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The 2004 Pelotas birth cohort: methods and description

ABSTRACT

OBJECTIVE: To describe a birth cohort which started in 2004, aiming to assess pre and perinatal conditions of the newborns, infant morbimortality, early life characteristics and outcomes, and access, use and financing of health care.

METHODS: All children born in the urban area of Pelotas and Capão do Leão municipalities (Southern Brazil) in 2004 were identified and their mothers invited to join the study. In the first year of the study the children were seen at birth, at three and 12 months of age. These visits involved the application of a questionnaire to the mothers including questions on health; life style; use of health services; socioeconomic situation; estimation of gestational age; anthropometric measurements on the newborn (weight, length, head, chest and abdominal circumferences); anthropometric measurements on the mother (weight and height) and assessment of infant development.

RESULTS: Out of the eligible infants (4,558), more than 99% were recruited to the study at birth. Follow-up rates were 96% at three months and 94% at 12 months of age. Among the initial results we highlight the following. Infant mortality rate was 19.7 per thousand, with 66% of infant deaths occurring in the neonatal period. There were frequencies of 15% premature babies and 10% low birthweight. Cesarean sections represented 45% of deliveries.

CONCLUSIONS: The third Pelotas birth cohort showed an infant mortality rate similar to that of 11 years ago, with most deaths occurring in the neonatal period. The rates of prematurity and cesarean sections increased substantially.

KEYWORDS: Cohort studies. Longitudinal studies. Infant mortality. Infant, premature. Infant, low birth weight. Hypothesis-testing. Child development.

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INTRODUCTION

Cohort studies are at the roots of epidemiology, and date back to the mortality tables that began to be collected in England in the 17th century and to the work of John Snow on cholera, in the 19th century. The methodological focus of epidemiology, which, in the 1970's and '80's was placed predominantly on case-control studies, was once again turned to cohort studies with the work of Barker,[3] who raised the hypothesis of a fetal origin for cardiovascular disease. The interest in long-term effects on health is currently increasing, with the finding of effects of breastfeeding on asthma[13] and obesity.[2] Thus, the demand for birth cohorts, as an attempt to provide answers to a large number of questions, has also increased. Developed countries, where several birth cohorts are currently being followed, continue to invest in such studies, and two large cohorts are now in their initial stages: the Millennium Cohort Study, launched in the United Kingdom in 2001[18] and the National Children's Study,* planned to begin in 2006 in the United States.

Birth cohorts have the great advantage of immediate (or almost immediate) collection of the information of interest, minimizing recall bias, a major concern in retrospective studies. Likewise, the fact that outcomes are registered at a time very close to their occurrence, due to the frequent visits to cohort subjects throughout the follow-up period, allows for the study of less significant occurrences, such as diarrhea and upper respiratory infections. On the other hand, the risk of substantial losses to follow-up may jeopardize the entire study. Thus, study sites where populational mobility is low are more adequate for the development of such studies.

A birth cohort was begun in 1982 in the city of Pelotas, Southern Brazil. Study subjects are being followed to the present date, and this is the longest running birth cohort with regular follow-up outside developed countries.[5,22] Eleven years later, a second cohort was begun, with methods similar to those of the former study.[21,23] A third birth cohort was undertaken in 2004, thus maintaining the 11-year interval between cohorts. Generally speaking, the aim of this third cohort is to keep a record of changes in the epidemiological profile of the population, from the perspective of both health problems and risk factors, providing a detailed evaluation of the perinatal health conditions of newborns and providing the basis for another birth cohort with long-term follow-up. Specifically, the aims of the cohort study are as follows:

a) to evaluate the antenatal and perinatal conditions of live births occurred in Pelotas in 2004, with special emphasis to gestational age, birthweight, mode of delivery, and delivery and newborn care;
b) to identify all fetal and infant deaths, defining their causes and evaluating potential intervention strategies;
c) to study characteristics and early-life outcomes such as growth, breastfeeding, development, infections, and accidents;
d) to evaluate the access, usage, and financing of health care;
e) to study inequalities in health characteristics between different social and ethnic groups.

We decided to carried out a visit at age three months in order to investigate, with high precision, neonatal and early infant events such as breastfeeding, morbidity, and mortality, among others, and another visit at age 12 months to keep comparability with the other two birth cohorts.

The present article describes the methodology employed in the first 12 months of the 2004 Pelotas birth cohort, including the visits at birth (perinatal), three months, and 12 months, as well as in the morbidity and mortality study. This article also describes the major characteristics of mothers and children being followed.

