Cohort Profile

Cohort Profile: The French national cohort of children (ELFE): birth to 5 years

Marie Aline Charles [ID] ,[1,2]* **Xavier Thierry,[1,3] Jean-Louis Lanoe,[1] Corinne Bois,[1] Marie-Noelle Dufourg,[1] Ruxandra Popa,[1] Marie Cheminat,[1] Cécile Zaros[1] and Bertrand Geay[1,4]**

[1]French Institute for Demographic Studies (Ined), French Institute for Medical Research and Health (Inserm), French Blood Agency, ELFE Joint Unit, Paris, France, [2]French Institute for Medical Research and Health, UMR 1153 Centre for Research in Epidemiology and Statistics Paris University (CRESS), Team Early Life Research on Later Health, Villejuif, France, [3]French Institute for Demographic Studies, Fertility, Family and Sexuality Research Unit, Paris, France and [4]University Center for Research on Public Policy and Politics (CURAPP), University of Picardy, CNRS, Amiens, France

*Corresponding author. Ined, Joint Unit ELFE, 133 Boulevard Davout, 75980 Paris Cedex, France.
E-mail: marie-aline.charles@inserm.fr

Why was the cohort set up?

In various scientific domains, the early stages of development have been found critical to understanding individual health and social trajectories. The theory of the developmental origin of health and diseases (DOHAD) has stressed the plasticity of the developing organism in response to environmental cues and the role of some early developmental adaptations in programming later health.[1] Life course epidemiology, initially developed by social scientists,[2] offers a conceptual framework for the study of health and social trajectories. The framework integrates critical early life periods into the different pathways laid down by the familial, social and cultural environments and modulated by personal psychosocial and behavioural factors. Long-term longitudinal studies are the best tool to disentangle these factors that interact over time.

In France, several regional birth cohorts of children were launched in the 1990s to study the effect of exposure to environmental contaminants[3,4] or to a broader set of exposures,[5] on children's health. In the 2000s, two national projects were set up. The first study, led by the French Institute for Demographic Studies (Ined), was initiated in response to a series of recommendations from several national institutions and bodies that called for a French longitudinal study of children to better understand their life conditions, especially with respect to socioeconomic and health inequalities.[6] For example, data were needed on the living conditions and developmental outcomes of children raised in single-parent families (in 2011, 10% of children under age 3 and 19% of children 3 to 6 years old were living with only one parent)[7] or children with a migrant background (in 2011, 30% of children under age 18 lived with parents who were first- or second-generation immigrants).[8] Regarding health inequalities, the increasing disparities in the prevalence of obesity in 5-year-old children by socioeconomic status was also a concern: although decreasing from 3.1% to 1.8% between 2000 and 2006 in private schools, it has remained higher and almost unchanged (5.6% to 5.1%) among children attending schools in socially disadvantaged areas.[9]

The second project was proposed by the French Institute for Public Health Surveillance (InVS) at the request of the Ministry of Health, as part of the first French National Environmental Health Plan. Despite growing evidence of the potentially deleterious effects of new emerging

pollutants present at low doses and acting in synergy on developing organisms,[10] there were no national data on the level of exposure of French pregnant women and children.

For practical and financial reasons, the two projects were merged into a single, large national birth cohort, known as the ELFE cohort (Etude Longitudinale Française depuis l'Enfance/French Longitudinal Study since Childhood), with recruitment representative of live births in France. This merger offered a unique opportunity to set up a truly multidisciplinary project. Calls for proposals to select research priorities for the cohort were sent out to the French research community in 2005–06. More than 60 research teams responded. Researchers started to work in thematic groups to construct study protocol under the leadership of an overall coordinating team. The general objective of the cohort is to study determinants of child development, health and socialization from birth to adulthood. The priority research themes selected for ELFE were:

  i. aspects of children's environment that have undergone the most striking changes over recent decades including: modification of nutritional intake; reduction of physical activity; exposure to emerging exogenous pollutants; new communication technologies; weakening of the traditional family model (notably divorce and step-families); an increased proportion of working women; new patterns of care seeking, due to changes in medical practice and demography;
 ii. the relationship of these changes to the development of cognitive, language and socio-affective skills, educational outcomes, social integration and common childhood diseases;
iii. the complex interactions between biological, behavioural and social factors.

A study sample of 20 000 births (1/40 annual births) was chosen as feasible while still offering the statistical power required to address the main research questions. For an outcome prevalence of 10%, this sample size provides a power of 90% with an alpha risk of 5% to evidence relative risks from 1.12 to 1.77 when the frequency of exposure varies from 30% to 1%. For a less frequent outcome prevalence of 1%, corresponding relative risks would be from 1.41 to 4.1.

A joint unit of the French National Institute of Health and Medical Research (Inserm) and Ined was created in 2010 to support the project. At the same time, a study of the short- and -long-term outcomes of very preterm births, the Epipage 2 study,[11] was being planned and it was decided that ELFE, which would not include very preterm births, would provide a control group for the Epipage 2 study. The Ministries of the Environment, Health and Research provided initial funding for the ELFE cohort.

The funding for the first 5 years of childhood follow-up was obtained from the national 'Investment for the Future' research funding programme for a joint project bringing together the ELFE and Epipage 2 cohorts.

Who is in the ELFE cohort?

After a small-scale pilot cohort in 2007[12] and a national information campaign, the national cohort was launched in 2011. A total of 349 maternity units were randomly selected in metropolitan France and the children were recruited at birth from the 320 maternity units that agreed to participate. A stratified sampling strategy based on the size of each unit was adopted to allow for oversampling in larger units, thus reducing the cost of data collection (Figure 1). Recruitment took place during 25 selected days in 2011, grouped into four periods over the year; 12 of these days were selected to coincide with the French permanent demographic sample, a regular national survey of individuals born on specific days every year.[13] Inclusion criteria were single or twin live births at ≥33 weeks of gestation, mother ≥18 years old, no plan to leave metropolitan France within 3 years and informed consent signed by the parents or the mother alone, with the father being informed of his right to deny consent for participation. Information and consent documents were provided in French, Arabic, Turkish and English, the most common languages of women giving birth in France.

