not seem to change. However, since the estimates from column (3) and (4) are obtained from two nested models, we can test the difference between them with a likelihood ratio test. This test provides evidence that these two models are statistically significantly different at the 1% level. Similarly, we conduct an F-test on the joint significance of these fixed effects, and in this case, the null hypothesis is resoundingly rejected. As a consequence, from an empirical standpoint, it is meaningful to insert control variables for season-of-birth effects.

3.2 Robustness Checks

In this subsection, we control the sensitivity of the main results to the presence of non-regular students. We conduct two types of robustness checks that take care of this task: (i) we restrict the sample based on different criteria—following the previous literature, and (ii) we use a 2SLS where we instrument relative age with expected relative age.

3.2.1 Sample Restrictions

These robustness checks are conducted with the complete model (i.e. Table 3, column (4)) and include the four analyses. First, we exclude from the analysis those countries where students frequently start school one year earlier: Hungary, Ireland, the Netherlands, and

Switzerland (Bedard & Dhuey 2006).[20] Second, we redo the main investigation but exclude older and younger students. Third, we redo the investigation but focus on those classes that are formed exclusively by regular students. Fourth, based on the quantity of non-regular students, we investigate classes from countries that are characterized by high age-compliance—similarly to Mühlenweg (2010), that is, Norway, Poland, England, Scotland, Wales, Iceland, and Greece.[21] The results from these analyses are reported in Table 4, and those from the main analysis (i.e. Table 3, column (4)) are in column (5) to facilitate the comparison. For the sake of brevity, the estimates of demographic control variables are not reported.

Table 4. Relative age on standardized life-satisfaction; robustness checks on restricted samples. Source: HBSC data.

Variables	Life-satisfaction	Life-satisfaction	Life-satisfaction	Life-satisfaction	Life-satisfaction
	Not frequent early school entry	Only regular students	Classes with only regular students	High age-compliance	Results Table 3, column (4)
	(1)	(2)	(3)	(4)	(5)
Relative age	-0.004***	-0.010***	-0.013***	-0.007***	-0.004***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)
Demographic control variables	X	X	X	X	X
Fixed Effects					
School	X	X	X	X	X
Wave	X	X	X	X	X
Season-of-birth	X	X	X	X	X
N	305,121	296,944	116,585	90,079	344,009
R-squared	0.094	0.097	0.102	0.080	0.094

Note: Life-satisfaction is standardized to a z-score. Demographic control variables include: centered age and its square, dummy for being female, dummy for having both parents at home, and dummies for medium and high-socioeconomic status. Standard errors clustered on class are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

[20] Information on the country-specific possibility of entering school one year earlier is in Table O.2, Online Appendix.

[21] We consider a country to be highly age-compliant if: (i) 5% or fewer students are identified as older students, and (ii) 1% or fewer students are identified as younger students. This group of countries is very similar to that that we would obtain if we applied these two criteria to statistics from PISA surveys data (OECD 2010; Education, Audiovisual and Culture Executive Agency 2011): Norway, Poland, England, Scotland, Wales, Denmark, and Lithuania.

All in all, the results from this table confirm that there are negative RAEs on adolescents' life-satisfaction but suggest that the initial estimates are downward biased because of the presence of heterogeneous ages within-class. Column (1) reports the estimates obtained excluding countries where students frequently start school one year earlier, which are the same as the initial ones. Results from column (2) and (3) are obtained investigating only regular students and suggest that a twelve-month increase in relative age (i.e. the theoretical maximum age gap between classmates) decreases life-satisfaction by 0.120 standard deviations (-0.010 × 12) in column (2) and by 0.156 standard deviations (-0.013 × 12) in column (3), that is, 0.227 and 0.296 life-satisfaction points, respectively. Results from column (4), obtained only from students in high age-compliant countries are larger than the main ones: a student who faces a one-year age gap from the oldest regular student in the class has a life-satisfaction that is 0.084 standard deviations (-0.007 × 12), or 0.091 life-satisfaction points lower than the oldest regular student in her class. All of these results are highly statistically significant.

Insights from these first robustness checks should be considered carefully. The sample size varies widely, from 305,121 to 90,079 students; ergo, these results could be affected by sample selection bias.

