




## Cohort Profile

# Cohort profile: KiGGS cohort longitudinal study on the health of children, adolescents and young adults in Germany

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## Why was the cohort set up?

In the early 1990s, few nationwide representative data on the health of the under-age population in Germany was identified. Thus, the Robert Koch Institute (RKI) conducted the ‘German Health Interview and Examination Survey for Children and Adolescents’ (KiGGS) as the first nationwide health survey in this population, funded by the German Federal Ministry of Health, Federal Ministry of Education and Research, and the RKI. The survey comprised representative data on physical and mental health status, health behaviours and other health determinants based on health examinations and interviews.<sup>1</sup> Participants in the KiGGS Baseline study, who all grew up around the turn of the millennium in Germany, are tracked into adulthood, with regular follow-ups, within the KiGGS cohort.<sup>2,3</sup> Data from two longitudinal in-depth module studies using sub-samples, the BELLA Study for mental health<sup>4</sup> and Motoric Module focusing on motor fitness,<sup>5</sup> can be linked to the KiGGS cohort.

The main aims of the KiGGS cohort are to:

- identify typical health and health behaviour trajectories over the life course

- describe variation in trajectories across different populations
- analyse long-term health developments as a function of risk and protective factors
- observe transition periods and their implications on health development.

## Who is in the cohort?

The Baseline study of the KiGGS cohort was conducted from 2003 to 2006 as the first nationwide health survey among children and adolescents aged 0–17 years with primary residence in Germany.<sup>1</sup> A two-stage sampling protocol was used. First, to proportionately consider the population size according to degree of urbanization and geographic distribution in Germany, 167 communities were selected as primary sample units (PSUs), with a disproportionate number of PSUs in Berlin and East and West Germany, to represent these regions separately. Second, an equal number of addresses per birth cohort were randomly selected in each PSU from local population registries. Children and adolescents with non-German citizenship

were oversampled by a factor 1.5, to account for expected higher non-response rates<sup>6</sup> in this population.

The gross sample included 28 299 minors,<sup>6</sup> who were invited to participate in the survey by postal letter sent to their parents or custodians. To maximize participation, non-responding parents were contacted by telephone. Additionally, personal visits were conducted if parents did not respond initially or could not be reached via telephone. Moreover, incentives were used and accompanying local public relations work was carried out prior to the field phase. Migrant-specific activities were conducted to increase participation among children with a migration background.<sup>7</sup>

After excluding non-eligible cases, the gross sample was  $N=26\,787$ , including oversampling, and  $N=25\,602$  without including oversampling. In total, 17 641 respondents were included, with a response rate (RR) 66.6%; this RR refers to the gross ( $N=25\,602$ ) and net ( $n=17\,056$ ) sample without oversampling. Referring to the gross ( $N=26\,787$ ) and net ( $n=17\,641$ ) sample, including oversampling of children and adolescents with non-German citizenship, the RR was 65.9%. A total of 8985 boys (RR 66%) and 8656 girls (RR 67%) took part in the survey. One study participant requested retrospective deletion of all personal contact and survey data such that 17 640 respondents were finally included in the cohort. There were no differences in the RR with respect to sex and age group. A lower RR was reached among families with non-German citizenship (RR 51%) than among those with German citizenship (RR 68%). Response was lower in major cities (>100 000 residents; RR 58%) than in smaller municipalities (RR 70%). A short questionnaire on basic socio-demographic and health-related information was completed by two-thirds of non-responders. Comparison of basic information between non-responders and responders showed no differences in health indicators. Differences in mothers' education level suggested a slight middle-class bias.<sup>1,6</sup>

To yield representative statements, a weighting factor was calculated to account for the clustered sample design and deviations in the net sample from the population structure with respect to age (years), sex, non-German citizenship, federal state (on 31 December 2004) and parents' highest educational attainment (according to the German Census of 2005).<sup>6</sup> Crude and weighted sample characteristics are shown in [Table 1](#).