More than 96% of the mothers who satisfied the first two inclusion criteria ($n = 37\,494$) were contacted by research assistants during their stay in the maternity unit and 51% (18 040) agreed to participate in the cohort. The women gave birth to 18 329 babies, including 289 pairs of twins. With ethics approval, some data on births to mothers who refused to take part were collected from birth certificates and stored anonymously. This collection made it possible to apply a weighting procedure to correct for non-representativeness. The weights take into account the sampling plan and refusals at both maternity unit and individual levels; details on the research section/data and questionnaire are available at [https://www.ELFE-france.fr/en/]. Variance calculations were adapted for the sampling frame.[14] The raw and weighted frequencies for the main sociodemographic and health characteristics of the cohort are presented in Table 1, with national data for comparison if available.

Ethical approvals for data collection in maternity units and for each data collection wave during follow-up were obtained from the national advisory committee on information processing in health research (CCTIRS: Comité Consultatif sur le Traitement de l'Information en matière de Recherche dans le domaine de la Santé), the national
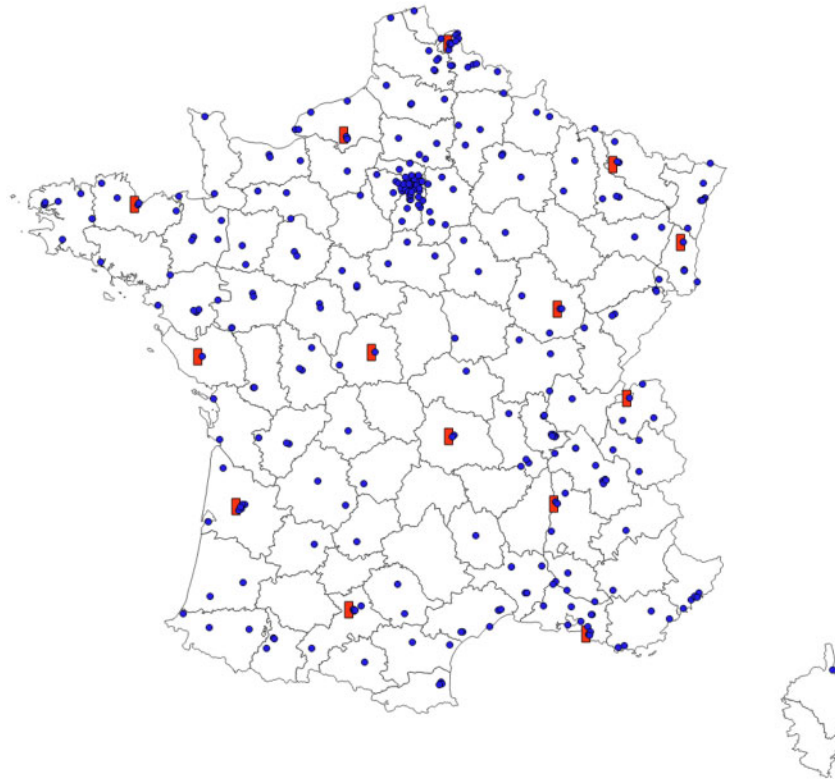
Figure 1. Randomly selected maternity units for the recruitment in the ELFE cohort (dots) and biological treatment and storage units (square).

data protection authority (CNIL: Comission Nationale Informatique et Liberté) and, in case of invasive data collection such as biological sampling, the committee for protection of persons engaged in research (CPP: Comité de Protection des Personnes). The ELFE study was also approved by the national committee for statistical information (CNIS: Conseil National de l'Information Statistique).

How often were the children followed up in their first 4 years?

Follow-up schedule

Follow-up was intensive in the infancy and pre-school periods (from 2011 to 2015), including telephone interviews of both parents at age 2 months and 1 and 2 years, and one parent (the mother or, if not available, the father) at age 3.5 years (Figure 2).

In addition to telephone interviews, information on infant feeding was collected every month from age 2 to 10 months via the internet or paper questionnaires. Parents were also given a questionnaire to be completed by the child's physician at age 2 years. A home visit was organized at age 3.5 years. With the collaboration of 30 district maternal and child welfare services, the results of the medical

examination performed at nursery school at age 3 to 4 years[15] were collected for 3124 ELFE children and 6815 control children born on the same day. A nursery school-teacher survey was performed when the children were 4 to 5 years old. It involved 5178 ELFE children and 10 877 control children with birthdays closest in time to those of the ELFE children.

Participation and attrition

Participation rates for the 2-month, 1- and 2-year and 3.5-year main surveys are presented in Figure 3. Some participants did not complete the questionnaires in full, but the rate of non-completers has remained low and stable at around 4% at each wave. Withdrawals from the study consist of families who sent a written request to end their participation, those who could not be contacted during any of the three previous waves or those who ever gave an oral request for withdrawal and could not be contacted thereafter. Families who moved out of metropolitan France were not eligible for telephone interviews but received a short paper version of the questionnaire.

