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MORTALITY ESTIMATES  
IN A PARISH OF SANTIAGO  
FROM ORPHANHOOD INFORMATION.  
ÑUÑO A. 1866-1871

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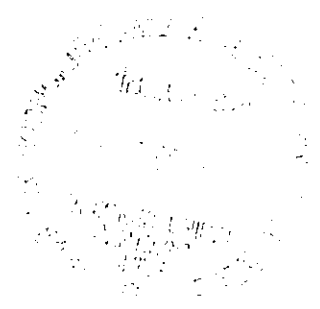
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# CELADE

## CENTRO LATINOAMERICANO DE DEMOGRAFIA

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(We are grateful of the collaboration  
given by Isabel Grau,  
Leonardo Jeffs and Oscar Moya)



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MORTALITY ESTIMATES IN A PARISH  
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Latin American Demographic Centre (CELADE).

## SUMMARY

This research is part of a series of works which look for an adequate methodology in the area of historical demography in Latin America. This study has been performed making use of historical data available in the Parish of Ñuñoa, when this site was a satellite town of Santiago, (1866-1871). It is investigated a peasant group, affected by a strong immigration coming from the whole country. Data were drawn from marriage records, which in this case contain, besides the age of the couple, information on whether the parents of the newly married were dead or alive. The method of Louis Henry (1960) and that of William Brass and Ken Hill (1973), were applied to this information on orphanhood to obtain adult mortality indicators. Results are consistent with mortality estimates for monks within the same period (the first monography of this series), as well as with mortality for european population at the same time. In fact, with information on orphanhood and on monks, values for expectation of life at age 30, are of 31 years for both sexes, in the same order of magnitude as those for european population.

## RESUMEN

Esta investigación forma parte de un conjunto de trabajos cuyo principal objetivo es llegar a establecer una metodología adecuada en el área de demografía histórica para América Latina. Se ha aprovechado la documentación histórica de la parroquia de Ñuñoa para años en que esta comuna era un pueblo satélite de la ciudad de Santiago (1866-1871). Se investiga, de este modo, un grupo campesino que se encuentra bajo el impacto de una fuerte inmigración proveniente de todo el país. Los datos se obtuvieron de los "registros matrimoniales" que en los años indicados contienen, además de la edad de los contrayentes, la referencia de si sus padres estaban vivos o no. Usando los datos de orfandad, se aplicaron, alternativamente, métodos indicados por Louis Henry (1960) y William Brass y Ken Hill (1973) para obtener indicadores de mortalidad adulta. Los resultados encontrados son coherentes con los publicados en esta misma serie sobre mortalidad de los monjes en la misma época y a poblaciones europeas del siglo XIX. Se obtienen valores de esperanzas de vida a los 30 años del orden de los 31 años, para ambos sexos, tanto con la información de orfandad como con la proporcionada por los registros conventuales.

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be supported by a valid receipt or invoice. The text also mentions the need for regular audits to ensure the integrity of the financial data.

In the second section, the author details the various methods used for data collection and analysis. This includes the use of statistical software to process large volumes of information. The document highlights the challenges of data quality and the steps taken to minimize errors.

The final part of the document provides a summary of the findings and offers recommendations for future research. It suggests that further studies should focus on improving data collection techniques and enhancing the accuracy of financial reporting.

The following section describes the implementation of the proposed system. It outlines the key components and the integration process. The document notes that the system was designed to be user-friendly and efficient, allowing for easy adoption by the organization.

The implementation phase involved several key steps, including the selection of hardware and software, the training of staff, and the migration of existing data. The document reports that the system was successfully deployed and has since been used to streamline various business processes.