METHODS

Study settings

Pelotas is a city in the extreme South of Brazil, state of Rio Grande do Sul, 250 km south of state capital Porto Alegre. According to the 2000 National Demographic Census, city population was 323,158 inhabitants, of which about 301 thousand lived in the urban area. The city's population in 2004 was estimated at about 340 thousand. The climate is subtropical and humid, with mean temperature ranging from 23.3ºC in January to 12.2ºC in July. Major economic activities are agriculture and commerce. The Pelotas region is declining economically when compared to the entire state of Rio Grande do Sul. In 2002, the per capita GIP in Pelotas was R$5,739 (US$1,958**), 58% of the average GDP for the State, whereas in 1999 it was as high as 70%. Per capita GDP in Pelotas is below the mean GDP in Brazil, which was R$7,631 (US$2,604) in 2002.***

*The National Children's Study. Disponível em http://nationalchildrensstudy.gov [acesso em 7 mai 2006]
**Conversão para o dólar americano feita pela cotação média de 2002, de R$2,93.
***Instituto Brasileiro de Geografia e Estatística – IBGE. Produto Interno Bruto a preço de mercado e Produto Interno Bruto *per capita*, segundo as grandes regiões, unidades da federação e municípios - 1999-2002 [tabela]. Disponível em http://www.ibge.gov.br/home/estatistica/economia/pibmunicipios/2002/tab01.pdf [acesso em 7 fev 2006].

The perinatal study

Eligible subjects for the perinatal study included all children born alive (live births), as well as stillbirths weighing at least 500 g or with at least 20 weeks gestational age, born to mothers living in the urban area of Pelotas and in the Jardim América district, which currently belongs to the neighboring municipality of Capão do Leão. The inclusion of this district is based on the need to maintain a similar populational basis to that of the 1982 and 1993 cohorts. Mothers living in the rural area, despite not belonging to the cohort, were also interviewed in order to avoid losses due to incorrect address. Mothers living in other municipalities were not interviewed.

Almost all (> 99%) deliveries took place in the five hospitals in the municipality, two of which were university hospitals. During the entire year of 2004, these five hospitals were visited twice a day (morning and afternoon) on a daily basis, by interviewers especially trained for this study. All deliveries were recorded in a form specifically developed for this purpose, which included mother's full name, date and time of birth, newborn's sex, birth certificate number, and mother's address. Information on delivery was obtained based on the nursing records of obstetric centers, the coverage and accuracy of which was previously evaluated in all hospitals. Data on the place of residence were obtained from hospital charts and confirmed by the mother. At this moment, eligible cases were assigned a cohort identification number. Based on this birth record, questionnaires were developed for administration to mothers. In parallel, the national live birth registration system (SINASC) records were screened in order to locate and interview, at home, the mothers of children born outside hospitals.

Both the interview with the mother and newborn evaluation were carried out within 24 hours of delivery. The standardized, pre-coded questionnaire included few open questions and was composed of nine sections: identification; delivery and newborn health; antenatal care and gestational morbidity; reproductive history; mother's characteristics and lifestyle; characteristics of work, father, and family income; tests taken by mother during antenatal care; newborn physical examination; and contact data. The topics included in the questionnaire are listed in Table 1. We used a specific questionnaire for the second newborn in case of twin pregnancies, thus avoiding the unnecessary repetition of questions.

Newborn evaluation included measures of length and head, chest, and abdominal circumference. For length, we used an infantometer with 1 mm precision following standardized procedure. Perimeters were measured using an inelastic tape measure with 1 mm precision, following standardized procedures.[14] Birthweight was obtained from nursing records, which, in all hospitals, was measured using electronic pediatric scales with 10 g precision. These scales were checked weekly by cohort staff using standard weights.

The gestational age of live births was evaluated using the Dubowitz method.[9] In addition to this evaluation, which is based on physical and neurological characteristics of the newborn, gestational age was also calculated based on the date of the last period (DLP), recorded on the mother's card or self-referred by the mother (in this order of priority), and on ultrasonographic evaluation performed before week 20 of pregnancy. For the final attribution of gestational age to each newborn, we first excluded from each method values deemed implausible according to the Alexander method.[1] Of the remaining valid values, gestational age was attributed according to the following priority: 1 - DLP; 2 - ultrasonography; 3 - Dubowitz. Gestational age was undefined for only 13 of all newborns recruited to the cohort.

Anthropometric and Dubowitz gestational age evaluations were also carried out by the interviewers trained for participation in the project, always within 24 h of delivery.

