Supplementary material

Table S1: Definitions of the independent variables included in the study

Early life	
Number of low educated parents	0, 1, or 2 parents with primary school, lower vocational, or lower secondary education as highest attained level of education
Prematurity	Birth after <37 weeks of gestation
Low birth weight	Birth weight <2500 g
Maternal smoking during pregnancy	Maternal smoking during at least the first 4 weeks of gestation
Breast feeding	Any breast feeding (exclusive or not exclusive) for $\geq$ 16 weeks
Secondhand smoke exposure at home at 3 months	Secondhand tobacco smoke exposure in the child's home at least once a week at the child's age of 3 months
General health, age 4-8 years	As indicator of childhood health we used the scores on the RAND 7-item general health rating index [Lewis, 1989; Brouwer, 2007] that was completed by the parents at the child's ages of 4, 6 and 8 years. Scores on the RAND index range from 0 – 32, where a high score defines a more favorable health state. We created a 'general health in childhood' variable by adding up the scores obtained at ages 4, 6 and 8 years.
Social and physical environment	
Adolescent level of education	At age 11, children are still in primary school and different levels of education can therefore not be defined. At ages 14, 17 and 20, low, intermediate and high education were defined as follows: At age 14, low

	education = preparing for labour market; intermediate education = (pre)vocational education or secondary general education; high education = preparing for university education. At age 17, low education = vocational education; intermediate education = general secondary education; high education = (pre) university education. At age 20, low education = vocational education; intermediate education = university of applied sciences; high education = university education; for 20-year-olds who were working and no longer following education, education was defined as missing.
Neighbourhood SES	Neighbourhood SES was based on the 'status scores' of 4-digit postal code (PC4) areas from the Netherlands Institute for Social Research (SCP). Status scores include the average income, the percentage of low educated residents, the percentage of residents with a low income and the percentage unemployed persons in a postal code area. A higher status score indicates a higher neighbourhood SES (Knol, 2012). In the period 1998-2017, status scores for all PC4 areas in the Netherlands ranged from -7.95 to 2.86.
Highly urbanized	The level of urbanization was based on address density and ≥1500 addresses/km^2 was defined as highly urbanized
Residential greenness	We used the Normalized Difference Vegetation Index (NDVI) using satellite remote sensors to measure and map the density of green vegetation to assess greenness levels around the adolescents' home addresses (Weier and Herring, 2000). The NDVI was derived from Landsat 5 Thematic Mapper data at 30m x 30m resolution. NDVI values range from −1 to 1, with higher values indicating a higher density of green vegetation. Negative values correspond

	to water and were set to zero. We calculated the average NDVI in circular buffers of 1 km around the adolescents' home addresses.
Secondhand smoke exposure at home	Secondhand tobacco smoke exposure at home was obtained from the questionnaires completed by the parents at ages 11, 14, 17 and the questionnaires completed by the adolescents at age 20 and defined as smoking in the adolescent's home at least 1x per week at those ages
Lifestyle	
Smoking	Smoking was defined at age 11 as 'ever smoked'; at age 14 as 'smoking at least occasionally'; and at ages 17 and 20 as 'smoking $\geq$ 1x per week'.
Alcohol consumption	Alcohol consumption was defined at age 11 as 'ever drank a whole glass'; at age 14 as 'drank $\geq$ 10 glasses in his/her whole life'; and at ages 17 and 20 as 'drinking $\geq$ 7 glasses per week'.
Energy drinks	Use of energy drinks was defined as using energy drinks at least once a week.
Skipping breakfast	Skipping breakfast was defined as skipping breakfast on 2 or more days per week.
Health	
Early puberty	Using the Pubertal Development Scale (PDS) (Carskadon and Acebo, 1993) we obtained adolescent reported pubertal development at the ages of 11, 14 and 17 years. A higher score on the PDS indicates more advanced pubertal development. We defined 'early puberty' as a PDS score above the seventy-fifth percentile at age 11 for girls and at age 14 for boys.
Sleeping problems	Sleeping problems were defined as (lying awake for a long time before falling asleep) and/or ((having night time awakenings (almost) every night