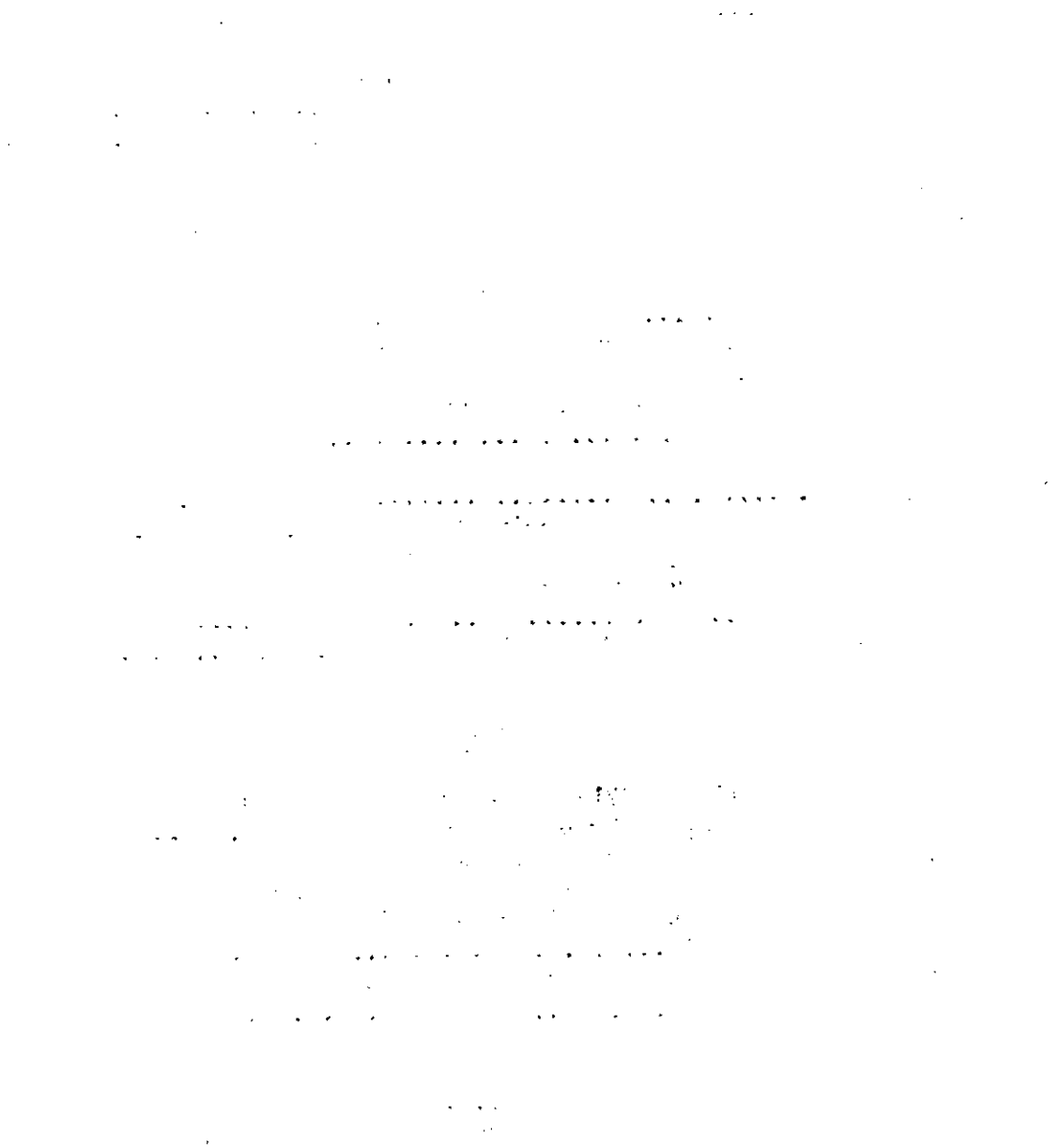
The results of the implementation are discussed in the next section. The data shows a significant improvement in operational efficiency and a reduction in errors. The document concludes that the proposed system is a viable solution for the organization's needs.

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## INTRODUCTION

There are basically two methods which have been developed in demography to derive estimates on adult mortality from information on orphanhood, classified by age of the population investigated. The first was proposed by Louis Henry,<sup>1/</sup> the second, developed by William Brass, was presented, in its most recent version, in a paper by W. Brass and K. Hill.<sup>2/</sup>

The two procedures differ greatly. Henry's method, apart from being the first, is specially attractive to us since it was developed having in mind its application to data drawn from marriage records in studies of historical demography. It estimates approximately the general level of adult mortality by selecting from a set of model mortality tables, the one that lies most closely to the observed values, which are previously transformed into a life table function. Once the model life table has been selected the functions by age of the said table are adopted if required.

The second procedure was developed aiming at making estimates on mortality of current populations in developing countries for which orphanhood information is collected in a survey. In contrast to the former method, this one estimates the functions of the life table for given age intervals, since it is assumed that in addition to information on orphanhood other data are available, which permit the estimates of mortality for other age intervals. The main result, therefore, is a set of life tables survivorship probabilities for selected age intervals from which it is possible, of course, to derive an estimate of general mortality expressed in a synthetic index.