### How often have they been followed up?

Up to 2018, two follow-ups have been completed ([Figure 1](#)). The first follow-up (KiGGS Wave 1) was carried out between 2009 and 2012 as a computer-assisted

telephone interview survey.<sup>12</sup> At that time, cohort participants were between 6 and 24 years old. The second follow-up (KiGGS Wave 2) was conducted as a health examination and interview survey between 2014 and 2017, with study centres located in the same 167 PSUs as in the KiGGS Baseline study.<sup>13</sup> If participants had moved to other communities or they did not want to or could not come to a study centre, they were invited to take part solely in the health interview part, which was conducted using a written questionnaire. To increase response among the young adult ( $\geq 18$  years) population, online health questionnaires were offered to all young people who had not responded by the end of the health examination period. Participants were 10–29 years old at the time of invitation and  $\leq 31$  years old at the time of survey participation.<sup>2</sup>

All Baseline study participants were invited to take part in these follow-ups if permission to be contacted again had been given by their parents, or later, by the adult participants themselves. Former respondents for whom permission to be re-contacted was not given, and those who had died or lived permanently abroad, were excluded from invitation. Current addresses were checked using local population registries. Postal invitations and reminder letters were sent. Non-respondents were contacted by telephone and in KiGGS Wave 2 home visits were conducted in the 167 PSUs.

In Wave 1, 11 992 (68%) of the 17 641 Baseline survey respondents participated again (6078 female and 5914 male participants). In Wave 2, 10 853 (62%) cohort members took part in the survey (5790 female and 5063 male participants). For 6465 of these participants (3254 female and 3211 male), additional examination data are available (37% of the Baseline sample).<sup>2</sup> For 8979 cohort members (51% of 17 641 Baseline participants), data are available for all three periods of data collection; for 5554 of these participants (31% of the Baseline sample), examination data in Wave 2 are available. A total 1874 participants (11% of Baseline sample) did not take part in Wave 1 but could be included again in Wave 2. A total 3013 persons (17% of the Baseline sample) took part in the Baseline survey and Wave 1 but not Wave 2. A total 3775 Baseline participants (21%) did not take part in either of the two subsequent waves.<sup>2</sup>

The reasons for non-participation in the two follow-ups are given in [Table 2](#). Only a few participants refused to be contacted again, so a high degree of commitment to the study can be assumed. In total, 33 participants are deceased; it would be necessary to conduct a mortality follow-up to obtain information about the causes of death.

The loss to follow-up in the KiGGS cohort is strongly associated with socio-demographic characteristics. A lower probability of re-participation is associated with older age,

**Table 1. Examples of baseline socio-demographic and health characteristics of the KIGGS cohort (recruited from 2003–2006)<sup>a</sup>**

Age, years	0–2 (N = 2805)			3–6 (N = 3875)			7–10 (N = 4148)			11–13 (N = 3076)			14–17 (N = 3736)		
	N	% <sup>b</sup>	% wt**	N	% <sup>b</sup>	% wt**	N	% <sup>b</sup>	% wt**	N	% <sup>b</sup>	% wt**	N	% <sup>b</sup>	% wt**
Demographics (according to registration office)															
Non-German citizenship	133	4.7	5.4	316	8.2	9.3	415	10.0	11.5	276	9.0	9.5	339	9.1	8.9
Region of residence: Western Germany (excluding Berlin)	1839	65.6	82.4	2571	66.4	83.9	2796	67.4	86.4	2065	67.1	86.5	2470	66.1	78.1
Municipality size: <5000	611	21.8	16.9	866	22.4	17.6	873	21.1	18.0	664	21.6	18.1	792	21.2	19.3
5000 to <20 000	755	26.9	24.8	1024	26.4	26.0	1108	26.7	27.2	817	26.6	27.6	951	25.5	27.3
20 000 to <100 000	800	28.5	29.8	1139	29.4	29.8	1218	29.4	29.6	890	28.9	28.9	1119	30.0	29.4
100 000 or more	639	22.8	28.4	846	21.8	26.7	949	22.9	25.2	705	22.9	25.4	874	23.4	24.0
Demographics (information given by parents)															
Child's sex: Female	1389	49.5	48.7	1924	49.7	48.7	2021	48.7	48.7	1488	48.4	48.7	1832	49.0	48.7
Migration background:															
One-sided	280	10.1	11.6	317	8.3	9.7	309	7.5	8.2	188	6.1	7.2	198	5.3	6.1
Two-sided	361	13.0	17.6	569	14.8	19.3	606	14.7	18.1	487	15.8	17.9	567	15.2	15.6
Missing	18			32			26			0			4		
Education of family <sup>c</sup> : Low	355	12.8	25.3	555	14.5	28.6	692	16.9	33.1	566	18.7	37.0	692	19.2	35.8
Middle	1616	58.3	49.4	2205	57.5	48.2	2281	55.6	46.0	1676	55.4	43.8	1940	53.9	44.5
High	803	29.0	25.2	1076	28.1	23.2	1131	27.6	20.9	785	25.9	19.2	969	26.9	19.7
Missing	31			39			44			49			135		
Socio-economic status of family: Low	417	15.0	19.1	606	15.8	20.1	681	16.6	21.4	493	16.3	19.9	517	14.4	18.4
Middle	1656	59.7	57.9	2270	59.3	58.6	2444	59.6	59.1	1840	60.9	61.5	2191	61.2	62.5
High	699	25.2	23.0	955	24.9	21.3	976	23.8	19.5	688	22.8	18.7	873	24.4	19.1
Missing	33			44			47			55			155		
Health status and behaviours															
General health <sup>8</sup> : Very good/good	2698	97.0	97.1	3595	93.4	92.9	3888	94.4	93.9	2828	93.0	92.4	3296	91.0	90.4
Missing	22			25			31			35			114		
Children with special health care needs: CSHCN <sup>9</sup>	128	5.0	4.7	405	11.7	11.4	645	17.0	17.0	503	17.4	16.1	545	15.9	15.4
Screening positive															
Missing	220			399			344			241			299		
Allergic rhinitis (hay fever): Lifetime diagnosis yes	39	1.5	1.6	226	6.2	6.5	442	11.4	11.7	460	16.1	15.4	680	20.0	20.0
Missing (refused/'don't know')	123			241			271			225			330		
Bronchial asthma: Lifetime diagnosis yes	15	0.5	0.5	91	2.4	2.9	192	4.7	4.8	215	7.1	6.6	261	7.1	7.0
Missing (refused/'don't know')	40			60			54			42			51		
Atopic dermatitis: Lifetime diagnosis yes	286	10.8	10.2	616	17.0	16.4	735	18.8	17.4	519	18.1	17.4	568	16.6	16.5
Missing (refused/'don't know')	165			250			245			201			312		
Attention deficit hyperactive disorder: Lifetime diagnosis	yes			91	2.5	2.7	287	7.5	7.8	255	9.0	9.1	237	6.9	7.9

