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Methodology of the Pelotas birth cohort study from 1982 to 2004-5, Southern Brazil

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Abstract

OBJECTIVE: To describe the methods employed in the longitudinal and follow-up studies of children born in Pelotas (Southern Brazil) in 1982.

METHODS: The cohort began with a perinatal health survey that included all 6,011 children born in maternity wards in Pelotas in 1982. The 5,914 children born alive in the city were included in the follow-up studies. By 2004-5, we had conducted eight follow-ups, which consisted of the administration of questionnaires to mothers and/or cohort members, depending on age, in addition to anthropometric and clinical examination. Cohort subjects are described in terms of demographic, socioeconomic, and health-related variables collected during early follow-up studies, which are used as exposure variables.

RESULTS: The majority of subjects in the cohort were followed for 23 years and on multiple occasions. The most successful follow-ups were those preceded by a city census. Using this method, we were able to locate 87.2% of subjects in 1984 (mean age 19 months), 84.1% in 1986 (mean age 43 months), and 77.4% in 2004-5, and 77.4% in 2004-5 (mean age 23 years).

CONCLUSIONS: Birth cohort studies can be carried out successfully in developing countries, and the methods employed in this life-cycle study have allowed us to investigate the influence of early exposures in determining disease outcomes in adult life.

Keywords

Cohort Studies; Epidemiologic Methods; Statistical Methods and Procedures; Child Development; Human Development; Brasil

INTRODUCTION

In developed countries, the study of birth cohorts has contributed markedly to our understanding of the long-term consequences of events taking place early in life. The first nation-wide study of a birth cohort was carried out in England in 1946,13 and further cohorts using the same methodology were begun in 1958, 1970, and 2000.10 In the United States, a large birth cohort began to be followed in 2007.[a]

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Despite the importance of such studies, large birth cohorts are rare in less developed countries, probably due to their high cost and to the difficulties involved in tracing patients for follow-up studies. Harpham et al4 have recently reviewed all longitudinal studies taken place in developing countries with samples of 1,000 or more. Of these studies, only three were followed for over ten years.

In chronological order, these are the 1982 Pelotas Cohort, with approximately 6,000 births, a study in Cebu, Philippines, begun in 1983-84, with approximately 3,000 newborns,[a] and the *Birth to Ten* study, which included 4,000 births from Johannesburg, South Africa (currently called the *Birth to Twenty* study).8 A smaller-scale study is under way in Guatemala, which includes 400 subjects born between 1969 and 1977 and that are still being followed.11 In India, the New Delhi study began as a cohort of about 8,000 children. This study was interrupted until adulthood, when 1,526 subjects were traced.9

The history of the 6,011 children of the 1982 Pelotas (Southern Brazil) cohort whose mothers lived in the urban area of the city was outlined in the book *Epidemiologia da Desigualdade* (Epidemiology of Inequality)12 and published in 60 articles that report the findings of this study.

Another two birth cohort studies were undertaken in Pelotas, spaced at 11-year intervals. The first comparison of the results of the first two cohorts was presented as a supplement in the Brazilian journal *Cadernos de Saúde Pública* in 1996. In 2008, another supplement, comparing the three birth cohorts (1982, 1993, and 2004), was published in the same journal.2

The present article was aimed at describing the methods employed for the longitudinal study of children born in Pelotas in 1982, as well as in the three universal follow-ups, carried out in 1984, 1986, and 2004-5. We present the distribution of variables used in all articles included in the present supplement.

METHODS

The 1982 birth cohort study was carried out in the city of Pelotas. Population in the city increased from 214,000 in 1982 to 342,000 in 2005. The city's major economic activities are agriculture (rice and cattle), commerce, and education (the city has two universities). Over 90% of households are connected to public water supply, and about one-half, to the public sewage network. At the beginning of the study, in 1982, the infant mortality rate in the city was 40 per thousand live births.

Initial stages of the study: 1982-1986

The study began with a perinatal health survey,[b] which included all 6,011 children born in the three city maternity wards, representing 99.2% of all births taken place in the city that year. A questionnaire collecting socioeconomic, demographic, and health-related information was administered to mothers, who were also weighed and measured while still in the maternity ward. The 5.914 living newborns were weighed using a frequently calibrated Filizola scale with 10g precision; child length was not measured at this point.