In this paper we will consider successively:

- a) the available data on orphanhood obtained from the marriage records of the parish of Ñuñoa between the years 1869-1871,
- b) the results obtained by applying the Henry's method,
- c) the results derived by using the procedure developed by Brass,
- d) a comparison of the results of the two methods, and
- e) the conclusions that can be drawn from the study.

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<sup>1/</sup> Henry, Louis, "Mesure Indirecte de la Mortalité des adultes", in Population, year XV, June-July 1960, N°3.

<sup>2/</sup> Brass, W., and Hill, K., Estimating Adult Mortality from Orphanhood, International Union for the Scientific Study of Population, International Population Conference, Liege, 1973.

In a methodological appendix three points are examined:

- a) the hypotheses that have been adopted, on the mean and variance of the parents' age distribution, in order to apply the methods,
- b) a brief description and application of Henry's method to the data collected, and
- c) the consideration and application of the procedure proposed by Brass-Hill.

## I. HISTORICAL BACKGROUND

1. The town of Nuñoa

Nuñoa is presently one of the core boroughs comprising Greater Santiago. It did not, however, obtain this status until 1891. Official documents of the past century speak of "the town of Nuñoa", and in 1895, it received the title of "villa". An evergreater migration toward the capital, along with a natural increase in the population, caused in these years, urban expansion to include what had been peripheral population clusters for two centuries. Nuñoa was one of the first to be reached, although its extensive limits were narrowed by the creation of the new boroughs (comunas) of San Miguel (1896) and Providencia (1897). By the year 1933 when Jorge M. McBride was making his observations on the Chilean hacienda he referred to Nuñoa as "suburban neighborhood" and a "small suburban city".<sup>3/</sup>

In 1541 when the Spanish reached the Mapocho River Valley, they decided to found there the center of their power, of administration, and of government for the new Kingdom. In agreement with custom and legislation, the conquistadores chose a site with exceptional characteristics: an abundant Indian population; level fields of high agricultural yield, irrigated by a system of stone channels that the Indians had extended in all directions to make use of the waters of the Mapocho River; the climate and prevailing winds appeared to assure the healthiness of the place.

To the east and southeast of Santiago existed at least five Indian villages -Vitacura, Apoquindo, Nuñoa, Tobalaba, Macul- each subject to a different cacique. The zone was inhabited by different ethnical groups, known traditionally as Picunches, heavily influenced by Aconcagua-Salmón and Inca cultures. In effect, the Inca Pachacuti initiates in 1463 the expansion of the Inca empire north and south, a policy continued by his son Topa Inca Yupanqui in 1471, and which ended in the case of Chile with the incorporation of the territory to the River Maule. This part of Chile was brought into the southern division of the Empire of the Four Parts (Tawantinsuyo), that division known as Coyasuyo.<sup>4/</sup> A good part of the infrastructure of roads, fortresses, cultivated land, and irrigation canals which induced the Spanish to found their capital in the Mapocho valley, derived directly from the invasion and Inca cultural influences.

<sup>3/</sup> McBride, Jorge M., Chile: su Tierra y su Gente, Universidad de Chile, 1939. León Echaiz, René, Nuñoa, Editorial Francisco de Aguirre, Buenos Aires, Santiago, 1972.

<sup>4/</sup> Berdischewsky, Bernardo, "Culturas Precolombinas en la Costa Central de Chile", in Antropología, I, Universidad de Chile, 1963.  
Latcham, Ricardo, Alfarería indígena de Chile, Santiago, 1928.  
Stehberg L., Rubén, Diccionario de Sitios Arqueológicos de Chile Central, Santiago, 1975.