3.2.2 Two-Stage Least Square

The results obtained on different restricted samples are not affected by heterogeneous ages within-class and confirm the main estimates; however, they could be affected by sample selection bias. To address this concern, we conduct a second type of robustness check, where we use a 2SLS regression model. Here we instrument the independent variable of interest with a set of dummies for month of birth. We opt for a set of dummy variables—in place of one discrete variable—to capture non-linear effects of academic month of birth on relative age.

The idea behind possible non-linear effects is that students born in the first few months and in the last few months of the grouping-year have the highest chances of being non-regular students (Sprietsma 2010; Bedard & Dhuey 2006). Additionally, the utilization of a set of dummies allows us to conduct the test for the over-identifying restrictions.

Column (1) to (3) of Table 5 report results from the reduced-form, the first, and the second stage, respectively, while the results from the main analysis (i.e. Table 3, column (4)) are reported again in column (4) to facilitate the comparison. Except for the estimated effects of the instruments, the estimates of demographic control variables are omitted for the sake of brevity.

Table 5. Relative age on standardized life-satisfaction; instrumental variables approach. Source: HBSC data.

Variables	Life-satisfaction	Relative age	Life-satisfaction	Life-satisfaction
	Reduced form	First stage	Second stage	Results Table 3, column (4)
	(1)	(2)	(3)	(4)
Relative age			-0.013***	-0.004***
			(0.001)	(0.000)
Academic month 1	-0.004	0.132**		
	(0.011)	(0.055)		
Academic month 2	-0.012	0.739***		
	(0.011)	(0.051)		
Academic month 3	-0.031***	1.247***		
	(0.011)	(0.053)		
Academic month 4	-0.032***	2.113***		
	(0.010)	(0.049)		
Academic month 5	-0.050***	2.733***		
	(0.011)	(0.054)		
Academic month 6	-0.031***	3.166***		
	(0.010)	(0.052)		
Academic month 7	-0.055***	3.705***		
	(0.011)	(0.058)		
Academic month 8	-0.054***	4.584***		
	(0.010)	(0.054)		
Academic month 9	-0.074***	4.837***		
	(0.011)	(0.063)		
Academic month 10	-0.062***	4.686***		
	(0.011)	(0.064)		
Academic month 11	-0.074***	4.638***		
	(0.011)	(0.069)		
Demographic control variables	X	X	X	X
Fixed Effects				

School	X	X	X	X
Wave	X	X	X	X
Season-of-birth	X	X	X	X
N	344,009	344,009	344,009	344,009
R-squared	0.094	0.278	0.094	0.094
2SLS tests				
Endogeneity test: Hausman statistic (p-value)		67.969 (0.000)		
Under-identification test: Lagrange-Multiplier statistic (p-value)		5376.477 (0.000)		
Weak identification test: F-statistic		1336.797		
Over-identification test of all instruments: Hansen J statistic (p-value)		11.402 (0. 327)		

Note: Life-satisfaction is standardized to a z-score. Demographic control variables include: centered age and its square, dummy for being female, dummy for having both parents at home, and dummies for medium and high socioeconomic status. The month of the grouping-year that starts with the cutoff date (i.e. Academic Month 0) is the reference. Standard errors clustered on class are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Column (1) reports the results from the reduced form, which measures the impact of academic month of birth on life-satisfaction. These results suggest that students born in late months have lower life-satisfaction. Column (2) reports the results from the first stage, where the outcome variable is relative age, which is regressed on demographic characteristics, including dummies for academic month. As by intuition, the academic month has an increasing, positive effect on relative age; that is, the later student *i* is born in the grouping-year, the larger is the age gap that separates her from the oldest regular student in her class. With illustrative purpose, consider students born in the last academic month: they are four months and 19 days younger than the oldest regular student in the class. As expected, there appear to be non-linear returns: for students born at the extremities of the grouping-year (i.e. Academic month 1 and 8-11), increments in relative age are lower; this confirms that especially among them, there are non-regular students. Column (3) reports the results from the second stage; the effect of the estimated relative age on life-satisfaction confirms a downward bias of the main results: a twelve-month increase in relative age decreases life-satisfaction by 0.156 standard deviations (-0.013×12) against 0.048 standard deviations (-0.004×12).

