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COHORT PROFILE

Cohort Profile: The 1993 Pelotas (Brazil) Birth Cohort Study

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How did the study come about?

In 1982, a birth cohort study[1] was initiated in Pelotas, a Southern Brazilian city with a current population of 323 000 inhabitants. It started as a perinatal survey and later became one of the largest and longest running birth cohorts in the developing world.[2] With the success of this initial study, our group decided to propose a second birth cohort, to be launched 10 years later. Due to delayed funding, the new cohort could only start in 1993.[3] Funding for the new cohort was obtained from the European Economic Commission, in a collaboration that included the London School of Hygiene and Tropical Medicine and the Escuela Andaluza de Salud Publica from Granada.

In the late 80s and early 90s, the hypothesis that intrauterine, infant and child growth could affect long-term health outcomes gained widespread attention.[4,5] The beneficial effects of breastfeeding were also becoming more evident.[6] To better describe growth and feeding patterns, we opted to examine infants on several occasions, at the ages of 1, 3, 6 and 12 months, differently from our 1982 cohort when the first home visit took place at the age of 9–15 months.[3]

What does the study cover? (and how has this changed?)

The original goals of the 1993 cohort were to evaluate trends in maternal and child health indicators, through a comparison with results of the 1982 study; to assess associations between early life variables and later outcomes, with particular emphasis on the detection of critical windows; and to improve data quality, using the lessons learned from the 1982 study.[3]

The 1982 cohort was focused on health problems affecting children from developing countries. Our infant mortality rate was close to 40 per thousand at that time, infectious diseases—such as diarrhoea, measles and pneumonia—were common, and malnutrition prevalence was high. These variables were also measured in 1993, but by then it had become clear that Brazil was undergoing rapid epidemiological and nutrition transitions. As a consequence, exposures and outcomes related to chronic diseases were also measured in the new cohort.

Deaths were monitored actively during 1993 and 1994, including regular visits to all hospitals, cemeteries, offices of civil registrations and local health authorities. Since 1994, the Brazilian official mortality registration system—whose coverage in Pelotas is universal—has been monitored.[3]

Due to budgetary and logistic constraints, all visits in infancy and childhood were restricted to subsamples of the cohort.[3] In the visits during the first year of life, particular attention was given to collecting detailed feeding information in all visits. Since we needed to understand the reasons behind breastfeeding choices, a sub-sample of 80 mothers was selected for an in-depth ethnographic study with repeated visits. Psychomotor development, morbidity patterns and use of medicines were also evaluated. A detailed sub-study on hospital admissions took place in the first year of the cohort.[3]

Visits carried out in late childhood addressed conditions associated with the nutrition and epidemiological transitions. At 4 years of age, special attention was given to psychomotor development, asthma and injuries. At 6 years of age, sub-studies investigated asthma and oral health. At 9 years of age, a sub-study on body composition and symmetry was carried out.

In early adolescence (11 years of age), the first attempt to locate all cohort members took place. The questionnaire covered risk factors for chronic diseases,

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schooling, lifestyle, morbidity, family and socioeconomic conditions. Four sub-studies were carried out: an ethnographic study; an oral health survey; a study on intellectual development and mental health; and a body composition and physical activity survey.

Because Brazil is consistently ranked among the 10 countries with the greatest socioeconomic inequalities in the world,[7] and because our cohort included children from every social stratum, special emphasis is given to the social determinants of health in the 1993 cohort.[8]

Who is in the sample?

During the whole of 1993, all maternity hospitals in the city were visited daily and 5265 births from women living in the city were recorded. Of these, 5249 agreed to take part in the longitudinal study; 50.3% were female, 18.4% belonged to very poor families (less than US$ 100 per month), 9.8% presented low birth weight, 10.8% were born preterm and 30.5% were delivered through caesarean sections.

How often have they been followed up, and what was attrition like?

Previous publications[3,9] provide detailed information on the follow-up visits. For the 1- and 3-month visits, a systematic sample of 13% of the cohort participants was selected. At 6 months, 1 and 4 years, a more complex sampling scheme was used: all low-birthweight children plus 20% of the remaining – including those visited at 1 and 3 months—were sampled. At 11 years, all cohort members were sought. The number of eligible subjects for each visit and the corresponding attrition rates are shown in Table 1.