The town of Macul -near Nuñoa- appears to be constructed by Peruvian Indians transplanted as colonos and warriors (mitimaes). 5/

## 2. The function of a satellite town

Immediately after the founding of Santiago, the Indians were given as indios encomendados to the most distinguished conquerors who stayed on as vecinos of the city. Unoccupied lands, declared "vacants" were also given out by the Cabildo in the form of chacras or estancias to those showing interest in cultivating them or for raising animals. 6/

In this manner, before the city was a hundred years old, all of the valley and its adjacent lands, especially to the east of the urban area, had been totally transformed. Although the precolumbian irrigation system remained in use, the indigenous population had practically disappeared, especially from the towns of Nuñoa and Vitacura. Some of these inhabitants had died from epidemics. Others were shifted to the city of Santiago or to outlying estancias. Their wives and the daughters of the caciques had married mestizos, or criollos or poor Spaniards. Their lands had been usurped or rented to non-Indians or passed by inheritance to mestizos and Spaniards. In place of the old Indian community structure, these towns had been transformed into communities of mestizos, dominated by small landowners and artisans. 7/

The eastern sector of Nuñoa was eminently agricultural and artisanal. Lands devoted to livestock were few and generally located in deep Andean valleys. On the other hand, mixed holdings, with crops and potatoes, wheat, barley, grapes and fruit, were the most common. These, dedicated to the export trade, and the truckfarms (chacras) which supplied the city, were interspersed with wineries, mills and tanneries. Along the narrow lanes that formed this suburban complex, abounded workshops in carpentry, leather, hardware and blacksmithing. In other areas they made roof-tiles, adobe, bricks and pipes. Nuñoa was the center of this manufacturing and artisanal activity. From the economic point of view, its functions were clear: supply construction materials to Santiago and manufactured goods to the estancias of high and sophisticated agricultural production. Furthermore, important commerce passed through there on the way to Santiago, explaining the great number of muleters, blacksmiths and leather workers that lived in Nuñoa. 8/ In effect, the "camino de Nuñoa", part of which is today the Avenue Irarrázaval, besides connecting with Santiago, was the junction of routes toward the south, Andean valleys, and across the Andes by way of Los Piuquenes Pass.

5/ Medina, José Toribio, Los aborígenes de Chile, Santiago, 1952.

Guevara, Tomás, Historia de Chile. Chile Prehispano, Tomo I, Santiago, 1929.

6/ Thayer Ojeda, Tomás, Santiago Durante el Siglo XVI, Santiago de Chile, 1905.  
Vicuña Mackenna, Benjamín, Historia Crítica y Social de la Ciudad de Santiago desde su Fundación hasta Nuestros Días (1541-1868), Valparaíso, 1869, 2 vols.

León Echaiz, René, op. cit.

7/ Vicuña Mackenna, Benjamín, op. cit.

León Echaiz, René, op. cit.

8/ Ibidem.

### 3. Nuñoa, town of In-migrants

When Nuñoa began to play a role as satellite of the capital, it no longer had, as we have said, an indigenous population. When the encomendero of Macul, for instance, needed Indians in 1708, he had to get them from the frontier and other outlying regions. And religious orders which had haciendas in Nuñoa did not work them with local labor, but with Negro slaves imported at high cost from Córdoba and Buenos Aires.

At the beginning of the past century, the inhabitants of Nuñoa of the estancias, chacras, and workshops that comprised the area were in their majority mestizos (white and colored). There were a few Negroes and non-local Indians and a considerable number of criollos and Spaniards. The parents and grandparents of the inhabitants had not been, in general, born there. They had migrated from other provinces of the country. During the nineteenth century the immigratory current affecting Nuñoa grew incessantly, and this as a consequence of the dense rural population of the Central Valley which made its effects felt on Santiago and nearby towns towards 1840. It is clear that the peasants wanted to reach Santiago. They did not go directly but stayed a time (sometimes permanently) in the towns and lanes that surrounded the city. In 1846 the Intendant of Santiago wrote in his annual report: "The attraction that the Capital exercises on all points of the Republic is a peculiarity of this Department... that in this area comes to loiter an immense superabundance of population". To alleviate the effect of this avalanche of migrants, authorities proposed, among other things, the creation of satellite towns, with the concrete result being the founding of Buin that same year.<sup>9/</sup>

Finally, of the marriages dealt with in this investigation, for the years 1869 to 1871, we have been able to establish that 62 percent of those contracting marriages were immigrants.<sup>10/</sup> We are able to say, in summary, that our study refers to a rural population composed in great part of immigrants.

### 4. Parish Registers

Society at the time of the Conquest attributed much importance to the social control of the conquered peoples. This signified not only the teaching and practice of the Catholic religion but also the rigorous fulfillment of the sacramental acts which marked the most important moments in the life of each person. Baptisms, marriages and deaths were registered with care from the founding of the colony. Thus as complying with the basic precepts of the religion, a register was maintained capable of reflecting the demographic state of the population.