Compared with mothers of children who were eligible for follow-up, mothers who have withdrawn from the study by the end of the 3.5-year survey ($n = 2092$) were more likely to be <25 years old at the child's birth (18% vs

Table 1. Main characteristics at birth of mothers and children included in the ELFE cohort and comparison with the national references (birth certificates or 2010 National Perinatal Survey[a])

| Parents		n[b]	ELFE crude % (n) or mean (SD)	ELFE weighted % or mean ± SE	National reference[c] % or mean
Mother's age at delivery[d]	<25 years	17 780	12.1 (2150)	14.1 ± 0.0	13.9
	25–34 years		66.4 (11 808)	64.5 ± 0.0	64.5
	≥35 years		21.5 (3820)	21.4 ± 0.0	21.6
Maternal education[d]	University degree	17 779	60.1 (10 689)	52.4 ± 0.0	52.3
Maternal employment	Employed	17 354	79, 9 (13 864)	65.9 ± 0.5	
	Housewife		9, 6 (1663)	15.9 ± 0.5	
	Unemployed		5, 8 (1016)	6.4 ± 0.3	
	Other		4.7 (811)	6.6 ± 0.4	
Paternal employment	Employed	17 273	91.6 (15 824)	84.1 ± 0.3	87.4
Mother born out of France[d]		17 642	13.2 (2322)	18.4 ± 0.0	18.7
Familial status	Lone mother	17 684	5.5 (976)	7.6 ± 0.3	
Parity[d]	Primiparous	17 693	45.6 (8068)	43.3 ± 0.0	43.1
Maternal smoking	Never smoker	17 640	79.9 (14 085)	78.3 ± 0.4	
BMI category before pregnancy	Underweight	17 546	7.9 (1380)	7.9 ± 0.3	8.2
	Overweight		17.5 (3077)	18.4 ± 0.4	17.3
	Obese		10.0 (1752)	11 ± 0.3	9.9
Gestational diabetes		16 959	7.5 (1271)	7.6 ± 0.3	7.1
Gestational hypertension		17 342	3.4 (586)	3.8 ± 0.2	4.6
Caesarean section		17 375	18.1 (3158)	18.6 ± 0.9	
Infants					
Inclusion period (2011)	1–4 April	18 143	15.2 (2765)	23.9	
	27–28 June, 1–4 July		25.2 (4575)	26.5	
	27–29 September, 1–4 October		28.3 (5128)	25.8	
	28–30 November, 1–5 December		31.2 (5675)	24.8	
Offspring gender	Male	17 967	51.4 (9 233)	51.4 ± 0.4	
Twins		17 858	1.6 (284)	1.6 ± 0.1	2.7
Birthweight	Grams	17 739	3309 (499)	3305 ± 5	
Preterm birth (weeks of amenorrhoea)	33–36	17 858	6.5 (1156)	5.9 ± 0.2	

SD, standard deviation; SE, standard error; BMI, body mass index.

[a][http://www.europeristat.com/images/French%20National%20Perinatal%20Surveys%202003-2010-2.pdf].

[b]Mothers or infants with available data at time of analysis (some included subjects have asked for withdrawal of their data).

[c]National reference when available, restricted to a population with the same eligibility criteria for the National Perinatal Survey but not for the birth certificates.

[d]Variables used for marginal calibration of weighted variables (in addition to region of residence).
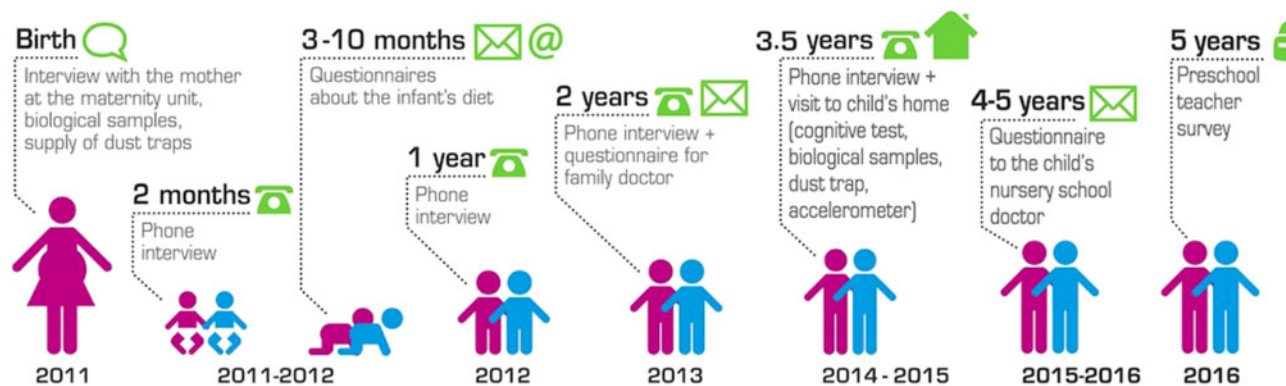
Figure 2. Follow-up schedule. ELFE cohort: birth to 5 years.
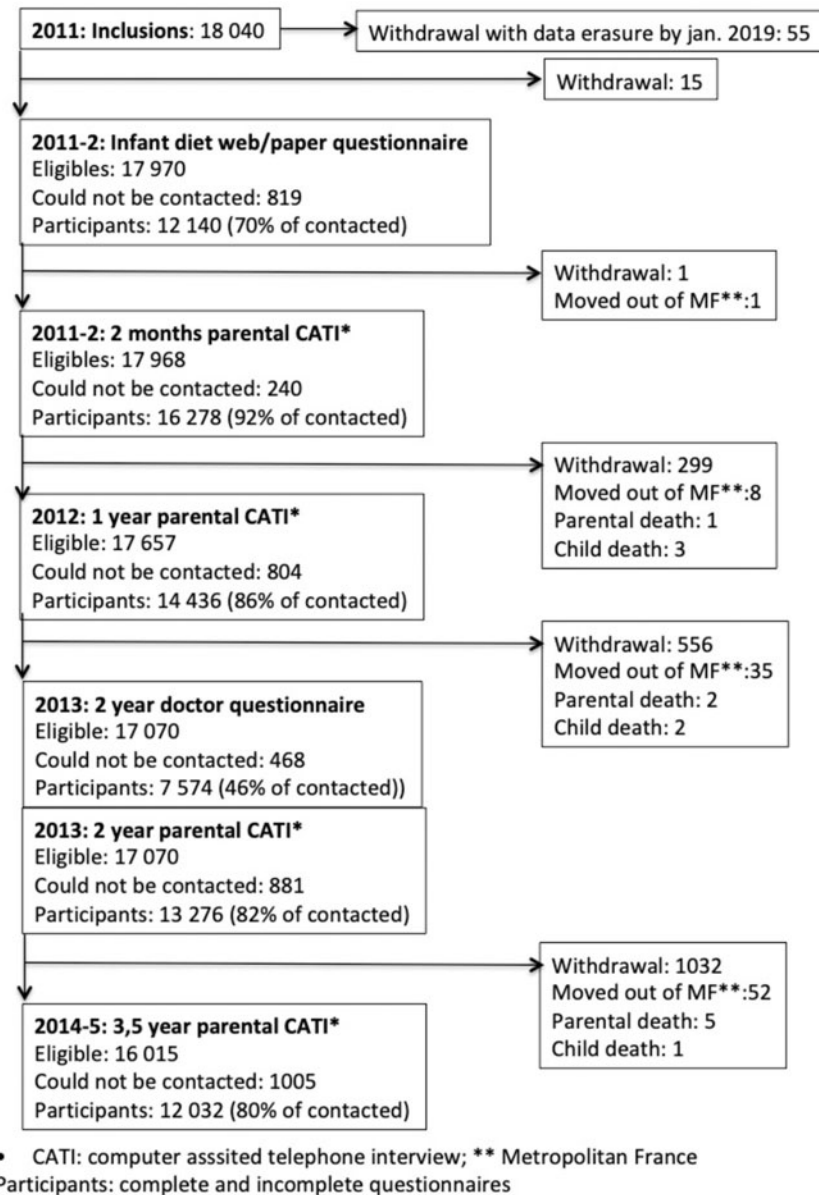
Figure 3. Participation in the main surveys during the first 5 years of follow-up. ELFE cohort.