	and then lying awake for a while or a long time) or (having night time awakenings sometimes and then lying awake for a long time))
Asthma	Asthma was one out of 15 items on a list of conditions with the following introductory question: 'Please indicate whether you (have) had one of the following diseases or disorders in the past 12 months.' (yes/no)
Hay fever	Hay fever was one out of 15 items on a list of conditions with the following introductory question: 'Please indicate whether you (have) had one of the following diseases or disorders in the past 12 months.' (yes/no)
Musculoskeletal complaints	Musculoskeletal complaints is a combined variable based on the presence of at least one of the following 3 items on a list of 15 conditions with the following introductory question: 'Please indicate whether you (have) had one of the following diseases or disorders in the past 12 months.': long-lasting complaints of the back, long-lasting complaints of the upper extremities (the neck, shoulders, elbows, wrists or hands) and long-lasting complaints of the lower extremities (hip, knees, ankles, or feet). (yes/no) Long-lasting was specified as at least 1 month.
Fatigue	'Fatigue or weakness lasting for more than 1 month' in the last 12 months was one out of 15 items on a list of conditions with the following introductory question: 'Please indicate whether you (have) had one of the following diseases or disorders in the past 12 months.' (yes/no)
Psychosocial wellbeing	
Being bullied	Participants were asked if they had been bullied in the last 12 months (yes/no).

Poor mental health	To assess mental health, we used the Mental Health Inventory (MHI-5) [Berwick et al 1991], a commonly used instrument that asks about the frequency of feeling nervous, calm, downhearted, happy and 'so down in the dumps that nothing could cheer you up' during the last 4 weeks. Response categories ranging from never to all the time are rescaled on a score from 0 to 100, with higher scores indicating better mental health. A score < 60 was classified as 'low mental health'.
Worrying	Worrying (yes/no) is based on the question 'Do you have a problem that keeps you busy day and night?' (yes/no).

Table S2: Prevalence (%) of headache by sex, age and study population characteristics

	Girls				Boys			
age	11 years	14 years	17 years	20 years	11 years	14 years	17 years	20 years
n	1302	1250	1074	1159	1321	1265	1009	1043
Early life								
Number of low educated parents								
0	9.4	13.5	19.5	17.6	7.2	7.1	6.1	6.1
1	9.5	15.4	20.5	21.8	8.6	8.4	6.9	7.4
2	9.4	17.4	24.8	30.0	7.9	-	-	-
Prematurity								
No	9.4	14.5	20.7	19.6	7.6	7.3	6.3	6.2
Yes	10.2	13.7	15.9	25.0	9.0	-	-	-
Low birth weight								
No	9.4	14.4	20.7	19.7	7.7	7.0	6.2	6.1
Yes	-	14.3	-	21.9	-	-	-	-
Maternal smoking during pregnancy								
No	9.5	14.4	20.6	19.5	7.3	6.5	6.6	6.2
Yes	8.7	14.3	19.7	21.4	8.9	10.2	-	5.6
Breast feeding								
0-16 weeks	9.5	16.0	22.3	22.3	7.3	7.3	6.6	6.6
$\geq$ 16 weeks	9.3	11.6	17.7	15.8	8.1	6.5	5.5	5.1

Secondhand smoke exposure at 3 months								
No	9.1	13.6	20.9	19.4	7.3	6.2	6.1	5.1
Yes	10.7	16.6	18.8	21.2	8.7	9.7	7.2	9.3
General health, age 4-8 years								
$\geq$ median	6.8	13.3	17.1	15.4	6.4	5.6	5.7	5.7
< median	12.1	16.1	23.7	24.7	9.5	8.0	7.0	6.4
Social and physical environment								
Education[a]								
High		11.2	16.7	14.2		7.1	5.6	2.4
Intermediate	N.A.	16.9	19.6	21.3	N.A.	5.9	7.8	8.4
Low		15.8	26.8	22.0		7.5	5.6	5.6
Neighbourhood SES								
$\geq$ median	9.6	14.5	18.1	19.8	7.6	7.5	5.9	6.2
< median	9.2	14.5	23.1	20.1	8.2	6.1	6.4	5.9
Highly urbanized								
No	8.7	13.6	19.9	22.4	7.1	7.1	4.7	5.7
Yes	10.4	15.7	21.4	18.7	8.9	6.6	8.1	6.3
Residential greenness								
$\geq$ median	7.6	13.7	20.2	18.9	7.1	6.7	5.4	6.5
< median	11.0	15.2	21.0	20.6	8.5	7.1	6.8	5.4