<sup>9/</sup> Archivo Nacional, Memoria de la Intendencia de Santiago, 1846, Archivo de Intendencias, 1846.

<sup>10/</sup> This appears to be an evident fact if we take a look to the origin of marrying couples, and of their parents, in the "Libro de Informaciones Matrimoniales N° 11" of the Parish of Nuñoa.

These activities were relegated to the Church which noted baptisms, marriages and deaths as they took place in registers called ambulantes or volantes (portable registers) and which were later transferred to the sacrariums of the principal churches of each region.

Later and in conformity with new necessities, parish priests and doctrineros from Indian missions opened special registers that were kept in the parishes. In 1573 the Spanish Crown, concerned with a more definitive organization, gave precise instructions to the governaciones and dioceses of Latin America as to the form for maintaining such registers.<sup>11/</sup>

For Nuñoa we know that in 1585 there was a mission priest (cura doctrinero) who surely maintained a portable register since the town had no parish. One was founded definitively in 1662 and its registers begin in 1670.

After the laws of 1573, the faults or omissions present in the registers, above all in births and deaths, are due fundamentally to the carelessness of the parish priest or, naturally, to the lack of religious services in certain populated areas. But, in the case of marriage registers, it was a different matter since the changing economic and social contexts of the marriage act in the distinct and farflung colonies, impeded its attainment to a rigid or uniform standard. A doctrinero marrying an Indian couple in the sixteenth or seventeenth centuries would first have to clarify whether or not the contracting parties met the basic requirements established by church and state: baptism, degree of kinship, no previous marriage, etc.. As a consequence, data of statistical-demographic interest, such as the ages of the couple, of their parents, place of residence, etc., were of negligible importance before the above criteria.

Faced with the complexity and magnitude of the problem, the ecclesiastical authorities took the following measures: 1) They created a complex set of regulations which instructed priests on what to do in the case of the diverse difficulties encountered with marriages. Many of these dispositions were compiled in "manuals" that were given out to pastors.<sup>12/</sup> In the final instance, the choice of effecting the marriage or not was left to the judgment and conscience of the priest when the situation of the contracting parties was unclear from a religious, moral or civil point of view.

<sup>11/</sup>"Ordenanzas e instrucciones reales, relativos a las personas que estaban obligadas a hacer las relaciones que se solicitan, materias sobre las que debían informarse y orden y forma cómo debían ejecutarse, 3 de julio de 1573", in José Torre Revello (editor), Documentos Históricos Relativos a la Conquista y Colonización Rioplatense, Tomo I, Buenos Aires, 1941. The same document has also been published in, Libro del Ilustre Cabildo, Justicia e Regimiento desta Muy Noble y Muy Leal Ciudad de San Francisco de Quito, 1573-1574", edited by Jorge A. Garcés, Publicaciones del Archivo Municipal, Quito, 1934.

<sup>12/</sup> See, for example, de la Peña Montenegro, Alonso, Itinerario para Parochos de Indios, en que se Tratan las Materias más Particulares, Tocantes a Ellos, para su Buena Administración, Amberes, 1726.

The ideal of the Spanish Crown was that marriages would take place within closed castes --that whites would marry whites; Indians, Indians; Negroes, Negroes. But the idea proved utopian in the sixteenth century. Nevertheless, ethnic mixtures and the growth of mestizo groups did not appear to constitute a problem as long as they were not very numerous and the colonial administration maintained control on society.

But by the eighteenth century no social control was possible. Colored mestizos, reinforced by ever more and numerous contingents of Negroes, pressured to the breaking point the social conventions which had previously been valid. The white European and white American creole groups felt threatened by a rapidly growing mestizo population. It was then that new segregational measures appeared which, touching our theme, accentuated endogamic pressures on the constitution of marriage and the family.<sup>13/</sup>

The official measures did not delay in making themselves felt, some of which affecting the form and proceedings for marriage, affected the form of registration. The "Pragmatic Sanction to Avoid the Abuse of Contracting Unequal Marriages" was promulgated in the year 1778 and given out to the parents of the engaged in the white under-25 group and served as the racial instruction in relation to the choice of a marriage partner. The "Pragmática" was not valid for the rest of the castes, in such a way that the white sector could impede the entrance into its group of mestizo individuals considered of impure blood or lineage.