A lesson learned with the 1982 cohort was that very detailed contact information should be updated at every visit. We collected information on the address of the family and of two friends or relatives, as well as their telephone numbers. We also recorded the workplace of the parents (employer, address, telephone), and information on whether or not they were planning to move homes in the near future. This is particularly relevant in Pelotas, because a previous analysis of the 1982 cohort indicated that 45% of the families had already changed addresses within a couple of years after birth.

Table 1 Number of eligible subjects and losses to follow-up for each visit of the 1993 Pelotas (Brazil) birth cohort study

Age	Number of eligible subjects	Losses to follow-up[a] (%)
0 (perinatal)	5265	0.3
1 month	655	0.9
3 months	655	1.7
6 months	1460	3.2
1 year	1460	6.6
4 years	1460	12.8
11 years	5249	12.5

[a]Subjects known to have died were considered as traced in all follow-up visits.

From 4 to 11 years, no visits (other than the above-mentioned sub-studies) were carried out. In 2004, a major grant was obtained from the Wellcome Trust for a 5-year period, and two follow-up visits to all cohort members, at 11 and 15 years of age, were planned in 2004 and 2008, respectively. These are the first visits since the perinatal period for the majority of the cohort, because earlier visits were restricted to sub-samples of less than 1500 children. Several strategies were used in 2004 to guarantee high follow-up rates. The main approaches included a school census, in which the registries of over 100 schools in the city were reviewed and a city-wide census, in which all 98 000 households in the city were visited. In both, we obtained the names and date of birth of subjects born in 1993, and later tried to match them to their birth records. From 1993 to 2005, the mortality system detected 141 deaths in the cohort. For those who had not been located in the two censuses and were not known to have died, additional approaches were used, including visits to their last known address, information from other cohort participants and media campaigns.

In all phases of the cohort, attrition was studied in relation to baseline characteristics.

Table 2 shows that, in the 11-year visit, follow-up rates did not vary according to sex and birthweight. Subjects from lower socioeconomic level—according to either family income or maternal schooling—were more likely to be traced, although the differences were not substantial; at least 79.9% of all children in each subgroup were traced in 2004.

What has been measured?

Table 3 summarizes the variables included in each follow-up visit. The study database includes over 2500 variables, searchable by topic or by the visit when the data were collected. The variables are named according to the visit: all perinatal variables start with the letter 'a', 1-month variables start with 'b' and so on. The study database is available in Stata and SPSS formats. The questionnaires and interviewer guides from all follow-up visits are available in electronic and paper formats.

In all phases of the study, ethical approval was obtained from the Federal University of Pelotas Medical School Ethics Committee. Written informed consent was obtained from parents or guardians at every visit.

Table 2 Follow-up rates according to key baseline characteristics

Variable	Original cohort (*N*)	Percentage Located[a]	*P*[b]
Gender			0.18
Boys	2580	86.9	
Girls	2667	88.1	
Family income (minimum wages)			<0.001
⩽1	967	88.3	
1.1–3.0	2260	88.7	
3.1–6.0	1204	88.9	
6.1–10.0	433	79.9	
>10.0	385	82.6	
Maternal schooling at birth (years)			<0.001
0	134	82.1	
1–4	1338	88.7	
5–8	2424	89.9	
⩾9	1350	82.5	
Birth weight (g)			0.16
<2500	510	89.8	
2500–3499	3361	86.9	
⩾3500	1361	87.9	
Pre-pregnancy body mass index			0.004
<20.0 kg/m^2	1147	87.6	
20.0–24.9 kg/m^2	2811	86.6	
25.0–29.9 kg/m^2	894	90.3	
⩾30 kg/m^2	245	92.2	
Overall	5249	87.5	

[a]Subjects known to have died were considered as traced.
[b]Chi-square test.