11%), not to have a university degree (38% vs 54%), be unemployed or housewives (21% vs 13%), to have been born outside France (17% vs 13%) or to be single mothers (8% vs 5%) (all $p < 0.0001$). However, the two groups did not differ in parity, maternal health before or during pregnancy, mode of delivery or mean birthweight.

What was measured?

Table 2 summarizes the main types of information collected at inclusion and each follow-up. For more details, English translated questionnaires are available at the study website: [https://www.ELFE-france.fr/en/the-research/access-to-data-and-questionnaires]

Specific data collection protocol

Table 3 lists the standard tools used either in full in the parental questionnaires or, to limit the average length of phone interviews to less than 60 min, with a subset of questions (or scales). A 122-item food frequency questionnaire, derived from the questionnaire used in the EDEN cohort,[16] on the usual diet in the last 3 months of pregnancy was completed in 2011 in the maternity unit by mothers literate in French.

At inclusion, a subsample of 211 maternity units (selected for their expected number of deliveries and their proximity to biological treatment and storage units made available by the French Blood Agency; Figure 1) were invited to perform biological sampling; 70% ($n = 154$)

Table 2. Data[a] collected in the ELFE study (2011–16)

	Delivery	2 months	1 year	2 years	3.5 years	4–5 years
Sociodemographic data						
Household composition		☎M	☎M	☎M	☎MorF	–
Familial situation	👤M	☎M	☎M	☎M	☎MorF	–
Education level	👤M	☎MF	☎MF	☎M	☎MorF	–
Employment status	👤M	☎MF	☎MF	☎M	☎MorF	–
Earnings and life conditions	–	☎F	☎F	☎MF	☎MorF	–
Family life						
Arguments between parents	–	☎MF	–	☎MF	–	–
Language spoken at home	–	☎MF	☎M	–	☎MorF	–
Educational practices	–	☎MF	☎MF	–	☎MorF	–
Infant/child feeding	👤M	☎M, ✎/💻[b]	☎M	☎MF	☎MorF	–
Equipment in cultural goods (TV, books, music player, computer…)	–	–	☎F	☎F	☎MorF	–
Description and perception of home environment	–	–	☎F	☎F	–	–
Housing		☎MF	☎MF	☎MF	☎MorF	–
Day care and school						
Type, schedule	–	☎M	☎M	☎M	☎MorF	–
Parental, child choice/satisfaction	–	☎MF	☎MF	☎M	☎MorF	–
Parental health, behaviour, life values						–
Pregnancy-related	👤M, 📁	☎M	–	–	–	–
Maternal exposure during pregnancy	👤M, ✎M	☎M	–	☎MF	☎MorF	–
Anthropometry	👤M, ✎MF	☎MF	–	–		–
Depression	👤M	☎MF	☎MF	☎MF	☎MorF	–
History of asthma/allergy	–	☎MF	–	–	–	–
Hospitalization	👤M, 📁	☎M	–	–	–	–
Chronic diseases	👤M, 📁	☎MF	–	–	–	–
Smoking	👤M	☎MF	☎MF	–	–	–
Sleep	–	☎MF	–	–	–	–
Diet, alcohol	👤M, ✎MF	–	–	–	–	–
Life value	–	☎MF	☎MF	☎MF	–	–
Physical activity	✎M	–	–	☎MF	–	–
Dental health	–	–	☎MF	–	–	–
Mental health	👤M	☎MF	☎MF	☎MF	–	–
Child health and development						
Birth-related	📁	–	–	–	–	–
General health	–	☎M	☎M	☎M	☎MorF	–
Health care use and reasons	👤M, 📁	☎M	☎M	☎M, 📁	☎MorF	–
Accident	–	☎M	☎M	☎M	☎MorF	
Anthropometry	📁	☎M	☎M	☎M, 📁		📁
Urogenital, endocrine	📁	–	☎M	📁		📁
Respiratory health	📁	☎M	☎M	☎M, 📁	☎MorF	–
Allergies	–	☎M	–	☎M, 📁	☎MorF	–
Hearing, vision	📁	–	☎M	☎M, 📁	☎MorF, 👤C	📁
Dental health	–	–	–	☎M	☎MorF	📁
Sleeping	–	–	☎M	☎M	☎MorF	
Vaccination	–	☎M	☎M	☎M, 📁		📁
Cognitive and motor development	📁	☎M	☎M	☎M, 📁	☎MorF, 👤C	📁
Child school performance						👤, ✎T
Child behaviour	–					
Physical (in)activity	–	–	–	☎MF	☎MorF, 👤C	–
Socialization	–	–	☎M	☎M	☎MorF	–
Mental health	–	–	☎M	☎M	☎MorF	