If the parents of one of the engaged believed that the marriage of their son or daughter would damage his prestige because one of the couple was of mixed race, he had the complete right to prohibit the marriage. To do this, he instituted before ecclesiastical authorities --from 1805 before civil authorities as well-- that called "juicio de disenso matrimonial". This meant a series of legal steps, including the ages of the couple (through baptismal records), family background, etc. Usually the basic question of the judgement was proof of majority. As age gained in importance, it became necessary to require it and note it a standard manner. By Royal Cedula of 1803, majority for men was fixed at 23 years and for women at 25.<sup>14/</sup>

The marriage registers can be used with confidence only after this date. The parents of the engaged or someone legally empowered had to appear before the parish priest weeks before the ceremony, accompanied by three witnesses, to make declarations. If some impediment to the marriage were encountered, more information would be required, such as certificates of baptism, proof of widowhood, notarized parental permission, etc.

After completing this step (información matrimonial), the intention to contract marriage was published, that is, read aloud at three masses,

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13/ Mellafe, Rolando, Negro Slavery in Latin America, University of California Press, 1975.

14/ This and beforehand disposition in Konetzke, Richard (publisher), Colección de Documentos para la Historia de la Formación Social de Hispanoamérica, 1493-1810, 3 vols., Madrid 1953-1962.

attending to all claims and impediments arising. Then, a marriage act was compiled from data and documents and, finally, in a separate book, were registered, simply, the names of the couple, of the witnesses and the date of the ceremony.

### 5. The Collection of Data

For this study we have used the "Informaciones Matrimoniales" with the characteristics described above. We chose the years 1869 to 1871 because Ñuñoa in these years used a printed form that recorded, among other things, the ages of the couple and whether the parents were living or not. The printed form assured that all data was recorded. Furthermore, we have not found the same preoccupation for the parish register in other parishes of Santiago that we have encountered in Ñuñoa.

We used the "Libro de Matrimonios" N° 7 (5 July 1869 to 31 December 1875) and the "Libro de Informaciones Matrimoniales" N°11 (24 August 1869 to 31 December 1871). The following steps were taken:

1) From the "Libro de Matrimonios" were noted all marriages effected between 25 August 1869 and 1 December 1875, taking the name of the couple, of the parents and godparents, and the date of the ceremony. We began with the "Libro de Matrimonios" and not with the "Informaciones" in order not to take into account the cases where the couple initiated the process but did not marry.

2) With marriages ordered chronologically and by the names of the couple, they were located in the "Libro de Informaciones" for the corresponding certificates. From these were obtained the ages of the couple, whether the parents were living, place of origin, the profession of the engaged, of parents and witnesses. Having recorded profession and place of origin, we could be sure that the group was constituted for the most part of immigrants who were peasants and that we were not dealing with a selective group of the society of the time.

3) Of the total of the couples computed, in 11 cases the age of the fiancé does not appear on the form but there is included a note that he is of majority. These were included in the 20-25 age group. In the same way, 9 cases noted as "minors" are included in the 15-19 age group. In 5 cases where the father was unknown and the son of majority, the father was considered as deceased. Finally, the cases were ordered by five-year age groups, separating those who were orphans distinguishing between those who were fatherless and those who were motherless. (See Table 1).



## II. DEMOGRAPHIC ANALYSIS

1. The Data

In Table 1 data on orphanhood from marriages registered between 1869 and 1871 in the parish of Nuñoa are presented. The mortality of the newly married's parents, which we will attempt to estimate, corresponds to a period naturally preceding these years. The period can be placed approximately in the middle of the nineteenth century.

Table 1

PARISH OF NUÑO A (1869-1871). ORPHANHOOD OF NEWLY MARRIED BY AGE GROUPS.  
PROPORTION NOT ORPHANED

Age of the newly married	Total	With mother alive	With father alive	Proportion not orphaned	
				of mother	of father
15-19	82	75	47	0,915	0,573
20-24	234	193	159	0,825	0,679
25-29	123	67	56	0,545	0,455
30-34	50	24	8	0,480	0,160
35-39	10	4	3	0,400	0,300
40-44	11	2	3	0,182	0,273
45-49	3	-	-	0,000	0,000
Total	513	365	276	0,712	0,538

2. Results obtained through the Henry method

With the method suggested by Henry, two estimates on male mortality and one on female mortality are obtained. The estimates are derived from paternal and maternal orphanhood information, respectively. These estimates, expressed in terms of the expectation of life at birth for both sexes, turn out to be 36,1 and 40,5 years (with a mean value of 38,3 years) for males, and 40,1 years for females.