Table 3 Variables collected in the main follow-up visits of the 1993 Pelotas (Brazil) birth cohort study

Visits	Main variables collected
Perinatal	Family socioeconomic status, maternal employment, parental schooling, maternal age, maternal marital status, parental skin color, reproductive history, gestational age, type of delivery, antenatal care, maternal anthropometry, maternal hospitalizations during pregnancy, social support during pregnancy, parental smoking, maternal alcohol intake, child sex, child anthropometry and breastfeeding initiation
1–12 months	Family socioeconomic status, maternal employment, maternal marital status, parental smoking, maternal mental health, child anthropometry, breastfeeding, dietary patterns, pacifier use, child care, child morbidity and medicine utilization, neurological development and number of teeth
4 years	Family socioeconomic status, maternal employment, parental schooling, maternal marital status, maternal anthropometry, child skin color, child anthropometry, breastfeeding, dietary patterns, pacifier use, child care, child morbidity and medicine utilization, neurological development, accidents and injuries
11 years	Family socioeconomic status, maternal employment, parental schooling, maternal age, maternal marital status, reproductive history, maternal anthropometry, parental smoking and alcohol intake, maternal mental health, parental morbidity, maternal physical activity, child skin color, child anthropometry and skinfolds, dietary patterns, child care, child morbidity and medicine utilization, neurological development, schooling performance, blood pressure, age of menarche, child physical activity, child television viewing, computer and videogame use, child labor, oral health, stressful events, body image, child smoking and alcohol intake, violence inside and outside home and knowledge on HIV infection

What has it found?

Results from this 11-year-old cohort have concentrated on three main themes. The first is the comparison of maternal and child health indicators with those from the 1982 cohort to assess time trends. These comparisons were initially published as a supplement to the Brazilian journal *Reports in Public Health*.[9] We find it important to publish results in Portuguese as well as in English, because many Brazilian practitioners and policymakers have limited knowledge of English. Overall, there was substantial progress between 1982 and 1993, in terms of family socioeconomic status, maternal education, water supply and sanitation. The 1993 mothers were on average 2.5 kg heavier and 3.4 cm taller than the 1982 mothers.[10] There were also substantial improvements in antenatal and delivery care as a whole, but the caesarean section rate increased from 28% to 31%. There was a slight increase in low birthweight (from 9.0% to 9.8%) and a marked on in preterm deliveries (from 6% to 11%), but the infant mortality rate fell from 36 to 21 per thousand.[10] Other secular trends observed through the comparison of the two cohorts were a slight increase in the median duration of breastfeeding (from 3.1 to 4 months).[11] The prevalence of weight/age deficits (underweight) at 1 year fell from 5.4% to 3.8% in the period, while stunting (low length/age) remained stable at around 5%, and obesity increased from 4.0% to 6.7%,

suggesting that the obesity epidemic being faced by Latin America can be detected as early as in infancy.[12] Regarding morbidity, the most striking finding was a sharp reduction in the proportion of children admitted to a hospital with diarrhoea in the first year of life, which dropped from ~6% in 1982 to 3% in 1993, in parallel to a reduction in diarrhoea mortality.[9]

Important social inequalities were observed for nearly all indicators in both cohorts. For example, 1993 children from the poorest socioeconomic level were 6.2 times more likely to die in the first year of life in comparison to those in the richest group,[13] a similar ratio to that observed 11 years earlier. Using a comparison of time trends in the two cohorts, as well as data from other Brazilian studies, we proposed in 2000 the 'inverse equity hypothesis', that helps explain why inequalities in health may increase or decrease over time, according to the speed with which new medical interventions reach different social strata in the population.[8] So far, this is the most widely cited paper coming out of the cohort.

The second set of studies addressed issues related to maternal and child health issues within the 1993 cohort. These include studies on the following topics:

(a) The association between parental smoking and infant outcomes, with the interesting finding that paternal—as well as maternal—smoking was associated with shorter breastfeeding duration.[14]
(b) The inverse association between breastfeeding duration and use of medicines in the first year of life.[15]
(c) The lack of association between pacifier use and psychomotor development, in contrast to a clear association between breastfeeding and development.[16,17]
(d) The association between cesarean sections and early interruption of breastfeeding, although there was no association with its mean duration.[18]
(e) The role of poverty in contributing to hospital admissions due to pneumonia.[19]
(f) The very strong protection afforded by breastfeeding against such admissions.[19]
(g) The inverse association between newborn anthropometry (birth length and ponderal index) and indicators of morbidity and mortality in the first years of life.[20]
(h) Wheezing at 4 years of life and its association with bronchiolitis admissions in infancy.[21]
(i) The lack of association between breastfeeding history and overweight or obesity at 4 years.[22]
(j) The epidemiology of childhood injuries and associated risk factors, particularly male sex and day care attendance.[23]
(k) The higher risk of mortality, morbidity and undernutrition for black children compared with whites even after adjustment for socioeconomic indicators.[24]
(l) Social and biological factors associated with the occurrence of acute respiratory infection and otitis media up to the age of 6 months.[25]