Additionally, we conduct four ancillary tests on the instrumental variables, which suggest that we are using the proper instruments. The endogeneity test rejects the null hypothesis that relative age can be treated as exogenous. The tests for under-identification and weak-identification reject, respectively, the null hypothesis that the instruments are not correlated with the endogenous variable and that they are only weakly correlated. For the latter test, the F statistic is well beyond critical values suggested in Stock and Yogo (2002). The over-identification test does not reject the null hypothesis that the instruments are valid, that is, uncorrelated with the second-stage error term.

3.3 Heterogeneity Analyses

The purpose of this subsection is twofold. First, we investigate how RAEs vary by absolute age, and then we investigate RAEs at a country level.

3.3.1 Relative Age Interacted with Absolute Age

In this analysis, we aim at gaining insights into the (possible) interaction effect of relative age with absolute age on life-satisfaction in adolescence; this is interesting for two reasons. First, we can understand better the nature of RAEs. One would intuitively expect the relevance of relative age—as a proxy of maturity differences between classmates—to decrease with the increase in absolute age. Gaps in performance, non-cognitive abilities, and well-being should decrease with age and then reflect into smaller life-satisfaction gaps. In other words, we expect a positive interaction effect, an increase in absolute age reduces the negative effect of relative age. Second, despite the increase in the quantity of studies investigating the mechanisms behind the negative effect of absolute age on life-satisfaction in adolescence, no study has yet investigated the role of relative age. Thus, we could interpret the estimates from the following analysis the other way around; in doing this exercise, a positive interaction effect would imply a larger decrease in life-satisfaction in adolescence for the oldest students in a class.

Table 6 reports all of the analyses with the full model specification plus the interaction between relative age and absolute age. Column (1) displays the main results obtained with the OLS, on the entire sample. Column (2) to (5) reports results from robustness checks on restricted samples that include: the entire sample minus countries where students frequently start school one year earlier—column (2); only regular students—column (3); classes with only regular students—column (4); only students from countries with high age-compliance—column (5); column (6) reports the results from the second stage of the 2SLS, where relative age and its interaction with absolute age are instrumented with dummies for academic month of birth and their interaction with absolute age. For the sake of brevity, this table reports only the estimates on relative age, absolute age, and their interaction.

Table 6. Relative age interacted with absolute age on standardized life-satisfaction. Source: HBSC data.

Variables	Main analysis	Robustness checks				
		Restricted sample				2SLS
	Life-satisfaction	Life-satisfaction	Life-satisfaction	Life-satisfaction	Life-satisfaction	Life-satisfaction
	Entire sample	Not frequent early school entry	Only regular students	Classes with only regular students	High age-compliance	Entire sample
	(1)	(2)	(3)	(4)	(5)	(6)
Relative age	-0.004***	-0.004***	-0.010***	-0.013***	-0.007***	-0.013**
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Relative age*Age	0.002***	0.002***	0.001***	0.001**	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Age	-0.113***	-0.112***	-0.112***	-0.116***	-0.100***	-0.115***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.003)
Demographic control variables	X	X	X	X	X	X
Fixed Effects						
School	X	X	X	X	X	X
Wave	X	X	X	X	X	X
Season-of-birth	X	X	X	X	X	X
N	344,009	305,121	296,944	116,585	90,079	344,009
R-squared	0.094	0.094	0.097	0.102	0.081	0.051
2SLS tests						
Endogeneity test: Hausman statistic (p-value)						58.327
						(0.000)
Under-identification test: Lagrange-Multiplier statistic (p-value)						3417.965
						(0.000)
Weak identification test: F-statistic						265.856
Over-identification test of all instruments: Hansen J statistic (p-value)						18.664

(0.5438)

Note: Life-satisfaction is standardized to a z-score. Age is centred. Demographic control variables include: the square of centred age, dummy for being female, dummy for having both parents at home, and dummies for medium and high socioeconomic status. Standard errors clustered on class are in parenthesis. 2SLS means that the results refer to the second stage of the two-stage least square. *** p<0.01, ** p<0.05, * p<0.1.

This table provides one interesting result. There is only partial support for the possible existence of an interaction between relative age and absolute age. As expected, the interaction effect is positive throughout the analyses: maturity gaps become less and less important with the increase in age. Moreover, the estimates are quite stable: an increase in absolute age by one year decreases the effect of one additional month of relative age by about 0.001-0.002 standard deviations. This interaction effect is mostly highly statistically significant throughout the robustness checks conducted on restricted samples. However, it is important to note that the strictest robustness check, which is conducted with the 2SLS, does not provide statistical evidence for such an interaction effect—see column (6).