Three-month follow-up visit

At age three months, all children in the cohort were sought for the first follow-up visit, with the exception of those known to have died (based on information from the morbidity and mortality substudy, described below). Mothers who had moved to other municipalities were not interviewed, with the exception of those that were in Pelotas at the time of the interview, totaling 103 losses at this follow-up wave. Mothers were contacted by telephone and invited to schedule an interview either at the Medical School of the Universidade Federal de Pelotas or at the mother's home, depending on their preference. For this interview, we defined a seven-day window period, including the day on which the child completed three months and the three days before and after this date; 85% of interviews were carried out within this window period.

The structure of the three-month follow-up questionnaire was similar to that of the perinatal questionnaire, and included the subjects listed in Table 1. During the interview, the child was weighed and had his or her length measured (electronic scale with 10 g precision; portable stadiometer, 1mm precision).

Head, chest, and abdominal circumferences were measured using an inelastic tape measure with 1 mm precision. Mother's weight and height were also measured, (mechanical scale, 1 kg precision; stadiometer manufactured in aluminum, 1 mm precision).

Training for the Dubowitz method was administered by a pediatrician with wide-ranging experience in this method (EPA), each interviewer having performed the exam numerous times before the beginning of the study. Re-training sessions were carried out every three months during the length of the study.

Twelve-month follow up visit

The second follow-up visit was carried out when children reached age 12 months. All children in the cohort presumed alive were sought, including those whose mothers refused to participate in the three-month follow-up. Household interviews were scheduled by telephone. We also sought to locate mothers who had moved to other cities at the time of the three-month interview, through telephone contact with friends or relatives of the mother. As in the three-month interview, mothers living outside the municipality were not interviewed (unless they planned to be in the city during the appropriate period), which led to 172 losses. We defined a 15-day window period, including the child's birthday and the seven days immediately before and after this date.

The main 12-month questionnaire was composed of nine sections; identification; child care and feeding; child's health; maternal, family, and household characteristics; health care expenditures; mother's health and contraception; lifestyle; visits by *Pastoral da Criança*; and anthropometry. As in the previous interview, we used a standardized, pre-coded questionnaire, with few open questions that were post-coded. We evaluated child development, using the same

Table 1 - Information collected during the first year of visits of the 2004 Pelotas birth cohort.

Information		Visit		
		Perinatal	3 months	12 months
Family	Family composition	X	X	X
	Family income	X		X
	Economic classification*	X		X
	Healthcare expenditures		X	X
	Smoking among family members	X	X	X
Mother	Employment	X	X	X
	Schooling	X		X
	Age	X		
	Marital status	X		X
	Skin color	X		
	Reproductive history	X		
	Medicine utilization	X		
Pregnancy	Mode of delivery	X		X
	Antenatal care	X		
	Weight	X		X
	Height	X		
	Hospital admission		X	X
	Characteristics of sleep			X
	Smoking	X	X	X
	Drinking	X	X	
	Consumption of caffeine and chimarrão (tea)	X	X	
	Contraception		X	X
	Mental health - SRQ-20[16]		X	X
	Previous gestational morbidity	X		
	Physical activity	X	X	
Child	Sex	X		
	Gestational age	X		
	Weight and length	X	X	X
	Abdominal and chest circumference	X	X	
	Head circumference	X	X	X
	Breastfeeding	X	X	X
	Diet (including 24 hour survey)		X	X
	Pacifier use	X	X	X
	Child care		X	X
	Morbidity and hospital admission	X	X	X
	Medication use		X	X
	Development – Denver and Battelle		X	X
	Teeth erupted		X	X
	Accidents and injuries			X
	Sleeping patterns		X	X
	Vaccination		X	X
	Healthcare service usage		X	X
	Coverage by Pastoral da Criança program	X	X	X
	Sphincter control			X
	Mode of financing of medical care		X	X

*We collected data to generate the National Wealth Score IEN[4] and the Critério Brasil, proposed by Abep (http://www.abep.org/codigosguias/ABEP_CCEB.pdf)

items of the Denver[10] test used in the 1993 cohort, and the Battelle[17] screening test. We prepared a set of sheets separate from the main questionnaire for this evaluation. This set included all items referring to ages zero until the age group immediately after the child's age (usually 12-18 months). Unlike test administration in a clinical scenario, where the examiner tests only a subset of items depending on the results obtained, all items were administered in the our evaluation. In another separate sheet, we also administered the Edinburgh test for the evaluation of maternal depression.[8] A specific questionnaire was used for twins in order to avoid the unnecessary repetition of questions regarding parents and household.