Two other studies were published at this time that used a combination of results from the epidemiological and ethnographic studies. We described a strong association between pacifier use and shorter breastfeeding duration and used ethnographic methods to show that this seemed to be largely due to self-selection by mothers, concluding that efforts to reduce pacifier use 'will fail unless they also help women face the challenges of nursing and address their anxieties'[26]—a finding that predicted the negative results of randomized trials on this topic published later.[27,28]

A similar combination of qualitative and quantitative methods was used to understand why many women from different social classes prefer caesarean sections to normal delivery, and how this preference affects the final decision on the type of delivery and contributes to the major epidemic of caesarean sections in our country.[29]

The most recent publications from the cohort are focused on risk factors for chronic disease measured in adolescence. Our main findings were:

(a) Birthweight and weight gain in the first 6 months of life were directly associated with height and lean mass at 9 years, while weight gain after infancy tended to be associated with fat mass deposition.[30]
(b) Also at 9 years of age, fluctuating asymmetry was associated with rapid weight gain in infancy but not with fetal growth.[31]
(c) At 11 years, 58% of the adolescents had sedentary lifestyles; those from poor families were less likely to engage in formal and leisure-time physical activities, but more likely to engage in informal and transport-related physical activity.[32,33]
(d) Variables that—according to the literature—are associated with increased with later risk of chronic diseases (low birth weight and rapid weight gain in childhood) are not associated with low levels of physical activity in adolescence, suggesting that a sedentary lifestyle is not a pathway through which such variables affect adult health.[32]
(e) At the age of 11 years, only 3.7% of the cohort members reported having experimented smoking. Maternal smoking during pregnancy and low family income were risk factors for experimentation.[34]
(f) Blood pressure levels in adolescence were positively associated with birth length, but not with birth weight.[35]

(g) At 11 years, 13.5% of the cohort participants were current wheezers, and risk factors varied considerably between boys and girls.[36]

What are the main strengths and weaknesses?

The main strengths of the cohort include its population base and the low rate of attrition, with 87.5% follow-up after 11 years. The cohort includes all social classes represented in the city, thus allowing detailed investigation of social inequalities. It also allows the study of time trends in child, adolescent and adult health through the comparison with the previous (1982)[1] and subsequent (2004)[37] birth cohorts, that used similar methodologies. Another positive point is its multi-disciplinary scope, epidemiology, statistics, paediatrics and clinical medicine, anthropology, dentistry, psychology, exercise physiology and nutrition. Finally, although early growth is increasingly shown to be important for later health in all populations, study findings are often inconsistent between cohorts from high-income countries, compared with those from low or middle-income countries. Therefore, cohort studies from industrialized countries may not offer an appropriate evidence base for global public health policies.

Our main drawbacks were related to a lack of continuous funding to allow for more frequent visits to the whole cohort. There were only seven main visits (not including sub-studies) in an 11-year period, and only two of these—at birth and at 11 years of age—attempted to examine the whole cohort. Information on important variables, such as breastfeeding duration and anthropometry in infancy and childhood, are available only for a sub-sample of subjects. Therefore, low statistical power may be an issue in some of the analyses.

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

We welcome joint analyses of the cohort data. We have collaborated successfully with investigators from the UK (London School of Hygiene and Tropical Medicine, Institute of Child Health, MRC Epidemiology Unit, Cambridge), USA (Cornell, Emory and Michigan Universities) and Australia (University of Newcastle) as well as several Brazilian institutions and the World Health Organization.

In our experience, there are limits to collaboration at a distance that often requires substantial involvement of our own staff. We much prefer investigators from other institutions to spend some time in Pelotas, and help build local capacity in the process. This has been particularly successful with doctoral or post-doctoral fellows. For interested young researchers from Latin America, we launched a Wellcome-Trust sponsored post-graduate programme in Life Course Epidemiology in 2005 which has so far trained nine MSc and two PhD students from the region, who receive full scholarships to work in our cohorts. For further information contact our website at http://www.epidemio-ufpel.org.br/projetos_de_pesquisas/estudos/coorte_1993 or e-mail the corresponding author.

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