(continued)

Table 2. Continued

	Delivery	2 months	1 year	2 years	3.5 years	4–5 years
Child environmental exposures						
Ultraviolet radiation	–	–	–	–	☎MorF	–
Ionizing radiation	–	☎ M	☎M	☎M	☎MorF	–
Electromagnetic fields	–	☎ F	–	☎MF	☎MorF	–
Indoor contaminants	–	☎ F	☎	☎F	☎MorF	–
Pesticides	–	☎ F	–	–	☎MorF	–
Home dust samples	–	x	–	–	x	–

The table specifies whether information was collected through health records or physician (⌷), self-administered (✐) or web (🖥) questionnaires, face-to-face interview or test by survey technician (⚕), telephone interview (☎), environmental, biological sampling (x).

Questions asked to: M mother, F father, F(M) father or mother if father is not participating, MorF mother or father if mother not available, C child, T teacher.

[a]Some data have been collected only on subsamples (see Table 3).

[b]Infant feeding data for the period 2–10 months collected monthly by ✐ or 🖥.

agreed to participate. The biological samples included maternal blood and urine at arrival in the maternity unit for delivery; cord blood and umbilical tissue at delivery; meconium and stool from the infant; and colostrum from lactating mothers during the initial stay in the maternity unit (Table 4).

Electrostatic dust fall collectors were randomly distributed in all participating maternity wards according to the anticipated number of deliveries. They were provided in 2011 to a subsample of 6390 mothers to be placed in the infant's bedroom during the first 2 months, then mailed to the laboratory in charge of the analysis (Table 5).

In 2014–15, with children aged 3.5 years, 81% of the families still eligible for follow-up and contacted for a telephone interview ($n = 11\,453$) were recruited for a home visit. For children born before August 2011, eligible families were selected by stratified probability sampling with a 100% probability for all families that had provided biological samples at inclusion, and a probability inverse to the inclusion weights for the remaining cohort members in order to over-represent families with a lower probability of participation. However, because of lower recruitment than expected, all families with an ELFE child born after August 2011 were eligible for home visits.

The main objective of the home visit (Table 3) was to assess the child's cognitive function, because this aspect of psychomotor development is difficult to assess by behaviours observable by the parents themselves. The Picture Similarities test of the British Ability Scale[17] was chosen for this assessment because it is a validated instrument previously used in other national cohorts.[18] The Picture Similarities test assesses the child's ability to solve non-verbal problems, identify pictures, formulate and test hypotheses and attach meaning to pictures. It can be administered by trained non-specialized research assistants and is brief (11 min, on average, in our cohort). We developed computer-assisted software to provide administration instructions and 'stop' rules for the test. Because nearly half of children with visual acuity impairment

may be undiagnosed before age 4 years in France,[19] a simple test of near vision was also administered to detect visual acuity impairment liable to compromise the interpretation of the Picture Similarities test. In addition, three tests were performed to assess visuo-attentional abilities: gaze fixation, recognition of embedded figures, and praxis (we asked the child to imitate a position with both hands).[20] The children were also asked to draw a man on a blank sheet of paper. The drawings were scored using the Baldy[21] and Goodenough scales[22] to assess the child's level of development. A 7-day recording of the child's physical activity and sleep was obtained by use of an Actigraph wGT3X-BT accelerometer (Actigraph Co., Pensacola, FL, USA) for consenting families when one of a total of 70 rotating devices was available at least 15 days before the planned home visit.

In 2014–15, we performed non-invasive biological sampling (urine, hair and stools from children) in families from whom biological samples from the mother or child had been collected at inclusion. In families for which both maternal urine and hair samples at inclusion were available, we obtained samples of dust from the home (from the vacuum cleaner and the floor of the room where the child played most often). The aim was to form a subgroup of children with material available for environmental contaminant exposure assessment at different life stages (Table 4).

In April-June 2016, when most children were in year 2 of nursery school (at 4.5 years old), questionnaires to be completed by the children's teachers were sent to parents who had provided a school address at the 3.5-year telephone interview. In parallel, schools were informed by letter and a media campaign. Material to perform learning tests was sent directly to the schools and was used to assess ELFE children as well as three other children in the same class who were born closest in time to the ELFE child, as a control group. The tests measured their understanding of numbers and quantities (27 items[23]) as well as letter recognition, phonological processing and vocabulary comprehension (35 items[24]). The exercises

Table 3. Standardized questionnaires included in the parental telephone interviews, ELFE study