Secondhand smoke exposure at home								
No	9.3	13.9	19.8	19.6	7.5	6.4	6.4	6.1
Yes	8.9	20.5	20.8	20.7	9.8	9.8	11.1	7.1
Lifestyle								
Smoking[b]								
No	9.4	13.7	19.4	19.7	7.3	6.8	6.1	6.4
Yes	-	22.2	29.1	19.8	18.4	9.0	7.4	5.4
Alcohol consumption[c]								
No	9.4	13.7	20.8	20.8	7.4	6.5	6.3	7.5
Yes	12.0	22.7	15.9	14.8	10.6	11.0	6.6	4.5
Energy drinks								
No	9.6	13.5	18.5	19.1	7.8	6.3	6.5	5.9
Yes	-	19.7	31.5	25.2	7.6	8.4	6.0	7.7
Skipping breakfast								
No	9.5	13.0	18.2	17.5	7.7	6.6	5.9	5.8
Yes	9.8	22.7	26.6	24.6	-	10.3	8.9	8.2
Health								
Early puberty[d]								
No	9.0	13.3	18.9	17.8	N.A.	7.5	6.1	6.3
Yes	10.2	17.0	21.7	23.9		5.4	6.8	5.0
Sleeping problems								
No	8.3	11.8	17.7	17.7	7.0	6.2	6.1	5.9
Yes	13.9	24.6	33.7	29.8	10.9	12.4	8.7	8.1

Asthma								
No	9.2	13.9	20.2	18.4	7.1	6.4	5.6	5.5
Yes	13.6	20.9	24.1	36.0	15.7	14.6	16.9	15.9
Hay fever								
No	9.0	12.7	18.9	18.1	6.8	6.5	5.9	5.2
Yes	13.3	23.4	27.0	25.5	13.5	9.5	8.3	8.9
Musculoskeletal complaints								
No	7.7	9.5	14.5	13.5	7.0	5.9	4.8	4.1
Yes	17.4	25.8	31.4	30.1	11.8	11.9	13.2	13.5
Fatigue								
No	8.6	10.1	14.1	13.9	7.0	5.4	4.3	4.4
Yes	25.0	36.4	38.3	34.7	23.2	36.9	27.6	21.3
Psychosocial wellbeing								
Being bullied								
No	8.9	13.7	N.A.	N.A.	6.2	6.6	N.A.	N.A.
Yes	10.8	18.3			10.2	9.4		
Poor mental health								
No	9.2	11.9	17.4	17.7	7.3	6.1	5.0	5.0
Yes	12.6	26.9	29.8	24.7	15.4	18.9	17.3	12.1
Worrying								
No	9.1	12.7	17.1	17.5	7.0	6.5	5.4	5.6
Yes	15.7	22.9	33.6	27.9	16.5	14.1	13.1	8.8

- Cells containing fewer than 5 participants are indicated by '-' . No percentages are shown for these subgroups.)

N.A. = not available

[a] At age 11, children are still in primary school. The percentages shown for the type of education in the column 'age 11' are the percentages at age 14

[b] Smoking was defined at age 11 as 'ever smoked' and at 17 as 'smoking $\geq$ 1x per week'.

[c] Alcohol consumption was defined at age 11 as 'ever drank a whole glass' and at 17 as 'drinking $\geq$ 7 glasses per week'.

[d] Early puberty was defined for girls at age 11 and for boys at age 14

Table S3: Prevalence of early life characteristics of the PIAMA participants at baseline (prenatally and in the first year of life), at age 20 years and in the subgroup of participants included in the headache study

	Prevalence n/N (%)		
Characteristics	Baseline	At age 20 years	Included in the headache study
Female sex	1906/3963 (48.1)	1159/2206 (52.5)	1512/3064 (49.4)
Low educated mother	894/3807 (23.5)	419/2195 (19.1)	626/3051 (20.5)
Low educated father	973/3761 (25.9)	482/2176 (22.2)	718/3027 (23.7)
Prematurity	190/3930 (4.8)	98/2200 (4.5)	141/3057 (4.6)
Maternal smoking during pregnancy	703/3920 (17.9)	312/2191 (14.2)	480/3038 (15.8)
Breast feeding $\geq$ 16 weeks	1266/3896 (32.5)	814/2188 (37.2)	1079/3034 (35.6)
Secondhand smoke exposure at home at 3 months	1129/3935 (28.7)	526/2203 (23.9)	800/3061 (26.1)