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[a]The National Children's Study. Bethesda, MD-USA 2000 [cited 2006 Dec 7]. Available from: www.nationalchildrensstudy.gov [Bethesda, MD-USA]

[a]Cebu Longitudinal Health and Nutrition Survey. Cebu, Philliphines. 1983 [cited 2006 Nov 13]. Available from: www.cpc.unc.edu/projects/cebu/about.html [Cebu, Philliphines]

[b]Barros FC. The epidemiology of perinatal health in southern Brazil: a study of perinatal mortality, low birth weight and the utilisation of health care [dissertation]. London: University of London; 1986.

Children in the cohort were followed up at different times (Table 1). In the 1983 follow-up, when children were 8-16 months of age (mean age 11.3 months), children born between January and April 1982 were visited were visited at home, using the address provided by the hospital at the time of birth. However, we were unable to locate about 20% of children born in this period based on the address provided by the hospital.

Thus, for the following follow-ups, we chose to visit all households in the city (approximately 70 thousand), as an attempt to identify children born in 1982 and who had been interviewed in the perinatal study. Using this approach, we determined that under 1% of births in Pelotas took place outside hospitals.

Subsequent stages in the study included the 1984 follow-up, when children were aged 19.4 months on average (range: 12-29 months), and the 1986 follow-up, when children were aged 43.1 months (range: 35-53 months).

In order to calculate the proportion of children located in each follow-up, children known to have died were added to those visited. For example, in 1983, 66 of the 1,919 children born between January and April 1982 had died; when added to the 1,447 whose mothers or guardians were interviewed, the follow-up rate for the first follow-up study was 79.3% of attempted children. In this first follow-up, errors in the collection of address information were the major cause of failure to locate children. The follow-up rates of later stages of the study are presented in Table 1.

The mortality substudy by Horta et al5 identified all deaths among cohort children. All hospitals, cemeteries, civil records offices, and the Regional Secretariat of Health were visited on a regular basis beginning in 1982 in order to detect any deaths among cohort members. From 1987 onwards, we concluded that all deaths were detected by civil records, and other sources of monitoring were subsequently abandoned. Causes of death were investigated by reviewing patient charts from hospitals and outpatient facilities and by interviewing family and physicians providing care to the deceased. During the interviews, a complete history of the events preceding death was obtained by means of a questionnaire. Causes of death were classified according to the Portuguese Language version of the International Classification of Diseases, version 9.7

Cause of death was defined by two independent arbiters who used the information collected in the questionnaires to decide upon cause of death. In case of disagreement between the two arbiters, a third arbiter would make the final decision.

Subsample follow-ups: 1995-2001

In early 1995, we attempted to locate a subsample of children in the cohort using the addresses available until 1986 in order to evaluate academic achievement and knowledge of means of transmission and prevention of HIV/AIDS. High population mobility and the extended time period between this and the last follow-up led to the lowest follow-up rate since the beginning of the study.

In 1997 and 2001, a new search strategy was employed with the goal of identifying subsamples of 1982 cohort members. Of 265 city census tracts, 70 (or 27% of urban households) were systematically selected, all households in these tracts were visited, and all cohort members located were interviewed.

In 2000, all males born in 1982 underwent mandatory military enlistment. During physical examination, male cohort members were identified and interviewed.

During this period, we also carried out an ethnographic study aimed at describing the patterns of emotional, social, and reproductive behavior of a subsample of adolescents from the cohort. This study was based on repeated and intensive contacts with the same adolescents in two stages, between ages 15 and 17, and once more between ages 18 and 20. Census tracts included in the 1997 sample were divided into four family-income strata, with two tracts being randomly selected from each stratum. In each tract, six male and six female adolescents were randomly selected among those traced in the 1997 survey, totaling 96 subjects.