Overall, although these results further confirm the main findings on the effect of relative age on life-satisfaction and suggest that they might actually represent an underestimate, they seem to rule out the interaction effect of relative age and absolute age.

3.3.2 Relative Age by Country

We replicate the main analyses but at a country-level. The goal of these analyses is twofold: (i) they work as further robustness checks, and (ii) they help us gain a greater understanding on whether RAEs, intended as age differences between classmates, could change with different educational settings. In particular, concerning the second goal, we are interested in knowing whether educational settings that are less disadvantageous for relatively young students—proxied by the lower rate of non-regular students—are associated with negative RAEs that are lower in absolute value, as suggested in Bedard and Dhuey (2006).

The model specification used in these analyses is similar to those carried out in the main analysis and those with the 2SLS, except for season-of-birth fixed-effects, which are not used. The reason is that since there is no within-country variation in cutoff dates in our sample of countries, relative age would be perfectly correlated with calendar month. The results from country-level analyses are illustrated in Table 7, where we report the estimates from the OLS and the second stage of the 2SLS[22] in column (1) and (2), respectively. Column (3) reports the samples size. The first row reports the estimates from the pooled sample of countries.

Table 7. Effect of relative age on standardized life-satisfaction, by country. Source: HBSC data.

	OLS	2SLS	
	RAEs	RAEs	N
Countries	(1)	(2)	(3)
Entire sample	-0.004***	-0.014***	344,009
Austria	-0.002	-0.018**	11,973
Belgium, Flanders	0.000	-0.024***	7,264
Belgium, Wallonia	0.001	-0.031**	2,802
Bulgaria	-0.012**	-0.014**	4,724
Croatia	-0.008***	-0.013***	14,545
Czech Republic	-0.008***	-0.010	8,796
Denmark	-0.005**	-0.011***	11,579
England	-0.007***	-0.009***	11,210
Estonia	-0.006***	-0.020***	10,298
Finland	-0.005**	-0.008***	16,442
France	-0.002	-0.018***	16,853
Greece	-0.045	-0.045	4,626
Greenland	0.071	0.071	167
Hungary	-0.006**	-0.015**	7,794
Iceland	-0.008***	-0.010***	16,652
Ireland	-0.007***	-0.015*	8,962
Italy	-0.008***	-0.012***	12,744
Latvia	0.001	-0.010*	10,981
Lithuania	-0.005**	-0.019**	14,717
Luxembourg	0.002	-0.025**	4,716
Macedonia	-0.005*	-0.024*	11,097
Netherlands	-0.009***	-0.008	8,613
Norway	-0.008***	-0.014***	8,568
Poland	-0.009***	-0.010***	15,493
Scotland	-0.003	-0.011***	15,610
Slovakia	-0.012***	-0.002	3,919
Slovenia	0.000	-0.019***	13,848
Spain	-0.010***	-0.021***	16,005
Sweden	0.001	-0.012***	13,085
Switzerland	-0.013***	-0.001	13,352
Ukraine	-0.005**	-0.018***	13,672
Wales	-0.008***	-0.010***	12,902

Note: Life-satisfaction is transformed into a z-score. All of the analyses include demographic control variables (i.e.

[22] Additionally, we conduct analyses at a country-level where we include the interaction term between relative age and absolute age. Overall, the results confirm the findings in Subsubsection 3.3.2, suggesting that there is no effect of such interaction.

centered age and its square, dummy for being female, dummy for having both parents at home, and dummies for medium and high socioeconomic status) and fixed-effects for school and wave. Grey cells refer to highly age-compliant countries (i.e. countries with few non-regular students). OLS stands for ordinary least square and 2SLS means that the results refer to the second stage of the two-stage least square. RAEs stands for the estimated effects of relative age. Standard errors clustered on class are in parenthesis. *** p<0.01, ** p<0.05, * p<0.1

Table 7 shows two interesting results. First, even though we investigate much smaller samples—see column (3), we find confirmation of the initial findings. This is true even when we refer to the 2SLS estimates—see column (2); this is the strictest robustness check and provides evidence of a negative and (mostly) highly statistically significant for 26 countries out of 32. Second, there appears to be a relationship between educational setting and the magnitude of RAEs on life-satisfaction. Grey cells refer to highly age-compliant countries (see footnote 19), where we would expect RAEs to be lower since their educational settings create fewer disadvantages to youngest students (Bedard & Dhuey 2006). Average RAEs for highly age-compliant countries (i.e. countries in grey cells), with statistically significant estimates, is about -0.011—with 0.001 of a standard deviation, while the corresponding average for the other countries is -0.017—with 0.005 of a standard deviation.