Figure S1A: Diagram representing the generalized linear mixed model used to estimate the

association between potentially associated factors and the overall prevalence of headache

throughout 11-20 years, taking into account the correlations between repeated measurements
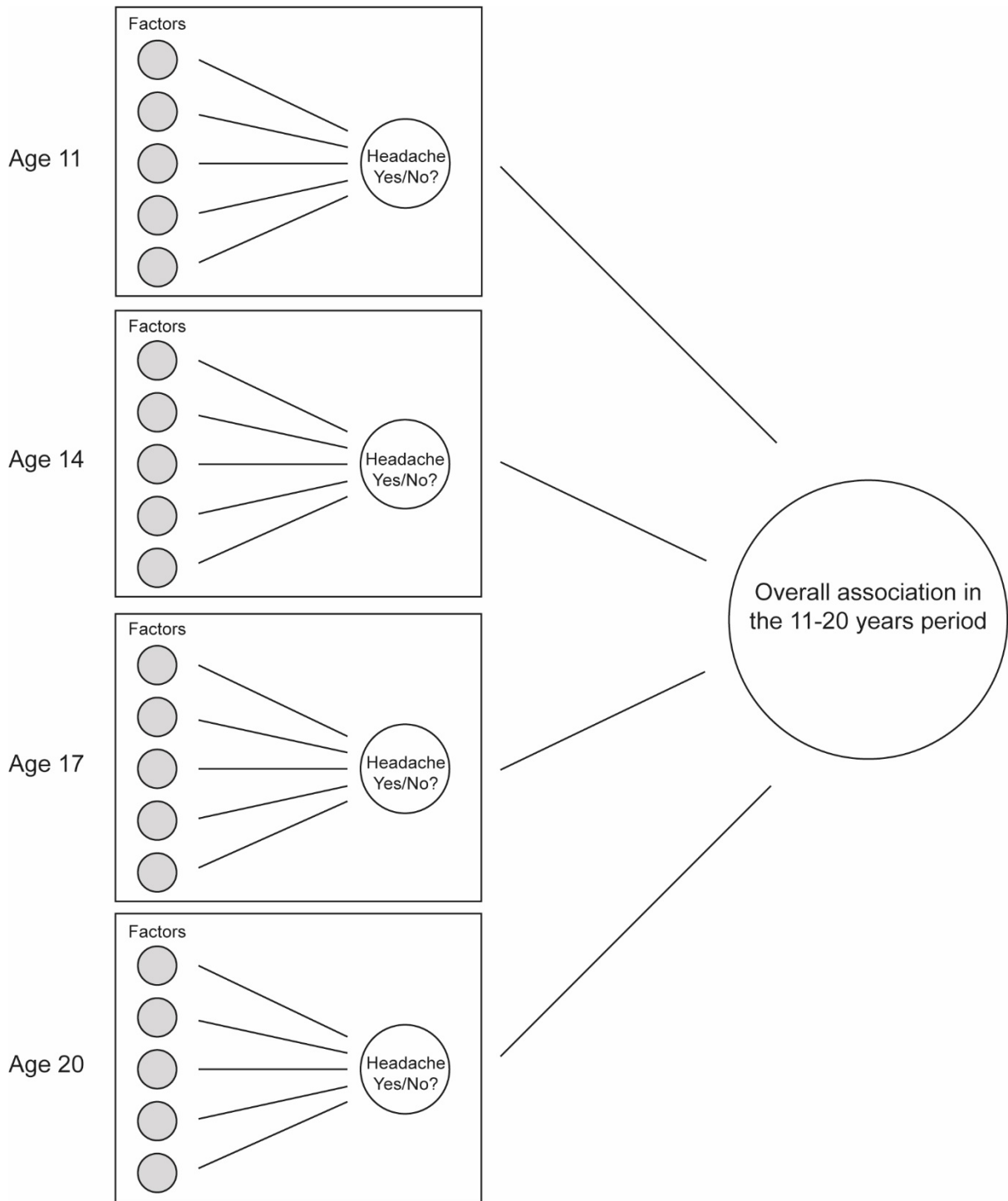
Figure S1B: Diagram representing the discrete time hazard model used to estimate the association between potential risk factors measured at ages 11, 14 and 17 and incidence of headache (a first report of headache in adolescents who never reported headache before) in the subsequent questionnaire