(continued)

Table 1. Continued

Age, years	0-2 (N = 2805)			3-6 (N = 3875)			7-10 (N = 4148)			11-13 (N = 3076)			14-17 (N = 3736)		
	N	% <sup>b</sup>	% wt <sup>**</sup>	N	% <sup>b</sup>	% wt <sup>**</sup>	N	% <sup>b</sup>	% wt <sup>**</sup>	N	% <sup>b</sup>	% wt <sup>**</sup>	N	% <sup>b</sup>	% wt <sup>**</sup>
Missing (refused/'don't know')	2805	not measured		275			319			240			305		
SDQ-measured mental health problems: <sup>10</sup>				691	18.2	19.4	854	21.0	22.5	627	20.8	21.5	557	15.5	16.7
Total score borderline or abnormal				69			75			68			146		
Missing	2805	not measured													
Current smoking: Yes				3875	not measured		4148	not measured		124	4.1	3.4	1170	31.7	33.2
Missing	20	2.2	2.5	120	3.1	3.2	269	6.5	7.1	43			40		
Obesity <sup>d</sup> : Yes	1890	(1860 children		39			17			207	6.8	7.9	308	8.3	9.5
Missing		age <2 years excluded)								12			21		

<sup>a</sup>n = 17 640 because one study participant requested the retrospective deletion of all of their contact and survey data.

<sup>b</sup>Proportion in crude net sample (excluding missing values); wt<sup>\*\*</sup> = weighted prevalence rates (to German minor population 31.12.2004).

<sup>c</sup>Education groups according to CAsMIN (Comparative Analysis of Social Mobility in Industrial Nations).

<sup>d</sup>Based on national German reference percentiles.<sup>11</sup>

male sex, lower socio-economic status (SES) and a migration background (see Table 3).

Longitudinal weighting factors have been calculated for both follow-ups, to compensate for possible attrition bias owing to differential dropout. Weighting factors were calculated as the cross-sectional weight of the KiGGS Baseline (adjusted to the population as of 31 December 2004) multiplied by a dropout weight. The dropout weight is given by the inverse probability of participation in the follow-up wave. This probability was modelled using a weighted logistic regression model that includes socio-demographic and health behaviour-related indicators as predictors. This weighting results in higher weights for groups that tend to be less willing to participate in the follow-up.

## What has been measured?

The KiGGS cohort is characterized by a thematic breadth of collected data, ranging from physical and mental health to health behaviour, psycho-social factors, social background and use of health care services. The survey contents are dependent on the survey modes used in the Baseline survey and the two follow-up waves (Figure 2).