4 Conclusions

A quickly expanding economic literature shows that within-class age gaps (relative age) cause performance gaps and differences in non-cognitive skills and well-being. It is natural to expect that, in turn, this would be paralleled by lower life-satisfaction for the younger students in a class. However, the literature has so far neglected to investigate this outcome, leading to its economic importance for at least two reasons: (i) life-satisfaction seems to directly affect adolescents' school performance, the big five traits, and self-esteem, and (ii) adolescence is the best predictor of adults' life-satisfaction and emotional health. By means of international survey data from the Health Behaviour in School-Aged Children (HBSC) on European countries, we fill this gap in the literature.

We find evidence that relative age negatively affects adolescents' life-satisfaction. More concretely, we find that regular students who are about one year younger than the oldest regular student in the class (i.e. the largest hypothetical age difference) have a level of life-satisfaction that is about 0.091 points lower on a 0-10 scale. However, due to the presence of non-regular students in class (e.g. retained students or students who entered one year earlier than expected), this result might be biased.

To address this concern, we conduct two types of robustness checks. First, we conduct analyses on restricted samples where we try to gain estimates on RAEs only on regular students. These analyses suggest that the main analyses could provide an underestimate of RAEs. In fact, we find evidence that regular students who are one year younger than the oldest regular student in the class have a life-satisfaction that is about 0.3 points lower. Second, robustness checks on restricted samples might provide estimates that are affected by selection bias. To address this concern, we conduct an additional robustness check where we use a 2SLS, where we instrument relative age with expected relative age (i.e. the expected age difference between student *i* and the oldest regular student in the class, if student *i* was a regular student) and find results that are equivalent to those from the restricted samples. We find definitive confirmation that the initial estimates are downward biased; in fact, the 2SLS provides evidence that regular students who are one year younger than the oldest regular student in the class have a life-satisfaction that is up to about 0.3 points lower. Standard tests provide evidence that we are using proper instruments.

Our study contributes to the literature on RAEs and to that on life-satisfaction in a second manner. Although a number of recent studies have investigated the mechanisms behind the negative effect of absolute age on life-satisfaction in adolescence, no study has yet investigated the possible role of relative age. Intuitively, one would expect that RAEs on life-satisfaction decrease with the increase in absolute age. With the increase in absolute age, maturity differences tend to fade away; thus, gaps in performance, non-cognitive abilities, and well-being that are caused by maturity differences decrease with the increase in absolute age and should reflect smaller life-satisfaction gaps.

We do not find sound evidence that this negative effect of relative age could change with absolute age. As expected, the interaction effect between relative age and absolute age is positive throughout the analyses. Moreover, its magnitude is quite stable: an increase in absolute age by one year decreases the effect of a within-class month gap by about 0.001-0.002 standard deviations, that is, 0.002-0.004 life-satisfaction points on a 0-10 scale. The 2SLS leads to the equivalent result in terms of economic significance, but it is no longer statistically significant. The lack of statistical evidence of the interaction effect seems to suggest the persistence of life-satisfaction gaps in later ages.

Finally, country-level analyses provide additional support to the main findings. 2SLS regressions at a country-level provide statistical evidence of negative RAEs for 26 out of 32 countries. These analyses suggest that RAEs might be lower in countries with high age-compliance, where educational settings create fewer disadvantages to the youngest students.

There is an important policy implication of the negative RAEs on life-satisfaction. In order to improve the life-satisfaction of the youngest students in a class, the age-grouping system could be modified by shortening the largest possible within-class age differences down to 9-6 months, as suggested in previous papers (e.g. Pellizzari & Billari 2012; Barnsley & Thompson 1988). Although costly in the short-run, a reform of the age-grouping system promises positive long-term returns in both human capital formation (Zi et al. 2015; Soto 2015; Lippman et al. 2014; Specht et al. 2013) and long-term life-satisfaction and emotional health (Clark et al. 2018). Additionally, the reduction in the class size, which would result from the reduction in the largest possible within-class age differences, would have a positive effect on students' achievements on its own (Krueger 2003).