2004-5 follow-up

The latest follow-up of the entire cohort began in August 2004, based on a census of all the city's households. Approximately 98 thousand homes were visited by a team in search of residents born in 1982 and belonging to the birth cohort. During this visit, we also enquired about the existence of close relatives who had been born in 1982 and emigrated from Pelotas. For subjects born in 1982, we collected name, date, and hospital of birth, name of father, and name of mother at time of birth, for comparison the original cohort records. This strategy was complemented by a search of school records, *vestibular* (college admissions) applications, and information from SINASC (the national registry of live births) for female subjects with children. Subjects who remained unidentified were sought at their addresses collected during earlier stages of the study. In the case of family members who reported cohort members living in other cities within Rio Grande do Sul state, we invited the cohort member to come to Pelotas for an interview, all expenses covered by the study. In the case of municipalities with a greater number of cohort members (Porto Alegre, Caxias do Sul, and Florianópolis), or even of small municipalities neighboring Pelotas, a study team was relocated to the area for interviews.

During all childhood follow-ups, the mother or guardian was interviewed using a standardized, pre-coded questionnaire. In follow-ups during adolescence, one questionnaire was administered to the youth and one to the mother or guardian, with the exception of the army recruitment and the 2004-5 follow-ups, when only the subject was interviewed. For anthropometric evaluation, subjects were weighed using portable scales and measured using locally-built stadiometers.3 Standardized methods were employed, and all interviewers were trained prior to fieldwork. Quality control measures employed included frequent scale calibration, repetition of 5% of interviews and measurements by a field supervisor, standardization sessions, and double data entry.

Verbal informed consent was obtained from guardians in study phases between 1982 and 1986, following common practice at the time, when an ethics committee was not available at the Federal University of Pelotas. In more recent stages, the study received the approval of the university's Research Ethics Committee, affiliated to the *Conselho Nacional de Ética em Pesquisa* (National Research Ethics Committee – CONEP), and written informed consent was obtained. Confidentiality of data was ensured at all stages of the study, and computer archives containing the names of subjects and parents are maintained under restricted access, in separate from the remaining data.

At all stages of the study, any subjects diagnosed with health-related problems were referred to the university's health clinics for treatment.

RESULTS

Follow-up rates for the study's different stages varied according to search strategy and are described in Table 1. Follow-ups with greater success were those preceded by a city census, when all households in the city were visited. Using this method, we were able to locate 87%

of children at mean age 19 months in 1984, 84% of children at mean age 43 months in 1996, and 77% of youths at mean age 23 years in 2004-5. Of the latter, 2,928 were traced through the census, and another 1,627 by other means.

Each outcome was analyzed according to a general hierarchical model, with exposure variables obtained mainly during earlier (childhood) follow-ups, whereas outcome variables were studied during the 2004-5 follow-up (Table 2).

Our analysis model included, in a first hierarchic level, variables of socioeconomic and demographic nature – maternal and paternal schooling, family income in 1982, change in income between 1982 and 2004-5, and skin color. Subsequent levels included variables related to the child's health, such as birthweight and breastfeeding. For specific outcomes, other exposure variables deemed important were also included; for example, for youth's smoking, we included maternal smoking during pregnancy in the second hierarchical level. For asthma (presence of wheezing), parental history of asthma was analyzed together with the socioeconomic and demographic variables included in the first level. For other outcomes – such as paternity/maternity, nutritional status and obesity, health care service usage, and early sexual initiation –, the schooling level of the subject him or herself was considered.

The demographic and socioeconomic characteristics of the cohort are presented in Table 3. At birth, there was a slight predominance of males (51.3%), a proportion which is similar to that found in 2004-5 (51.5%).

Information on skin color was obtained in 2004-5 according to the procedure adopted by the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística* – IBGE); subjects classified themselves as White, Black, Mixed, Asian, or Indigenous. For analysis purposes, these categories were reencoded as White, Black or Mixed, and Asian or Indigenous, as presented in Table 3. According to this criterion, roughly one in five subjects classified themselves as Black or Mixed, this proportion being similar between men and women.