## Health examination

An age-specific health examination was conducted in the KiGGS Baseline study and KiGGS Wave 2. Measurement of body weight, height and waist circumference<sup>14</sup> in both waves was supplemented with analysis of body composition by means of bioimpedance measurement in Wave 2, to observe the development of obesity over the life course. Further anthropometric measurements included head circumference and skinfolds at baseline. As important indicators of cardiovascular health, the resting blood pressure and heart rate were measured in both waves.<sup>15</sup> In addition, to identify preclinical arteriosclerosis, sonographic evaluation of the intima-media thickness of the carotid artery wall was implemented in Wave 2. Thyroid size and structure were also examined by ultrasound at baseline. An eye examination was performed, and motor restlessness and skin condition were additionally assessed.

Physical fitness was tested in both waves for children aged 4-10 years using a motor ability test battery to test strength, flexibility, coordination;<sup>16</sup> in adolescents and young adults aged 11-29 years, a cycle ergometry test was used to assess cardiorespiratory fitness. Measurement of total physical activity using accelerometry over 7 days was added in Wave 2.

Participants were asked for a blood sample and spot urine sample.<sup>17</sup> Electrolytes, transaminases, retention

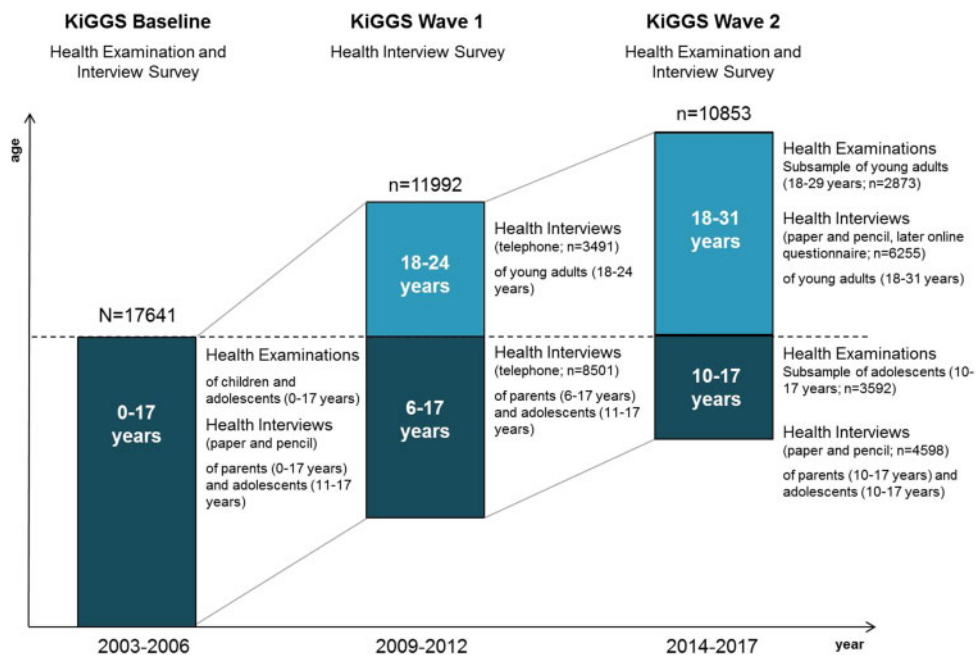


Figure 1. Study design of the KiGGS cohort.

Table 2. Final disposition codes and loss to follow-up in KiGGS Waves 1 and 2

	Wave 1	Wave 2
Temporary codes		
Non-participation: refusal	2036	2753
Non-participation: no contact <sup>a</sup>	2914	3562
Non-participation: minimum requirements not met <sup>b</sup>	497	85
Respondents	11 992	10 853
Sub-total	17 439	17 253
Constant loss (cumulative)		
Retrospective deletion of all contact and survey data, requested by respondent	1	1
Deceased	16	33
Non-participation: permanently living abroad	99	205
Non-participation: unknown address <sup>c</sup>	7	8
Non-participation: cohort consent withdrawn	79	141
Sub-total	202	388
Total	17 641	17 641

<sup>a</sup>In this article, ‘contact’ is defined as having an interaction with the specific target person. During participant recruitment, it was common to have contact with other (family) members of the target persons’ household. These cases were assigned to the ‘no contact’ category. Therefore, the number of contacts may be underestimated.