Anthropometric evaluation of children included measures of weight, length, and head circumference. Interviewers underwent standardization sessions[11] for the measurement of length and head circumference during training and every three months during fieldwork. Length was measured using a foldable wooden anthropometer, custom made for the study, using for measurement a nylon tape measure with 1 mm precision adhered to a groove carved into the body of the instrument. All instruments were checked regularly using standard length wooden sticks. Head perimeter was measured using an inelastic tape measure (7 mm wide, with spring and weight). Mother and child weight were measured using an electronic scale (150 kg capacity and 100 g precision), the mother being weighed first alone then holding the baby. The child's weight was calculated as the difference between the two measures. The mother was weighed clothed, but without heavy outfits, and clothes worn by the mother were recorded. The child was weighed undressed, whenever allowed by the mother. Otherwise, the child's clothing was recorded.

Morbidity and mortality substudy

For the fetal death study, mothers were interviewed soon after delivery. The interviewers and instruments were the same as for the perinatal study. Sections of the questionnaire that did not apply were omitted. These mothers were not sought again after this interview.

In order to evaluate infant and perinatal mortality and the care provided to high-risk babies, the two neonatal intensive care units and all pediatric wards in the city were visited on a daily basis. An interviewer reviewed medical charts and collected information with the assistant physician, using a standardized questionnaire. We also visited, on a monthly basis, the notary publics, cemeteries, and the Regional Health Department in order to check for deaths occurred outside hospitals.

The hospital admissions taken place within the newborns' first seven days of life were recorded. Mortality screening was performed for the period between 1st January 2004 and 31 December 2005, when the last child from the 2004 cohort completed one year of age.

In order to record the circumstances of the fetal death, we interviewed the obstetrician responsible for the delivery. This interview was conducted by an obstetrician who was part of the research team (IKT). For neonatal and post-neonatal deaths, a team pediatrician (EPA) interviewed the pediatrician who provided care to the newborn or who registered the death. We also carried out a systematic review of hospital charts in case of hospitalized children. For neonatal and post-neonatal deaths, we interviewed the mother or caretaker between two and eight weeks after death. This interview was carried out by a psychologist.

Underlying cause of death was also determined by two pediatricians with experience in the investigation of neonatal health and trained in identifying underlying cause of death, who acted as independent arbiters. These pediatricians evaluated chart reviews, death certificates, and interview material. In case of discrepancy, both pediatricians (EPA and AM) reviewed the material together, arriving at a consensus diagnosis. Fieldwork was coordinated by a pediatrician (EPA) and two other interviewers were responsible for the identification and collection of more general data.

Training, supervision, quality control, data entry, and data consistency

The fieldwork teams involved in each of the follow-up visits were similar, being composed of interviewers, fieldwork supervisors, secretarial staff, and coordinators. All interviewers employed in the perinatal study were nutritionists. In the three and 12-month follow-up visits, all interviewers had completed at least secondary education.

Interviewer training included general orientation, reading of the questionnaire and fieldwork manual, detailed discussion of each question, and questionnaire administration among the trainees and later with mothers. Specific anthropometry techniques were practiced at maternities (perinatal study) or at daycare centers (three and 12-month follow-ups), until all interviewers were performing measurements correctly. About twice the number of interviewers necessary for each visit were included in the training program. Interviewer selection was based on a written test and performance evaluation during training.

In all stages of the study, a fieldwork coordinator and supervisors closely followed data collection. The team held weekly meetings for distributing new interviews, handing in those already performed, and discussing doubts and difficulties. All instruments used in the study* were accompanied by a manual containing detailed filling instructions, which was used during training and was always available together with the interviewer's fieldwork material.

Following the interviews, all questionnaires were reviewed by the interviewer herself and then by one of the fieldwork supervisors. Questions were then grouped into batches (of varying size, depending on the size of the instrument), and passed on to data entry. For quality control purposes, 5% of interviews were repeated with mothers, at home or while still in the hospital, using an abridged version of the questionnaire. Of mothers who provided telephone numbers for contact – about 80% of all mothers – 50% were contacted by telephone, and the adequate administration of the interview and newborn examination were investigated, and some questions repeated. The major aim of quality control was not the validation of questions, but rather to ensure that interviews were being carried out fully and adequately.