For the analyses presented in this supplement, the majority of socioeconomic information refers to the subjects' conditions during childhood, as is common practice in life-cycle studies. Thus, data on maternal schooling and family income were obtained in 1982, whereas paternal schooling was included in 1984. Parental schooling was collected in years of study with passing, and was categorized based on the current school system as primary (0-4; 5-8 years), secondary (9-11 years), and post-secondary or university (≥ 12 years). Family income at birth was collected in five categories, as presented in Table 3, according to the minimum wage at the time. To evaluate the effect of socioeconomic conditions throughout life on certain health-related outcomes, we constructed a variable representing change in family income from 1982 to 2004-5. For this purpose, family income in 1982 was transformed into a continuous variable using a process of income imputation based on household and family characteristics, employing principal component analysis of four variables (social security affiliation at time of delivery, schooling, and mother's stature and skin color).1 Based on income terciles in 1982 and 2004-5, interviewers were classified into the following categories: always poor (those belonging to the lower tercile in both 1982 and 2004-5); poor → non-poor (lower tercile in 1982 on to middle or upper tercile in 2004-5); non-poor → poor (middle or upper tercile in 1982 on to lower tercile in 2004-5); and never poor (middle or upper tercile in both 1982 and 2004-5).

The distribution of these socioeconomic variables (Table 3) shows that the majority of youths were the children of fathers and mothers with low schooling, and almost one-quarter had schooling beyond the elementary level. Almost one-half of subjects came from families whose income was between one and three minimum wages in 1982; almost the entirety of

subjects (94.3%) came from families who received up to 10 monthly minimum wages, which corresponds to R$3,800.00 in today's values. Regarding the change of income variable, two-thirds of youths remained in the same income group.

The characteristics of children at birth, used in the remaining articles of this supplement, are presented in Table 4. Information on birthweight was obtained in 1982 for 5,909 live births, and 9% of these were considered as low birthweight (<2,500 g), 8% among males and 10% among females. On the other hand, the proportion of babies born weighing 3,500 g or over was greater among boys. Almost one-quarter of children were weaned within the first month of life. This information, collected during childhood, refers to breast milk offered to the child exclusively or complemented by other milks or foods, given that the habit of exclusive breastfeeding was practically nonexistent at the time. Roughly three in four children had already been fully weaned at six months of age (Table 4).

The distribution of other variables pertaining to maternal health showed that over one-third of the mothers of 1982 children had smoked during that pregnancy. Approximately 10% of subjects reported family history of asthma in 2004-5. Still in Table 4, roughly two-thirds of youths interviewed had secondary education.

Table 5 presents the associations between the socioeconomic variables described above. Considering the relationship between family income in 1982 and parental schooling (collected in 1982 for the mother and in 1984 for the father), there was a clear difference between income strata with respect to the schooling level of all family members, with richer parents having approximately 10 more years of schooling than poorer parents. The same general trend was maintained among youths, but differences between groups were smaller. When schooling was evaluated in terms of change of family income between 1982 and 2004-5, a more complex pattern emerged for families whose income changed in the period. This was true both for families whose conditions improved and for those whose conditions worsened. Generally speaking, parental education was associated with financial status in 1982 – families who were non-poor and became poor had higher schooling levels than those who were poor and became non-poor. As to the youth's education, those who were never poor had on average four years more schooling than those who were always poor. Youths who changed income showed similar levels of schooling, regardless of the direction of change.

DISCUSSION

The present article shows that cohort studies can be successfully conducted in developing countries. Our study succeeded in following the majority of subjects in the cohort across 23 years of life and a number of follow-up visits. The over-75% follow up rate in 23 years is the highest among cohort studies with more than 1,000 subjects in developing countries.4

Follow-up rates varied according to the search strategy employed, and were especially high for visits preceded by a city census. Notwithstanding, the 2004 census was able to locate only about 3,000 subjects, with subsequent searches identifying another 1,600 youths that had not been traced by the census, in spite of subjects or their close relatives still residing in Pelotas. This may suggest that people are more reluctant to answer questions from strangers regarding the composition of their families in comparison to the 1980's, when concerns with security in the city were less pressing.