Questionnaire name (references)	Sweeps	Completeness	Validation in French
Pregnancy physical activity questionnaire (1)	Maternity	Full version	No
Edinburgh Postnatal Depression Scale (2)	2 months	Full version	Yes
SF-12 (3)	1 year	Full version	Yes
K6 (4)	2 years	Full version	No
Minimum European health module Eurostat (5)	2 months	Full version	Yes
Child development inventory (6)	1 year	Partial (50 questions)	Yes
	3.5 years	Partial (44 questions)	
M-Chat (7)	2 years	Full version	Yes
MINI (8)	5.5 years	Partial (3 questions)	Yes
MacArthur-Bates (9)	1 year,	Partial (12 words)	Yes
	2 years	Brief version (100 words)	
Strength and difficulty questionnaire (10)	.5 years	Partial (3 questions)	Yes
	5.5 years	Full version	
Child Eating Behaviour Questionnaire (11)	5.5 years	Full version	No
Comprehensive Feeding Practices Questionnaire (12)	2 years	Partial (8 questions)	Yes
	5.5 years		
Spruyt Apnea Score (13)	5.5 years	Full version	No
Children Sleep Habit Questionnaire (CSHQ) (14)	5.5 years	Partial (3 questions)	No
Household members and educational, occupational and familial situation (15)	2 months, 1 year, 2 years	National household survey on employment surveys (EEC), living conditions and assets (SRCV), Insee	
Housing, neighbourhood (16)	2 months, 1 year, 2 years	National housing survey (Enquête Logement), National institute of statistics and economic studies (Insee)	

References: (1) Chasan-Taber *L et al. Med Sci Sport Exerc* 2004;**36:**1750–60.

(2) Cox JL *et al. Br J Psychiatry* 1987;**150:**782–86.

(3) Gandek B *et al. J Clin Epidemiol* 1998;**51:**1171–78.

(4) Kessler RC et al. Psychol Med 2002; 32: 959–76.

(5) Cox B et al. Int J Public Health 2009;**54:**55–60.

(6) Duyme M *et al. Devenir* 2010;**22:**13–26.

(7) Chlebowski C *et al. Pediatrics* 2013;**131:**e1121-17.

(8) Sheehan DV *et al. J Clin Psychiatr* 1998;**59**(**Suppl 20**):22–33.

(9) Kern S et al. Approche Neuropsychologique des Apprentissages chez l'Enfant 2010;**2010:**217–28.

(10) Goodman R *et al. J Abnorm Child Psychol* 1999;**27:**17–24.

(11) Wardle J et al. J Child Psychol Psychiatr 2001;**42:**963–70.

(12) Musher-Eizenman DR *et al. Appetite* 2009;**52:**89–95.

(13) Spruyt K *et al. Chest* 2012;**142:**1508–15.

(14) Owens JA *et al. Sleep* 2000;**23:**1043–51.

(15) SRCV/SILC, Eurostat

(16) Briant P. Documents de travail n° F2010/02. Insee, 2010.

were designed to enable the children to respond non-verbally by pointing to pictures drawn on a paper. A short visual perception test was administered to test the reliability of the children's responses.[20]

Table 5 presents participation numbers and rates for specific data collection operations undertaken in the subsamples.

External sources are used to characterize the local environment by linking home addresses with data in sociodemographic or environmental surveillance databases. Individual linkage to the French National Health Insurance database was authorized in 2016. This linkage allows for retrieving information on reimbursed ambulatory care (including prescribed drugs) and hospitalizations (including discharge diagnosis) concerning the mother during pregnancy and the child since birth.

What has the ELFE study found? Key findings and publications

Some selected results of the first publications based on ELFE data are described below. A complete list of publications can be found at [https://www.ELFE-france.fr/en].

Some of the samples collected at birth have been used by the French National Public Health Agency as part of the first national perinatal biomonitoring plan. The measurements obtained (see Supplementary data available at *IJE* online) are included in the ELFE database and are available to researchers. The results presented thus far have highlighted the greater exposure of French pregnant women to pyrethroids, a group of pesticides, as compared with pregnant women in the USA.[25] This finding is consistent with a 2007 observation in the French general population.[25]

Microorganisms represent another type of environmental exposure. The dust collected in the rooms where ELFE infants slept during their first 2 months of life was analysed for the presence of DNA specific to 10 microorganisms (three bacteria, one mite, six moulds).[26] Six different dwelling-contamination profiles were identified and showed a significant region-specific distribution. In addition, the number of occupants per dwelling space and dwelling type (house or apartment) and the presence of pets were significantly associated with the contamination profiles. The next stage of this research project will be to examine links with children's respiratory health and allergies.

From ELFE data, an estimated 13% of pregnant women experienced persistent psychological distress during pregnancy.[27] Of these, only 25% had a consultation with a mental health specialist and 10% used a psychotropic drug during pregnancy. The likelihood of consulting a mental health specialist was decreased among women of younger age, with an intermediate educational level, who were born outside France and who had uncomplicated pregnancies. These findings highlight the need to improve mental health care during pregnancy.

ELFE also provided new data on how young French couples in the 2010s managed the work–life balance after the birth of a new child in families with two or three children.[28] Two months after the child's birth, if both parents were employed, 40% of mothers with a blue-collar profession expressed the intention to take parental leave (which, since 1984, has been available to both parents and can last from 1 to 3 years) after their maternity leave, versus only 20% of mothers in white-collar professions. In these dual-earner families, 80% of the fathers took their 11-day paternity leave whatever their social class (except for the self-employed fathers). In contrast, when only one parent was employed (mostly the father), 50% of fathers with blue-collar professions took the paternity leave versus 75% of those with white-collar professions. These figures do not show a trend toward a more equal division of child care between fathers and mothers as compared with previous French data, and confirm strong differences between social classes.

What are the main strengths and weaknesses of ELFE?

ELFE is the first French national birth cohort, and as such will provide relevant information on children born in the 2010s for national authorities and for international

Table 4. Biological samples collected. ELFE study

		Birth 2011	3.5 years[a] 2014–15
		n	*N*
DNA	Mother	2515	
	Cord	2351	
Plasma	Mother	2788	
	Cord	2648	
Serum	Mother	2813	
	Cord	2857	
Urine	Mother	2281	Child 1969
Erythrocytes membrane	Cord	1810	
Colostrum	Mother	1901	
Meconium	Infant	2763	
Stools	Infant	2419	Child 596
Hair	Mother	2956	Child 2044

[a]Indicative numbers awaiting consolidation.