For future studies, a logical next step is to further investigate the (possible) persistence of negative gaps in life-satisfaction. For now, there is only minor indirect support to our finding. Low life-satisfaction is associated with higher suicide rates (among adolescents, Valois, et al. 2004; among adults, Koivumaa-Honkanen et al. 2001) and violent delinquent behavior (MacDonald 2005). Thus, the result that low life-satisfaction persists in time for relatively young students relates to studies that find that late teenagers and young adults (in their 20s-30s), who were among the youngest students in their class, tend to have both higher suicide rates and higher propensity to commit crimes (Landersø et al. 2015; Matsubayashi & Ueda 2015; Thompson et al. 1999). To our knowledge, panel data sets covering a long time-period and including information on life-satisfaction and precise details on people's education (e.g. information on retention up to the end of high-school) do not exist at the moment; therefore, it is not possible to follow the evolution of RAEs on individuals' life-satisfaction over time. However, it could be possible to integrate ex-post longitudinal data with survey data on individuals' educational career in order to conduct studies such as that of Frijters et al. (2013), who investigate what childhood characteristics affect adults' life-satisfaction.

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Online Appendix: Additional Basic Statistics

Table O.1. Number of observations, by country and wave. Source: HBSC data.

	Wave			
	2001/2	2005/6	2009/10	
Country	N	N	N	N by country
Austria	4,150	4,771	4,715	13,636
Belgium, Flanders	1,805	3,051	2,956	7,812
Belgium, Wallonia	3,018	3,589	3,113	9,720
Bulgaria	-	4,811	-	4,811
Croatia	4,336	4,779	6,058	15,173
Czech Republic	5,006	-	4,316	9,322
Denmark, mainland	4,474	5,363	3,924	13,761
England	4,082	4,730	3,411	12,223
Estonia	3,345	4,188	4,131	11,664
Finland	5,143	5,143	6,494	16,780
France	7,416	5,710	5,471	18,597
Greece	3,102	-	4,801	7,903
Greenland	-	-	198	198
Hungary	-	3,450	4,569	8,019
Iceland	-	8,494	8,780	17,274
Ireland	1,956	3,716	3,890	9,562
Italy	4,313	3,896	4,734	12,943
Latvia	3,206	4,091	4,053	11,350
Lithuania	5,577	5,574	5,211	16,362
Luxembourg	-	2,886	2,968	5,854
Macedonia	3,704	4,838	3,432	11,974
Netherlands	3,769	3,138	3,206	10,113
Norway	4,943	-	4,050	8,993
Poland	6,239	5,466	4,185	15,890
Scotland	4,381	6,130	6,668	17,179
Slovakia	-	276	4,475	4,751
Slovenia	3,894	5,005	5,320	14,219
Spain	5,418	7,729	3,890	17,037
Sweden	3,778	4,332	6,627	14,737
Switzerland	4,083	4,204	5,694	13,981
Ukraine	3,976	4,859	5,345	14,180
Wales	3,804	4,384	5,355	13,543
Total N	108,918	128,566	142,040	379,524

Note: Flanders and Wallonia as well as Denmark mainland and Greenland hold separate surveys within Belgium and Denmark, respectively.

Table O.2 Cut-off dates and additional educational settings by country. Source: HBSC data.

Country	Cut-off date
Austria	Sep 1st
Belgium, Flanders	Jan 1st
Belgium, Wallonia	Jan 1st
Bulgaria	Jan 1st
Croatia	Apr 1st
Czech Republic	Sep 1st
Denmark	Jan 1st
England	Sep 1st
Estonia	Oct 1st
Finland	Jan 1st
France	Jan 1st
Greece	Jan 1st
Greenland	Jan 1st
Hungary	Jul 1st
Iceland	Jan 1st
Ireland	Jan 1st
Italy	Jan 1st
Latvia	Jan 1st
Lithuania	Jan 1st
Luxembourg	Sep 1st
Macedonia	Jan 1st
Netherlands	Oct 1st
Norway	Jan 1st
Poland	Sep 1st
Scotland	Mar 1st
Slovakia	Sep 1st
Slovenia	Jan 1st
Spain	Jan 1st
Sweden	Jan 1st
Switzerland	Jul 1st
Ukraine	Jan 1st
Wales	Sep 1st

Table O.3 Educational settings sources. Source: HBSC data.