Data entry was performed twice, independently, by two different data entry clerks. When the entry of each lot of questionnaires was completed, both entries were compared and discrepancies listed. Each of the data entry clerks then carried out the necessary corrections and the batches were compared again. If necessary, a further cycle of corrections was performed. Normally, a few inconsistencies remained, which were corrected by the entry supervisor, after which the process was terminated. The following step was to verify data consistency according to a consistency map previously constructed based on the questionnaire. Incongruent answers were thus identified and, if necessary, questionnaires returned to the supervisors, who tried to solve the problem by discussion with the interviewer. At the end of the process, data were accumulated in a database for the computation of variables derived from the original ones, such as, for instance, a low birthweight indicator based on the baby's weight in grams. All personal information, necessary for the future identification of mothers and children for the cohort's subsequent visits, were entered into a separate database, which was passed on to study coordinators. This ensured the anonymity of children and mothers during all stages of data analysis. Data entry was carried out using Epi Info 6.4, and validation was performed using a routine programmed into Stata 8 software. The entire process of consistency and variable computation was performed using Stata 8.

Strategies for joining of records and reducing losses

A few simple procedures helped expedite the process of identification of children and questionnaires, as well as the subsequent joining of data collected during each visit. In order for the joining of records to be perfect, it is necessary that a single and correct identifier exists for each subject. Thus, from the very beginning, a six-digit number was created for each child, as follows: the first digit corresponded to the hospital of birth, the second digit indicates the order of birth within the delivery, and the four last digits were generated sequentially for each hospital. To this number, we associated a verifying digit, which is the remainder of the division indicated below:

$$\sum_{i=1}^{6} (3+i) \times d_i \Big/ 11$$

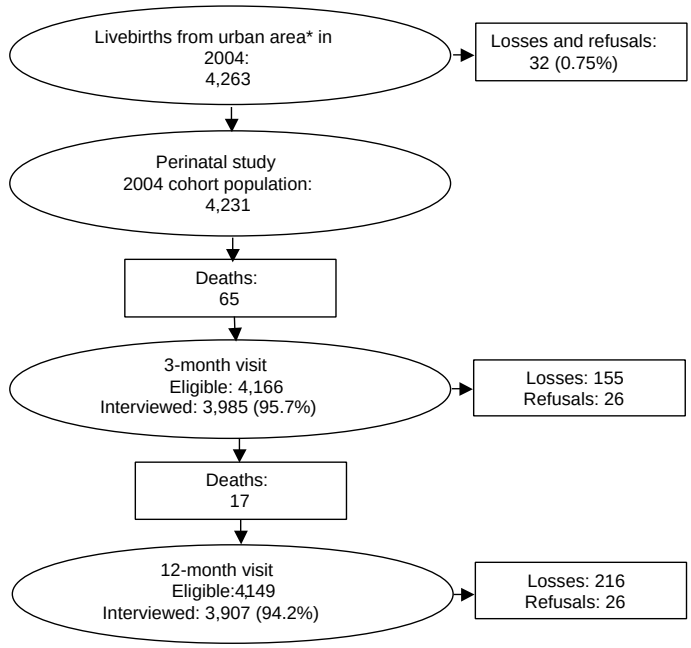
where d_i is the i^{th} digit of the identifier. For example, if the identifier is 120345, d_1=1, d_2=2, d_3=0, and so forth. In case the remainder equals 10, the verifying digit was calculated as $10 - (d_6 + 1)$. In the perinatal study, sticky labels containing sequential identifiers were produced previously. These labels were placed on the delivery record, on the cover of the main body of the questionnaire, and on the section containing personal information. We thus prevented any transcription errors during the identification of questionnaires. Upon entry, the verification digit calculation was incorporated into the Epi Info CHK file, so that an error message would appear in case the verifying digit was entered incorrectly, thus avoiding mistakes during this stage.

During the three and 12-month follow-up visits, questionnaires received a cover generated based on a database containing personal information: mother's name, newborn's name, address, and contact telephone numbers. This cover was generated as a text document, by merging personal data from an electronic spreadsheet. There was plenty of room on the cover for the correction and updating of data, always with the intent of locating the child during the next visit. In addition to the address, at least three telephone numbers were recorded, including fixed, mobile, home, or work phones belonging to the mother herself or to friends/relatives.

In addition to the concern with the quality of contact data, we also valued a well-mannered and polite con-

*All instruments and manuals are fully available through request.

tact with the mother in all opportunities. Complaints regarding the interviewers were always evaluated, measures taken if necessary, and mothers always received feed-back. Gifts were offered to children at the three-month (a T-shirt with the study logo and a participation diploma) and 12-month (a cap for boys and a hat for girls) follow-up visits. Mothers whose three-month interview was carried out at the school of medicine received also a package of nappies, a photograph of herself with the child, and transportation tokens.



*Includes children born from mothers living in the Jardim América district, which is contiguous to the Pelotas urban area but belongs to the municipality of Capão do Leão.

Figure - Diagram indicating the number of births, deaths, losses, and refusals in the 2004 Pelotas birth cohort.