<sup>b</sup>Insufficient amount of data and/or missing informed consent.

<sup>c</sup>Research at official residency registries prior to invitation returned status of non-traceable address.

values, blood lipids, thyroid hormone levels, micronutrients, sensitization to common allergens and immune status for selected infections were determined using

standardized laboratory methods (see [Supplementary data](#), available at *IJE* online). To document vaccination status, participants were asked to provide their vaccination records.

Participants’ use of drugs within the last 7 days (prescription and over-the-counter) was registered using a computer-assisted personal interview.<sup>18</sup> Data on physician-diagnosed diseases and chronic conditions (allergic diseases such as hay fever, neurodermatitis and asthma; migraine; epilepsy; and heart diseases) were collected in a second computer-assisted personal interview by the study physician in both examination waves. Participants who only took part in the health interview in Wave 2 answered these questions using a self-administered written or online questionnaire.<sup>13</sup>

### Health interview

A broad range of health information was collected using self-administered questionnaires in the Baseline study and Wave 2, whereas a telephone interview was conducted in Wave 1. Age group-specific questionnaires were used. In all waves, questionnaires were administered to parents of participants aged 0–17 years and directly to participants aged 11–17 years. Starting from Wave 1, all information of participants aged ≥18 years was collected exclusively via self-report questionnaires.

As a short assessment of participants’ health status, questions from the Minimum European Health Module<sup>8</sup> were included, supplemented with the screening

**Table 3.** Loss-to-follow-up in the KiGGS cohort by socio-demographic characteristics; all numbers and percentages are unweighted

	t0: KiGGS Baseline 2003–2006		t1: KiGGS Wave 1 2009–2012		t2: KiGGS Wave 2 2014–2017		
	<i>n</i>		<i>n</i>	%	<i>n</i>	%	
	Health examination and interview	Health Interview (Telephone)	Health interview	Subgroup with additional examination			
<b>Age at t0</b>							
0–2 years	2805	1929	68.8	1923	68.6	1472	52.5
3–6 years	3875	2881	74.3	2699	69.7	2082	53.7
7–10 years	4148	3021	72.8	2527	60.9	1458	35.1
11–13 years	3076	1986	64.6	1697	55.2	747	24.3
14–17 years	3736	2175	58.2	2007	53.7	706	18.9
<b>Sex</b>							
Male	8986	5913	65.8	5061	56.3	3211	35.7
Female	8654	6079	70.2	5792	66.9	3254	37.6
<b>Socio-economic status of the family at t0</b>							
Low	2714	1199	44.2	1179	43.4	711	26.2
Middle	10 401	7292	70.1	6575	63.2	3969	38.2
High	4191	3396	81.0	2980	71.1	1727	41.2
Missing	334	105	31.4	119	35.6	58	17.4
<b>Migration background</b>							
No	13 678	9941	72.7	8926	65.3	5277	38.6
One-sided	1292	799	61.8	738	57.1	432	33.4
Two-sided	2590	1214	46.9	1143	44.1	724	28.0
Missing	80	38	47.5	46	57.5	32	40.0
<b>Total</b>	<b>17 640<sup>a</sup></b>	<b>11 992</b>	<b>68.0</b>	<b>10 853</b>	<b>61.5</b>	<b>6465</b>	<b>36.6</b>

<sup>a</sup>*n* = 17 640 because one study participant requested the retrospective deletion of all of their contact and survey data.