Table 5. Participation rate in specific data collection undertaken in subgroups. ELFE study 2011–16

	Dust collection	Home visit	Home dust sampling	Accelerometry	Biology[b]		Nursery school	
							Teacher	Doctor
Age	Birth-2 months 2011	3.5 years 2014–15	3.5 years 2014–15	3.5 years 2014–15	Birth 2011	3.5 years 2014–15	3–4 years 2014–16	4–5 years 2016
Eligible[a]	6390	11 453	1035	595[c]	9053	3415	10 553	4458
Participants	3217	9293	837	463	5903	2125	5178	3124
% of eligible	51%	81%	81%	78%	65%	62%	49%	70%
% of initial inclusions	18%	52%	5%	3%	33%	12%	28%	17%

[a]Defined as numbers of families with selection criteria who were effectively proposed to participate at the substudy.

[b]Participants = numbers with at least one biological samples.

[c]Defined by the availability of an accelerometer 15 days before home visit for the 2390 families who agreed to participate (65% of those contacted).

comparisons. For this purpose, in addition to the initial distortion of representativeness linked to consent to participation in the cohort, weights are produced for each wave to account for attrition. However, individuals in very precarious situations are under-represented in the ELFE cohort, and correction by weighting is not perfect when based on a small number of selected individuals. Although ELFE is therefore not a good tool for studying these specific subjects, this does not rule out the study of social inequalities. Indeed, social inequalities are unfortunately spreading over the remaining range of the distribution, as shown in the first publications from the cohort.[27,29] Linkage with national health insurance data, for which 95% of the cohort consented, will provide health information for active participants and also for those lost to follow-up. In addition, both the medical and teacher surveys performed in schools have collected data on children not included in the ELFE cohort but born on the same days as ELFE children in 2011; they represent another means of quantifying selection and attrition biases for some outcomes. ELFE is also a source of controls for studying children of the same age with specific characteristics, such as children born prematurely in the Epipage2 study,[11] or children of same-sex parents in the Devhom study.[30]

ELFE is a recent cohort, and care has been taken to collect data and samples for developing research fields such as the impact of environmental contaminants or of communication technologies on child development and health, the role of the infant's gut microbiota on risk of chronic diseases, or the health and social trajectories of first- and second-generation immigrants. Another innovative aspect in the French context will be the linkage of social, familial and personal trajectories from birth to educational achievement, notably with detailed information on learning outcomes at nursery school in a subgroup of children.

Importantly, ELFE is a multidisciplinary project. More than 100 researchers are working in the ELFE thematic groups covering the field of epidemiology and different specialist fields of medicine, biology, nutrition, physical activity, demography, economics, sociology, psychology and environmental science. They are contributing by proposing research questions, data collection tools and other protocols. Increasingly, each discipline is expanding the ELFE database by adding constructs, indicators and variables etc. from external sources. They bring specific methodologies that can be used by others with the support of a network of colleagues.

The potential downside of a large, multidisciplinary team is the long process needed to reach agreement on the data to be collected. Moreover, despite consensus on the part of investigators, the length of the questionnaires may prove burdensome for participants. Efforts are made to keep the families regularly informed of the study process

and results and to thank them for their participation by offering small birthday gifts to the children. Nonetheless, the attrition, which may be due in part to the study procedures, remains a cause for concern.

As the ELFE families are scattered all over France (and, over time, in some foreign countries as well), the costs and logistical challenges present a major obstacle—for example, for extensive phenotyping that would require visits to specialized centres.

In conclusion, ELFE is the first French national birth cohort. It will provide descriptive information on the development, health and socialization of children born in mainland France in 2011 and will contribute to the international research effort to better understand their determinants. As a multidisciplinary medium-sized cohort, it has so far proven to be affordable and manageable, despite the need to make certain difficult choices and compromises. However, the cross-fertilization of data from the health, environmental and social fields should compensate for the inevitable loss of precision within each field.

Can I obtain access to the ELFE data? Where can I find out more?

Additional and updated information can be found via the ELFE website [https://www.ELFE-france.fr/en/]. The ELFE has an open-data policy after an 18-month exclusivity period for the ELFE-associated research teams following each release of new data. Study protocols, questionnaires and the data catalogue can be found online. Data access requests can also be submitted via the data access platform for approval by the ELFE data-access committee. All proposals must comply with the ELFE data-access policy that can be downloaded from the data-access platform.

ELFE profile in a nutshell

- ELFE is the first French national birth cohort. Its objective is to study determinants of the development, health and socialization of children from birth to adulthood through a multidisciplinary approach.
- A total of 18 329 children were recruited at birth in a random sample of maternity units in metropolitan France during 25 selected days of 2011 spread over the year.
- Follow-up in the first 5 years consisted of telephone interviews of both parents of the child at age 2 months and 1 year and 2 years, and of one parent at age 3.5 years; a home visit at age 3.5 years; questionnaires to the child's physician at age 2 years, the child's nursery school doctor at age 3 to 4 years, and

the child's nursery schoolteacher at age 4 years.

- Participation rates at the age 2-month, 1- and 2-year and 3.5-year parental interviews were 92%, 86%, 82% and 80%, respectively, of contacted participants.
- The main categories of data collected concern: sociodemographic characteristics; family life; parental health, behaviour and life values; child development and health; child school performance, behaviour, and socialization; day care and school; and childhood environmental exposures.
- The ELFE has an open-data policy after an 18-month exclusivity period following each release of new data. The data-access policy, study protocols, questionnaires and data catalogue can be found online: [https://www.ELFE-france.fr/en/].

Supplementary data

Supplementary data are available at *IJE* online.