Ethical aspects

All substudies described were approved by the Research Ethics Committee of the Medical School of the Universidade Federal de Pelotas and by the World Health Organization's Ethics Committee (Geneva). During each of these visits, a written consent form was read to mothers so as to explain, in general terms, the aims and procedures of the study. In addition, the confidentiality of data, voluntary participation, and the possibility of leaving the study at any time, without justification, were ensured. After clarifying any doubts the mother may have had, she was invited to sign the term, keeping a copy for herself. The signed form was archived at the study headquarters.

Children with severe developmental problems detected through our evaluation, or whose mothers requested some type of medical care for the child were examined by a team pediatrician in order to evaluate the need for medical follow-up. Mothers who, after the depression scale interview, requested help or health care, or who showed obvious depression according to the interviewer were referred to treatment, when necessary, in the municipal health care network.

RESULTS

In 2004, 4,558 children were born to mothers living in the city of Pelotas or in the Jardim América district (municipality of Capão do Leão), including fetal deaths. We interviewed the mothers of 4,519 of these children, including fetal deaths (mortality substudy) and those living in rural areas, as a precaution. Losses at this stage totaled 0.9%. Of the 4,263 live births from the urban area, 4,231 were included in the perinatal study (0.8% loss). This was the reference group for the subsequent follow-up waves.

Although sample size was fixed (all urban births), we performed calculations in order to estimate sampling error. Proportions may be estimated with a maximum error of 1.5 percentage points for 95% confidence intervals. The study also showed high statistical power to detect associations, with at least 80% power to detect as significant relative risks of 1.7 or greater for an exposure affecting 10% or more of cohort subjects, estimating an outcome with a frequency of 5% or more among unexposed subjects, at the 5% significance level.

The Figure shows visits carried out during the children's first year, including the number of eligible subjects, deaths, losses, and refusals. Follow-up rates were quite high, with the lowest proportion being registered for the 12-month follow-up (93.6%, excluding deaths). Virtually all losses were due to changes of address to other municipalities.

An overview of infant mortality in Pelotas in 2004 is presented in Table 2. For this analysis, we included all births recorded, including mothers who refused to participate in the study and rural residents. The infant mortality rate observed was 19.7 per thousand live births, and 65.5% of these deaths occurred in the neonatal period.

Of the live births recruited to the cohort, 52% were male, 15.3% were preterms, and 10% were low birthweight. There was a small number of children with very low birthweight. About 13% of live births showed some type of neonatal intercurrence, which

Table 2 - Mortality during the first year of life in Pelotas, Southern Brazil, 2004, including all births (Cohort plus rural births, nonrespondents, and refusals).

Variable	N	Rate/1,000	95% CI
Number of births	4,558		
Fetal deaths (20+ weeks or 500+ g)	62	13.6	10.4-17.4
Fetal deaths (28+ weeks or 1,000+ g)	44	9.7	7.0-13.0
Number of live births	4,496		
Neonatal deaths	57 (65.5%)	12.7	9.6-16.4
Infant deaths	87 (100%)	19.4	15.5-23.9

determined the child's permanence in the hospital beyond the usual period. Details are presented in Table 3.

Table 4 presents the characteristics of 4,189 mothers and their pregnancies. The majority of mothers classified themselves as white (61.7%), followed by mixed color (20.8%), and black (16.5%). The greatest proportion of mothers was in the 20-29 years age group (49.9%), and 18.9% of mothers were still adolescents. There was a predominance of mothers with less than eight complete years of schooling (42.8%) – that is, who did not conclude elementary schooling.

Almost one-half of mothers (40%) reported having carried out some type of paid work during pregnancy, and 83% of mothers were living with a partner at the time of delivery. Family income in the month preceding delivery was concentrated in the 1-2.9 minimum wages group (45.9%). Roughly one in every five mothers reported family income below one minimum wage. Mean and median family income was 3.2 and 2.0 minimum wages, respectively. Most deliveries (81.1%) of were paid for by the Brazilian Health System (SUS).

Table 3 - Description of the neonatal characteristics of the 4,231 children recruited to the 2004 Pelotas Birth Cohort.