As mentioned previously, the articles in this supplement are a continuation, now in youth, of the report begun with the book "*Epidemiologia da Desigualdade*",12 the main emphasis of which was always on the impact on health of social inequality. In this series, economic conditions are defined in terms of family income at birth in 1982, change in income between

1982 and 2004-5, and parental schooling. The life-cycle studies included in this Supplement are intended to contribute to our understanding of the influence of early exposures in determining disease outcomes in adult life,6 in addition to allowing for an evaluation of the impact of social inequalities on the health status of a population.

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Table 1

Major stages of the 1982 cohort study. Pelotas, Southern Brazil, 1982 to 2004-5.

Year	Target population		Main search strategy	Mean age (range)	Studied population		Losses (%)
	Description	n			Interviewed	Deaths	
1982	All live births in Pelotas hospitals between January and December 1982	5,914	Daily visits to hospitals	Zero	5,914	0	-
1983	All children born between January and April 1982	1,916	Addresses obtained at hospital	11.3 months (8 to 16)	1,457	66	20.7
1984	All children	5,914	Census of 70,000 households	19.4 months (12 to 29)	4,934	227	12.8
1986	All children	5,914	Census of 80,000 households	43.1 months (35.4 to 53)	4,742	237	15.9
1995	20% of the cohort	1,100	Visit to previous addresses	13.1 years (12.5 to 13.7)	715	47	30.1
1997	27% of the cohort	1,597	Visit to 27% of households	14.7 years (14.0 to 15.6)	1,076	70	28.2
2000	All male subjects	3,037	Identification during military enlistment	18.2 years (17.6 to 19.1)	2,250	143	21.1
2001	27% of the cohort	1,597	Visit to 27% of households	18.9 years (18.1 to 19.9)	1,031	71	31.0
1997 and 2001	Ethnographic study	96	Visit to 8 census sectors identified in 1997 and 2001	15 to 19 years	96	-	-
2004-5	All youths in the cohort	5,914	Census of 98,000 households	22.8 years (21.9 to 23.7)	4,297	282	22.6

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Table 2

Exposure and outcome variables, with year of collection. Pelotas, Southern Brazil, 1982 to 2004-5.

Variable	Year of collection
Exposure	
Demographic	
Sex	1982
Skin color	2004-5
Socioeconomic	1982
Family income	
Maternal schooling	1982
Paternal schooling	1984
Change in income	1982 → 2004-5
Youth's schooling	2004-5
Maternal/paternal health	1982
Smoking during pregnancy	
History of asthma (mother or father)	2004-5
Child health	1982
Birthweight	
Breastfeeding	1983, 1984 and 1986
Outcome	
Socioeconomic	
Youth's employment	2004-5
Youth's schooling	2004-5
Youth's nutrition	
Body mass index	2004-5
Health care	
Number of appointments	2004-5
Type of service	2004-5
Youth's behavior	
Smoking	2004-5
Physical activity	2004-5
Sexual initiation	2004-5
Alcohol and drug intake	2004-5
Maternity/paternity	2004-5
Youth's health	
Wheezing	2004-5
Minor psychiatric disorders	2004-5
Arterial pressure	2004-5
Glycemia	2004-5

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Table 3

Distribution of socioeconomic and demographic variables. Pelotas, Southern Brazil, 1982 to 2004-5.