	KiGGS cohort Baseline (2003-2006) Health Examination and Interview Survey	KiGGS cohort Wave 1 (2009-2012) Health Interview Survey	KiGGS cohort Wave 2 (2014-2017) Health Examination and Interview Survey
<b>Physical Measurements and Tests</b>	Anthropometry Blood pressure, heart rate Vision tests Cycle ergometry test, motor ability test battery Sonography of the thyroid gland		Anthropometry Bioimpedance Blood pressure, heart rate Cycle ergometry test, accelerometry Sonography of the Arteris carotis (CIMT)
<b>Computer Assisted Personal Interviews (CAPI)</b>	History of selected physician-diagnosed conditions Medication use within past 7 days Vaccination status (CAPI) & copy of vaccination cards		History of selected physician-diagnosed conditions Medication use within past 7 days Copy of Vaccination cards only
<b>Laboratory Tests (whole blood, serum, urine)</b>	General Health Indices (clinical chemistry; red blood count; urine status) Seroprevalence studies (infections; immunization status) Atopic sensitization Markers of nutritional status		General Health Indices (clinical chemistry; urine status) Seroprevalence studies (infections; immunization status) Atopic sensitization Markers of nutritional status
<b>Self-administered Questionnaires (Baseline, Wave 2)</b> <b>Telephone Interview (Wave 1)</b> Parents (0-17 years) Adolescents (11-17 years) Adults (18+ years)	<b>Physical Health</b> Communicable and non-communicable diseases Impairment, disability, malformation  <b>Mental Health</b> Screening of behavioural and emotional problems & mental disorders; Mental disorders (diagnosed) Health-related Quality of Life (HrQoL) Social and psychological resources  <b>Health-related Behaviour</b> Physical activity, nutrition, substance consumption  <b>Health Care Services Utilization &amp; Prevention</b>  <b>Social determinants of health</b> Age, Gender, Income, Education, Occupation, Migration, Living environment, Family structure	<b>Physical Health</b> Communicable and non-communicable diseases Impairment  <b>Mental Health</b> Screening of behavioural and emotional problems & mental disorders; Mental disorders (diagnosed) Health-related Quality of Life (HrQoL) Social and psychological resources  <b>Health-related Behaviour</b> Physical activity, nutrition, substance consumption  <b>Health Care Services Utilization &amp; Prevention</b>  <b>Social determinants of health</b> Age, Gender, Income, Education, Occupation, Migration, Family structure	<b>Physical Health</b> Communicable and non-communicable diseases Focus on allergies & bronchial asthma (with treatment) Impairment, disability, malformation  <b>Mental Health</b> Screening of behavioural and emotional problems & mental disorders; HrQoL Mental disorders (diagnosed) & treatment history Social and psychological resources  <b>Health-related Behaviour</b> Physical activity, nutrition, substance consumption  <b>Health Care Services Utilization &amp; Prevention</b>  <b>Social determinants of health</b> Age, Gender, Income, Education, Occupation, Migration, Living environment, Family structure

**Figure 2.** Data collection methods and topics used in the KiGGS cohort across three data collection waves.

instrument to identify children with special health care needs (CSHCN screener)<sup>9</sup> in the Baseline study; other health indicators for physical health were pregnancy conditions, birth weight, premature birth, childhood infectious diseases, pain, accidents, development and maturity, and reproductive health.

Health-related quality of life was measured using the KINDL-R questionnaire<sup>19</sup> in the Baseline study for participants aged 3–17 years; in later surveys, this was followed by the KIDSCREEN<sup>20</sup> for participants in the same age range and the SF-8<sup>21,22</sup> for young adults. The Strengths and Difficulties Questionnaire (SDQ)<sup>10</sup> was administered to screen mental health problems (for ages 3–17 years) in every wave, complemented by the extended version starting from Wave 1, to include associated impairments.<sup>23</sup> Other mental health screening instruments were the SCOFF<sup>24</sup> for eating disorders (ages 11–31 years) and subscales of the Patient Health Questionnaire for panic and depressive disorders (ages 18–31 years).<sup>25</sup> Preclinical mental health symptoms of young adults were operationalized using two subscales of the 36-Item Short Form Survey SF-36, the Mental Health Inventory MHI-5 and Energy/Vitality.<sup>26</sup> At each point in the interviewing process, physician- or psychologist-diagnosed mental disorders were queried.

Personal protective factors were self-reported in all waves using the WIRKALL scale of self-efficacy<sup>27</sup> and a short scale of personal resources.<sup>28</sup> Social support was measured with the Social Support Scale.<sup>29</sup> Personality was operationalized in Wave 2 using a short version of the Big Five Inventory (BFI-10)<sup>30</sup> and well-being in young adults with the Personal Wellbeing Index for Adults (PWI-A).<sup>31</sup>

Self-reported experiences of violence were recorded in the Baseline study and Wave 1. Retrospective queries about childhood trauma (using the Childhood Trauma Questionnaire),<sup>32</sup> other adverse childhood experiences (using the Adverse Childhood Experiences International Questionnaire<sup>33</sup>), experiences of discrimination, major health events, critical life events such as parents' separation or death, moving out of the parents' home, and participants' own partnership and educational history were included in questionnaires administered to young adults in Wave 2.

Questions on several health behaviours like tobacco use, total physical activity and sporting activities, or use of screen-based media were queried in each survey. Alcohol consumption was operationalized using the Alcohol Use Disorders Identification Test (Audit-C).<sup>34,35</sup> In Wave 2, the European Health Interview Survey-Physical Activity Questionnaire<sup>36–38</sup> was implemented among young adults. To measure food intake, a food frequency questionnaire<sup>39</sup> was administered in the Baseline study and Wave 2.