Funding

Acknowledgements

References

1. Gluckman PD, Hanson MA, Cooper C, Thornburg KL. Effect of in utero and early-life conditions on adult health and disease. *N Engl J Med* 2008;**359**:61–73.
2. Kuh D, Shlomo YB. *A Life Course Approach to Chronic Diseases Epidemiology*. 2nd edn. Oxford, UK: Oxford University Press, 2004.
3. Guldner L, Monfort C, Rouget F, Garlantezec R, Cordier S. Maternal fish and shellfish intake and pregnancy outcomes: a prospective cohort study in Brittany, France. *Environ Health* 2007;**6**:33.
4. Boucher O, Simard MN, Muckle G *et al*. Exposure to an organochlorine pesticide (chlordecone) and development of 18-month-old infants. *Neurotoxicology* 2013;**35**:162–68.
5. Heude B, Forhan A, Slama R; Eden mother-child cohort study group. Cohort Profile: The EDEN mother-child cohort on the prenatal and early postnatal determinants of child health and development. *Int J Epidemiol* 2015;**45**:353–63.
6. Pirus C, Bois C, Dufourg M *et al*. A construction d'une cohorte: l'expérience du projet français ELFE. *Population* 2010;**65**:637–70.
7. Algava E, Les familles monoparentales. In: Lefevre C, Filhon A (eds). *Histoires de Familles, Histoires Familiales. Les Résultats de L'enquête Famille de 1999*. Paris: Ined, 2005.
8. Tribalat M. Une estimation des populations d'origine étrangère en France en 2011. *Espace Population Sociétés* 2015;**2015**:1–5.
9. Guignon N, Collet M, Gonzalez L. La santé des enfants en grande section de maternelle en 2005–2006. Études et résultats, DREES, N° 737. 2010.
10. Barouki R, Gluckman PD, Grandjean P, Hanson M, Heindel JJ. Developmental origins of non-communicable disease: implications for research and public health. *Environ Health* 2012;**11**:42.
11. Ancel PY, Goffinet F, Group EW. EPIPAGE 2: a preterm birth cohort in France in 2011. *BMC Pediatr* 2014;**14**:97.
12. Oleko A, Betsou F, Sarter H *et al*. A pilot study of the ELFE longitudinal cohort: feasibility and preliminary evaluation of biological collection. *Biopreserv Biobank* 2011;**9**:223–27.
13. Couet C. L'échantillon démographique permanent de l'Insee. *Courrier des Statistiques* 2006;**117-19**:5–14.
14. Juillard H, Chauvet G, Ruiz-Gazen A. Estimation under cross-classified sampling with application to a childhood survey. *J Am Stat Assoc* 2017;**112**:850–58.
15. Bois C, Guillemot G. Bilans de santé PMI 3-4 ans à l'école maternelle dans les Hauts-de-Seine, France: synthèse des études 2005 et 2010 et perspectives. *Bull Epidémiol Hebd* 2014;**29**:482–90.
16. Drouillet P, Forhan A, De Lauzon-Guillain B *et al*. Maternal fatty acid intake and fetal growth: evidence for an association in overweight women. The 'EDEN mother-child' cohort (study of pre- and early postnatal determinants of the child's development and health). *Br J Nutr* 2008;**101**:583–91.
17. Elliott CD, Smith P, McCulloch K. *British Ability Scales Second Edition (BAS II)*. London: NFER-Nelson, 1997.
18. Quigley MA, Hockley C, Carson C, Kelly Y, Renfrew MJ, Sacker A. Breastfeeding is associated with improved child cognitive development: a population-based cohort study. *J Pediatr* 2012;**160**:25–32.
19. Bois C, Binot M, Jonqua F, Guillemot G, Bremond-Gignac D. Visual screening in 3- to 5-year-old preschool children: Maternal and Infant Welfare evaluation program in the Hauts-de-Seine district, France. *J Fr D'ophtalmol* 2007;**30**:570–76.
20. Cavezian C, Vilayphonh M, de Agostini M *et al*. Assement of visuo-attentional abilities in young children with or without visual disorder: Toward a systematic screening in the general population. *Res Dev Disabil* 2010;**31**:1102–08.
21. Baldy R. Dessin et développement cognitif. *Enfance* 2005;**57**:34–44.

22. Goodenough F, Harris D. Studies in the psychology of children's drawings: II 1928-1949. *Psychol Bull* 1950;**47**:369–433.

23. Fischer J, Bocéréan C. Les modèles du développement numérique à l'épreuve de l'observation. *Bull Psychol* 2004;**57**:191–202.

24. Ecalle J, Magnan A. *L'apprentissage de la Lecture et Ses Difficultés*. 2 edn. Paris: Dunod, 2015.

25. Dereumeaux C, Fillol C, Charles MA, Denys S. The French human biomonitoring program: First lessons from the perinatal component and future needs. *Int J Hyg Environ Health* 2017;**220**:64–70.

26. Rocchi S, Reboux G, Frossard V; ELFE team. Microbiological characterization of 3193 French dwellings of ELFE cohort children. *Sci Total Environ* 2015;**505**:1026–35.

27. Bales M, Pambrun E, Melchior M *et al*. Prenatal psychological distress and access to mental health care in the ELFE cohort. *Eur Psychiatry* 2015;**30**:322–28.

28. Berton F. Deux mois après une naissance: quelle conciliation travail-famille en France dans les années 2010? *Rev Interv Econ* 2015;**53**. doi: 10.4000/interventioneconomiques.2622.

29. Sacri AS, de Lauzon-Guillain B, Dufourg MN, Bois C, Charles MA, Chalumeau M. Iron-fortified formula use in young children and association with socioeconomic factors in the French nationwide ELFE cohort. *Acta Paediatr* 2019;**108**:1285-94.

30. Geay B, Humeau P. Sociabilité et rapport au voisinage dans les familles homo et hétéroparentales. *Dialogue* 2017;**215**:95–110.