Variable	N	%
Sex		
Male	2,196	51.9
Female	2,035	48.1
Gestational age (weeks)		
<37	647	15.3
37-41	3,300	78.3
≥42	271	6.4
Birthweight (g)		
<1,000	26	0.6
1,000-	35	0.8
1,500-	82	1.9
2,000-	281	6.7
2,500-	1,043	24.7
3,000-	1,651	39.0
3,500-	912	21.6
4,000-	198	4.7
Low birthweight	424	10.0
5-minute Apgar score		
0-3	23	0.6
4-6	74	1.8
7-10	4,112	97.6
Neonatal intercurrences	531	12.6
Continuous variables	Mean (sd)	Min-max
Birthweight (g)	3,149.6 (566)	450-5,995
Length at birth (cm)	48.2 (2.6)	22.2-58.8

Reported alcohol use during pregnancy was low (3.3%), smoking being more frequent (27.5%). Before pregnancy, 15.2% of mothers performed some type of physical activity in leisure time, a percentage that fell to 13.2% during pregnancy.

Primiparae were the largest group of mothers (39.4%). Multiple pregnancies were seen in 1.0% of gestations, and no cases of more than two babies were registered. The gestational morbidity most frequently reported was urinary infection (37.2%), followed by hypertension (23.7%) and diabetes (3.0%).

The great majority of mothers began antenatal care within the first 16 weeks of pregnancy (86.0%), having had six or more appointments (82.5%). Ultrasonographic evaluation was frequent, with 36.8% of mothers having had one, and 60%, two or more evaluations. When asked whether pregnancy had been planned, 65.8% of mothers replied negatively.

Caesarian sections accounted for 45.4% of deliveries. Preliminary analyses indicate enormous differences in this variable according to the type of financing. Among Brazilian Health System users, the prevalence of C-sections was 36.4%, whereas among other mothers this prevalence was 84.5%. In one of the private hospitals, about 90% of deliveries were by C-section.

DISCUSSION

The present study continues the series of birth cohorts begun in Pelotas, Southern Brazil, in 1982. In 1993, a second cohort was initiated, 11 years after the first one. Another 11 years went by, and this third cohort signals the consolidation of this research program and of the Epidemiologic Research Center at the Universidade Federal de Pelotas. Large, countrywide studies are difficult to carry out and maintain – as exemplified by the Brazilian Demographic Health Surveys, done in 1986, 1991, and 1996 and then interrupted. In spite of this, the series of birth cohorts conducted in Pelotas places Brazil in a unique position among developing countries, and provides the conditions for the continued study of changes in the epidemiological profile of health prob-

lems and risk factors, as well as for keeping up with the most recent trends in epidemiological investigation. In this scenario, the investigation of what is being called life course epidemiology and fetal origins of disease is worthy of note.

Cohort studies, birth cohorts especially, allow for qualified investigation in these fields due to the availability of data on pregnancy, mother, family, and child, collected throughout the subject's lifetime. The sequence of cohorts allows for new hypotheses to be incorporated, by the collection of specific data, as is the case, for instance, for maternal physical activity and its short and long-term effects on pregnancy, delivery, and the fetus.

The 2004 cohort certainly benefited from the experience accumulated with the previous studies. Innovations were introduced, such as the system of data entry in parallel with collection and a more complete system of evaluation of the consistency of questionnaires. More importantly, the same level of quality was maintained, as evidenced by the high follow-up rate at 12 months (93.6%). This rate was practically identical to that obtained in the 1993 cohort (93.4%),[21] and much higher than that of the 1982 cohort (79.3%). Follow-up rates increased in subsequent stages of the 1982 cohort, after the adoption of new follow-up strategies.[5] We also highlight the low rate of nonresponders and refusals in the perinatal study (0.75%).

Table 4 - Description of maternal and gestational variables among the 4,189 mothers of the 2004 Pelotas Birth Cohort.

Categorical variable		N	%
Color (self-referred)	White	2,555	61.7
	Black	682	16.5
	Tan or mixed	862	20.8
	Yellow or Asian	13	0.3
	Amerindian	29	0.7
Color (interviewer's evaluation)	White	3,122	72.8
	Black	866	20.2
	Other	299	7.0
Age (years)	<20	800	18.9
	20-29	2,108	49.9
	30-39	1,184	28.0
	40+	137	3.2
Schooling (complete years)	0-3	358	8.4
	4-7	1,460	34.4
	8-10	1,070	25.2
	11+	1,356	32.0
Paid work	1,693	40.0	
Family income in minimum wages*	<1	884	21.0
	1-	1,939	45.9
	3-	945	22.4
	6-	243	5.8
	10-	207	4.9
Living with partner		3,536	83.6
Delivery paid for by SUS		3,428	81.1
Smoking during pregnancy		1,162	27.5
Drinking		140	3.3
Physical activity before pregnancy		645	15.2
Physical activity during pregnancy		558	13.2
Multiple pregnancy		42	1.0
Caesarian section		1,922	45.4
Parity	1 (primipara)	1,666	39.4
	2	1,111	26.3
	3	680	16.1
	4	352	8.3
	5+	421	9.9
Self-referred gestational morbidity	Diabetes	126	3.0
	Hypertension	1,002	23.7
	Urinary-tract infection	1,569	37.2
Antenatal care	6+ appointments	3,281	82.5
	Onset up to 20th week	3,803	93.0
Ultrasonography (n. of evaluations)	0	136	3.2
	1	1,555	36.8
	2	1,215	28.7
	3+	1,325	31.3
Planned pregnancy	Planned	1,467	34.2
	Unplanned	2,433	56.8
	"More or less"	386	9.0
Continuous variables		Mean (sd)	Min-max
Mother's age		26.1 (6,8)	12-46
Years of schooling		8.1 (3,5)	0-18
Family income in minimum wages		3.2 (4,4)	0-87.4
Family income in Real (R$)		805.8 (1,109)	0-22,000
Antenatal care appointments		8.3 (3,2)	1-30