Variable	Total		Men		Women	
	n	%	n	%	n	%
Subject's skin color (2004-5)	4,296		2,213		2,083	
White	3,238	75.4	1,658	74.9	1,580	75.9
Black or Mixed	908	21.1	471	21.3	437	21.0
Asian or Indigenous	150	3.5	84	3.8	66	3.2
Maternal schooling (years) (1982)	5,907		3,032		2,874	
0 to 4	1,960	33.2	1,008	33.2	952	33.1
5 to 8	2,454	41.5	1,288	42.5	1,166	40.6
9 to 11	654	11.1	330	10.9	324	11.3
≥12	839	14.2	406	13.4	432	15.0
Paternal schooling (years) (1984)	4,682		2,398		2,284	
0 to 4	1,315	28.1	676	28.2	639	28.0
5 to 8	2,069	44.2	1071	44.7	998	43.7
9 to 11	577	12.3	305	12.7	272	11.9
≥12	721	15.4	346	14.4	375	16.4
Family income-1982 (MW)	5,885		3,024		2,770	
≤1	1,288	21.9	666	22.0	622	21.7
1.1 to 3	2,789	47.4	1,463	48.4	1,325	46.3
3.1 to 6	1,091	18.5	544	18.0	547	19.1
6.1 to 10	382	6.5	184	6.1	198	6.9
>10	335	5.7	167	5.5	168	5.9
Change in income (1982 → 2004-5)	4,296		2,213		2,083	
Always poor	708	16.5	335	15.1	373	17.9
Non-poor → poor	714	16.6	340	15.4	374	18.0
Poor → non-poor	665	15.5	360	16.3	305	14.6
Never poor	2,209	51.4	1,178	53.2	1,031	49.5
Total	5,913	100.0	3,037	51.4	2,876	48.6

MW: Monthly minimum wage

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Table 4

Distribution of other variables included in the analyses. Pelotas, Southern Brazil, 1982 to 2004-5.

Variable	Total		Men		Women	
	n	%	n	%	n	%
Birthweight (grams)	5,909		3,035		2,173	
<2500	534	9.0	244	8.0	289	10.1
2500 to 2999	1,393	23.6	625	20.6	768	26.7
3000 to 3499	2,220	37.6	1,131	37.3	1,089	37.9
3500 to 3999	1,417	24.0	806	26.6	611	21.3
≥4000	345	5.8	229	7.5	116	4.0
Breastfeeding (months)	5,332		2,735		2,597	
<1.0	1,171	22.0	636	23.3	535	20.6
1.0 to 2.9	1,405	26.4	709	25.9	696	26.8
3.0 to 5.9	1,212	22.7	611	22.3	601	23.1
6.0 to 8.9	497	9.3	261	9.5	236	9.1
9.0 to 11.9	209	3.9	114	4.2	95	3.7
≥12.0	838	15.7	404	14.8	434	16.7
Maternal smoking during pregnancy (1982)	5,914		3,037		2,876	
Never smoked	3,811	64.4	1,946	64.1	1,864	64.8
1 to 14 cigarettes/day	1,594	27.0	807	26.6	787	27.4
15 or more cigarettes/day	509	8.6	284	9.4	225	7.8
Family history of asthma (2004-5)	4,246		2,183		2,063	
Yes (mother or father)	372	8.8	172	7.9	200	9.7
Youth's schooling (years) (2004-5)	4,296		2,213		2,083	
0 to 4	350	8.1	209	9.4	141	6.8
5 to 8	1,208	28.1	718	32.4	490	23.5
9 to 11	2,069	48.2	1,010	45.6	1,059	50.8
≥12	669	15.6	276	12.5	393	18.9

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Table 5

Years of schooling in relation to family income in 1982 and to change in income during the period. Pelotas, Southern Brazil, 1982 to 2004-5.

Socioeconomic indicator	Years of maternal schooling 1982Mean (standard-deviation)	Years of paternal schooling 1984Mean (standard-deviation)	Years of youth's schooling 2004-5Mean (standard-deviation)
Family income-1982 (MW)			
≤ 1	3.8 (2.5)	4.4 (2.9)	7.5 (3.1)
1.1 to 3	5.5 (3.0)	5.9 (3.2)	9.0 (2.9)
3.1 to 6	8.2 (4.0)	8.1 (3.9)	10.7 (2.4)
6.1 to 10	11.4 (4.0)	11.5 (4.0)	11.8 (2.3)
> 10	13.8 (3.6)	14.4 (4.0)	13.1 (2.2)
Change in income (1982 → 2004-5)			
Always poor	3.2 (2.2)	4.1 (2.6)	6.7 (3.1)
Non-poor → poor	6.3 (3.0)	6.2 (3.4)	8.4 (2.9)
Poor → non-poor	3.7 (2.2)	4.7 (2.7)	8.6 (2.7)
Never poor	8.4 (4.2)	8.3 (4.4)	10.8 (2.5)

MW: Minimum wage