Medical care utilization within the last 12 months was queried in all age groups and at all measurement times; this included several medical professions and institutions as well as health insurance. As a special focus in KiGGS Wave 2, information on treatment for diagnosed obesity, bronchial asthma and mental disorders over the lifespan was retrospectively collected.

The KiGGS cohort collects comprehensive information on family and social determinants of health. Questions on household composition, parental marital status and biological siblings were queried in each survey wave; starting from Wave 2, retrospective and current information on blended families can be provided. Familial predisposition to major diseases was assessed by asking about previous diagnoses in participants' biological parents. Family climate was assessed using a modified version of the Family Climate Scale,<sup>40</sup> parenting style with the D-ZKE (The Zurich Short Questionnaire on Parenting Behaviour),<sup>41</sup> well-being of parents using the PWI-A<sup>31</sup> and parental personality with the BFI-10.<sup>30</sup> Duration of out-of-family care during childhood is known for all respondents. Characteristics of the home environment and neighbourhood as well as environmental contamination and noise annoyance were included, especially in Wave 2.

Migration background was operationalized using a multidimensional view. Information collected included nationality, country of birth, year of parents' immigration and languages spoken at home.<sup>7,42</sup> Standardized questions on education, income and employment status of the parents and young adults themselves (ages 18–31 years) were queried.<sup>43,44</sup> For young adults, information about educational trajectories and employment over their lifespan was also collected. For participants <18 years old, data on education patterns such as school type, grade, history and performance were collected. As a subjective indicator, subjective social status<sup>45,46</sup> was implemented in Wave 2.

A detailed overview of all topics collected in the KiGGS cohort study is given in [Supplementary data](#), available at *IJE* online.

## What has it found? Key findings and publications

The Baseline study of the KiGGS cohort was a population-based cross-sectional health examination and health interview survey that provided nationally representative information on the health of children and adolescents aged 0–17 years living in Germany after the turn of the millennium. KiGGS Baseline study results identified crucial public health-related topics. Overweight and obesity were determined to be an increasing problem. Compared with the results of studies conducted in the 1980s and 1990s,

the prevalence of overweight children increased by 50%, and the proportion of obese children and adolescents more than doubled.<sup>47</sup> Non-communicable diseases, such as allergies and bronchial asthma,<sup>48</sup> emotional and conduct problems,<sup>49</sup> and diagnosed attention deficit hyperactivity disorder<sup>50</sup> have become more prominent in recent decades. A strong relationship between SES and children's health was identified for many health indicators,<sup>51,52</sup> with lower self-rated health and health-related quality of life and more mental health problems or hazardous health behaviours<sup>53,54</sup> among those living in socially disadvantaged families.

To date, two follow-ups of participants in the baseline survey have been carried out within the framework of the KiGGS cohort. After finalizing the data processing for KiGGS Wave 2, trajectories of the main topics of physical and mental health, health behaviours, and their causes and influences can be analysed over the life course. Currently, the first results have been published.

Analysis of laboratory parameters obtained in the Baseline study and Wave 2 showed clear positive transition probabilities among both sexes for allergic sensitization against the allergen mixture SX1, which includes eight common inhalant allergens (defined as specific IgE antibodies with a value of  $\geq 0.35$  kU/l) as a main risk factor in the development of allergies, such as hay fever or asthma.<sup>55</sup> For the same follow-up period, analysis of preschool children aged 2–6 years at baseline identified a high persistence of obesity in >60% of obese children into their adolescence; overweight showed a higher convertibility.<sup>56</sup> Mental health problems in childhood showed high variability as well. These were assessed using the parental version of the SDQ, which classifies respondents with a total SDQ score above the cut-off of the German norm sample as children and adolescents with mental health problems. Only 50% of children and adolescents with mental health problems in the KiGGS Baseline study still displayed symptoms 6 years later in Wave 1.<sup>57</sup> Focusing on the development of health or health behaviours during transition periods, we found that adolescence is the critical phase for smoking status in young adulthood; 85% of adolescent smokers continued smoking into young adulthood and approximately nine of ten adult smokers began smoking in adolescence.<sup>58</sup> Female sex, lower parental education level and income, and lower motor fitness at baseline were identified as the main predictors of a permanent lack of or intermittent participation in organized sports during the transition from childhood to adolescence.<sup>38</sup>