SUS: Brazilian Health System
*Mean monthly minimum wage in 2004 =R$251.67 calculated as the weighted average of 5 months (reference months December to April) at R$240 (US$83.76) and 7 months (May to November) at R$260 (US$89,66).

The overall evaluation of the subjects of the 2004 cohort shows evident changes, and some surprising similarities, in relation to the former studies. Whereas infant mortality fell from 36.4 to 21.1 deaths per thousand live births between 1982 and 1993 (a 42% reduction),[16] mortality in 2004 was 19.4 per thousand, only 8% lower than that of the previous cohort. Another aspect that remained practically stable across the different studies was the distribution of family income in minimum wages. However, distribution in 2004 was closer to that of 1982 than to that of 1993.[19]

Mean age of mothers did not change, but the proportion of adolescent mothers was greater than in 1993. The prevalence of white mothers is falling (82.1% in 1982, 77.2% in 1993). If we consider self-referred skin color, this percentage falls even more, to 61.7%. In this edition of the cohort, we collected skin color data both through the interviewer's observation – in order to ensure comparability with the previous cohorts – and through self-referral, in order to allow comparisons with data from the *Instituto Brasileiro de Geografia e Estatística* (Brazilian Institute for Geography and Statistics – IBGE). In the questionnaire, we used the term '*morena*' (tan) as a synonym of '*parda*' (mixed), based on previous tests that indicated that the latter term was not properly recognized as indicating mixed race. With some frequency in this test, even after reading the available alternatives, the respondent would classify herself as '*morena*.'

Regarding schooling, the results of the survey reflect the still precarious Brazilian situation, with two of every five mothers not having completed elementary school. Notwithstanding, there was an evident improvement in comparison with 1993, with an increase in mean schooling from 6.7 to 8.1 years.

The number of primiparae is greater than it was in 1993 (35.1%), practically returning to 1982 levels. The prevalence of smoking during pregnancy fell more markedly, from 33.4% in 1993 to 27.5% in 2004.[20] On the other hand, there was a low percentage of mothers who performed physical activities in leisure time before and during pregnancy. There was an increase in the mean number of antenatal care appointments, which increased from 7.6 in 1993 to 8.3 in 2004, in addition to the reduction in the number of mothers beginning antenatal care after the fifth month of pregnancy from 9% to 7%.[7]

The prevalence of c-sections increased about 50% when compared to the 30.5% observed in 1993. Among certain groups, C-sections are almost universal, the Brazilian Unified Health System (SUS) apparently being an impediment to this type of delivery. Such a scenario requires more detailed analysis, but it suggests that C-sections are the method of choice among the clients of private health plans.

Finally, from the standpoint of the fetus, we found an important increase in the proportion of preterm deliveries, which practically doubled in comparison with the 7.5% observed in 1993.[12] The prevalence of low birthweight remained stable at around 10%. The apparent incongruity between these two results may be explained by the concentration of preterms in 2004 in the 35 and 36-week gestational age range, very close to the prematurity cutoff point. The relationship between the increase in preterm delivery and in the occurrence of c-sections requires in-depth analysis, and was the subject of a study using the then partial data of the 2004 cohort, as well as other potential determinants.[6]

A 24-month follow-up visit is now being conducted for all members of the cohort, and another follow-up visit is planned at age 4 years. We believe that the present study, alone or in conjunction with the previous cohorts, will provide relevant contributions to the handling of health care problems in our country, and also, more generally, to current knowledge in the field of public health. Several analyses are already ongoing, so that such contributions may occur in the shortest possible timeframe.

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