Country	Source
Croatia	Sakic et al. (2013)
Estonia	Toomela et al. (2006)
Greenland	Statistics Greenland (2015)
Greenland	Rex et al. (2014)
Luxembourg	Ministry of Education correspondence, private correspondence
Multiple	https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Countries
Multiple	http://www.oecd.org/edu/bycountry/
Multiple	http://eacea.ec.europa.eu/education/eurydice/documents/thematic_reports/eu_press_release/126EN_HI.pdf
Multiple	https://www.nfer.ac.uk/eurydice/compulsory-age-of-starting-school
Netherlands	Plug (2001)
Norway	Lien et al. (2005)
Norway	Solli (2017)
Scotland	Gamoran (2002)
Ukrania	https://www.classbase.com/countries/Ukraine/Education-System

Table O.4 Descriptive statistics on regular, younger, and older students, and on classes with regular students. Source: HBSC data.

	Regular students		Younger students		Older students		Classes only with regular students	
Country	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Austria	0.854	0.353	0.027	0.161	0.119	0.324	0.137	0.344
Belgium, Flanders	0.800	0.400	0.073	0.261	0.126	0.332	0.286	0.452
Belgium, Wallonia	0.725	0.447	0.074	0.262	0.201	0.401	0.132	0.339
Bulgaria	0.935	0.247	0.049	0.215	0.017	0.128	0.454	0.498
Croatia	0.920	0.271	0.023	0.149	0.057	0.232	0.229	0.420
Czech Republic	0.800	0.400	0.033	0.180	0.167	0.373	0.038	0.192
Denmark	0.898	0.303	0.022	0.146	0.080	0.272	0.215	0.411
England	0.985	0.120	0.005	0.068	0.010	0.099	0.758	0.428
Estonia	0.807	0.394	0.071	0.257	0.121	0.327	0.117	0.321
Finland	0.959	0.199	0.012	0.109	0.029	0.168	0.532	0.499
France	0.728	0.445	0.120	0.325	0.152	0.359	0.139	0.346
Greece	0.973	0.162	0.001	0.025	0.026	0.160	0.750	0.433
Greenland	0.347	0.477	0.279	0.450	0.374	0.485	0.000	0.000
Hungary	0.745	0.436	0.011	0.105	0.244	0.430	0.024	0.154
Iceland	0.989	0.106	0.006	0.077	0.005	0.073	0.846	0.361
Ireland	0.523	0.500	0.083	0.275	0.395	0.489	0.012	0.108
Italy	0.916	0.277	0.026	0.160	0.057	0.232	0.345	0.475
Latvia	0.868	0.338	0.023	0.149	0.109	0.311	0.165	0.371
Lithuania	0.826	0.380	0.093	0.290	0.082	0.274	0.084	0.278
Luxembourg	0.765	0.424	0.102	0.303	0.134	0.340	0.163	0.370
Macedonia	0.729	0.444	0.126	0.332	0.145	0.352	0.134	0.341
Netherlands	0.868	0.338	0.079	0.270	0.053	0.224	0.276	0.447
Norway	0.979	0.142	0.007	0.083	0.014	0.116	0.798	0.402
Poland	0.986	0.120	0.004	0.064	0.010	0.101	0.786	0.410
Scotland	0.942	0.235	0.005	0.072	0.053	0.225	0.348	0.476
Slovakia	0.853	0.355	0.038	0.190	0.110	0.313	0.149	0.356
Slovenia	0.917	0.277	0.048	0.214	0.035	0.185	0.227	0.419
Spain	0.766	0.424	0.067	0.250	0.167	0.373	0.294	0.456
Sweden	0.957	0.202	0.017	0.131	0.025	0.157	0.469	0.499
Switzerland	0.652	0.476	0.036	0.187	0.311	0.463	0.022	0.148
Ukraine	0.819	0.385	0.015	0.122	0.166	0.372	0.163	0.369
Wales	0.989	0.103	0.004	0.060	0.007	0.084	0.794	0.405

Note: Older refers to students older than expected in a given class (e.g. they were retained or redshirted). Younger refers to students who are younger than expected in a given class (e.g. they skipped a grade or entered school one year earlier). Regular refers to students who have the expected age in a given class.

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