Looking at the importance of social and familial environments for health development revealed the importance of one's own education and intergenerational educational mobility for the existence and persistence of health inequalities among young people. Poor self-rated health is

less likely to be reported if intergenerational education levels are constantly high or upwardly mobile.<sup>59</sup> Another analysis focusing on family structure showed poorer health and higher rates of smoking among adolescents in non-nuclear families, especially those whose parents separated after the Baseline survey.<sup>60</sup>

## What are the main strengths and weaknesses?

The KiGGS cohort study is the only population-based cohort study in Germany to date in which a broad spectrum of health parameters is surveyed, beginning in early childhood and continuing through adolescence and well into adulthood. The sample is large and representative of minors living in Germany at the time of the KiGGS Baseline study. A wide range of topics enable comprehensive analyses of health trajectories and their determinants over the life course. Health interviews are supplemented with objective measurement data obtained by health examinations as well as blood and urine sample collection. Within the next 10 years, all 'children' in the KiGGS cohort will have become adults aged from 18 to >40 years. This will permit us to conduct comprehensive analyses of the effects of living conditions of children and adolescents at the turn of the millennium on their health status in adulthood.

A limitation of the study is the long period (5–6 years) between data collection waves. As the survey method changed from written questionnaires to telephone interviews between the Baseline study and Wave 1, possible mode effects must be carefully considered for the indicators analysed. Another restraint is owing to changes in the instruments used, particularly between adolescence and young adulthood. A further limitation is the relatively high dropout rate during the health examination portion of KiGGS Wave 2, owing to the high mobility of young adults combined with restriction of the examinations to those communities originally sampled at baseline. Additionally, reaching majority age has an impact on participation motivation, as parents are no longer part of the decision-making process. In line with other cohort studies, there is a lower willingness to re-participate among young men and those with lower SES or a migrant background. Using the longitudinal weighting factor is assumed to diminish possible effects of selective study participation for variables included in the weighting procedure. However, this can only control for variables collected at the time of KiGGS baseline, not at the time of the follow-ups.

## Can I get hold of the data? Where can I find out more?

The dataset of the KiGGS Baseline study is available to interested researchers on application as de facto anonymized



data for scientific secondary analysis. The use of longitudinal data of further waves is permitted upon receipt of a informal request and description of the planned project to the 'Health Monitoring' Research Data Centre, Robert Koch Institute, Berlin, Germany (e-mail: datennutzung@rki.de). Further information and additional study results can be found here: <http://www.kiggs-studie.de/english/results.html>

## Supplementary data

Supplementary data are available at *IJE* online.

### Profile in a nutshell

- The KiGGS cohort was established in addition to periodically conducted nationwide representative health surveys of children and adolescents aged 0–17 years (KiGGS cross-section) to complement regularly reported trends in prevalence rates among children and adolescents with health development analysis over the life course.
- The first population-based nationwide sample of children and adolescents in Germany (KiGGS Baseline study; ages 0–17 years;  $n = 8656$  girls and 8985 boys) was tracked for the first time using telephone health interviews (KiGGS Wave 1: 2009–2012;  $n = 6079$  female and 5913 male participants; re-participation rate 68%). A total of 10 853 participants of the Baseline study (5790 female, 5063 male) completed questionnaires in the health interview of the second follow-up (KiGGS Wave 2: 2014–2017). Additional examination data are available for 6465 of these re-participants (3254 female, 3211 male).
- Data were collected using questionnaires, physician-administered personal interviews, health examinations and testing, and laboratory analysis. Topics of the KiGGS cohort include numerous physical and mental health indicators, health behaviours, and health care utilization and personal, familial, environmental and socio-economic health determinants.
- Cohort data are available via request with a description of planned projects at Research Data Centre, Robert Koch Institute, Berlin, Germany (e-mail: datennutzung@rki.de).

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## Ethics

All studies of the RKI are subject to strict compliance with the data protection regulations of the EU Basic Data Protection Regulation (DSGVO) and Federal Data Protection Act (BDSG). The Ethics Commission of the Charité Universitätsmedizin Berlin has reviewed the KiGGS basic survey (No. 101/2000) as well as KiGGS wave 1 (No. EA2/058/09); and the Ethics Commission of the Medizinische Hochschule Hannover has reviewed ethical aspects and approved KiGGS wave 2 (No. 2275-2014). Participation in the studies was voluntary. Participants or their guardians were informed about the aims and contents of the studies as well as about data protection and gave their written consent.

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