It can be concluded then, that male mortality was higher than female mortality. This is a well-known fact, universally observed, that has already been documented for a sector of the Chilean population in the eighteenth and nineteenth centuries.<sup>15/</sup>

The model mortality table that lies closest to the average level 38,3 for men, within the tabulated set by the United Nations<sup>16/</sup> is that

<sup>15/</sup> Somoza, Jorge L., Arretx, Carmen, and Mellafe, Rolando, "Estimates of Mortality among Members of Religious Orders in Chile in XVIII and XIX Centuries", Centro Latinoamericano de Demografía, Santiago, Chile, October, 1975.

<sup>16/</sup> Naciones Unidas, Manual III, "Methods for Population Projections by Sex and Age", ST/SOA/Series A, Population Studies, N°25, Nueva York, 1956.

corresponding to an expectation of life at birth of 37,5 years. Therefore, we adopted this value as representative of the life table, for both sexes, associated with the observed values on proportions of paternal orphans.

In the case of women, as stated above, the estimate is 40,1 years, coinciding almost exactly with the model mortality table with 40 years of expectation of life at birth, for both sexes. This is adopted as the estimate of mortality based on maternal orphans. It should be pointed out that that information on maternal orphanhood, as on paternal orphanhood, yields two estimates of mortality level. One of these, however, is considered unreliable as it gives an extremely low estimate of mortality (associated with a value of the expectation of life at birth of 55 years). This results as a consequence of a very low proportion of maternal orphanhood among those aged 15-19 (91,5 percent appear with surviving mother). It has been observed in recent investigations that it is common, among young people, to consider the foster mother as the real one, and, therefore, to appear as not orphaned when actually the natural mother has died. It is possible that this confusion has occurred in the case under consideration and, for this reason, the estimate derived from that particular age group unreliable.

In Table 2 estimates obtained from the method of Henry are presented. They are life table functions for selected age intervals that will be compared, below, with estimates derived from the other method.

Table 2

SELECTED VALUES OF LIFE TABLE ESTIMATES ACCORDING TO THE METHOD OF HENRY  
(CORRESPONDING TO TWO UNITED NATIONS MODEL LIFE TABLES)  
AND CALCULATED ACCORDING TO THE PROCEDURE OF BRASS-HILL

Age	Men				Women			
	Expectation of life		Probability of dying within ten years		Expectation of life		Probability of dying within ten years	
	$e_x$		$1000 \cdot q_x$	$10^q x$	$e_x$		$1000 \cdot q_x$	$10^q x$
	Henry	Brass-Hill	Henry	Brass-Hill	Henry	Brass-Hill	Henry	Brass-Hill
30	30.0	29.7	121.7	116.8	32.7	31.7	113.0	103.5
40	23.5	23.0	175.5	167.8	26.2	24.7	137.4	146.0
50	17.4	16.5	272.9	282.0	19.6	18.1	107.5	243.2
60	12.0	11.0	443.5	491.3	13.4	12.2	371.6	431.0

### 3. Results obtained through the Brass-Hill method

The results obtained by applying the procedure developed by Brass-Hill also appear in Table 2. As before, the maternal orphanhood information of those aged 15-19 is not taken into account.

#### 4. Comparison of the results of the two methods

The information in Table 2 facilitates the comparison of the results obtained by the two methods.

Two functions of the life table, with different meaning, are compared: the expectation of life at selected ages, which is a general indicator of the mortality level from a given age (in the table values for ages 30 and 60 are presented in ten year intervals), and the probability of dying in a ten-year interval, which is, a specific indicator of mortality.

The comparisons should be limited to contrasting the values of the expectations of life and only for relatively young ages, say 30 years. It should be remembered that Henry's method aims only at determining the general mortality level and not at deriving mortality by age groups. Nevertheless, we extend the comparison to values of the expectation of life at various ages and to the probability of dying by decennial age groups just, to illustrate the uncertainty in the estimation of this functions.

In Graph 1, estimates on expectation of life are presented in natural scale, while in Graph 2 the probabilities of dying are shown in a semilogarithmic scale.

Having in mind the limitations stated above it is possible to conclude that both methods yield basically similar results: the expectation of life at age 30 can be set at 30 years for men and 32 for women. There are also quite acceptable similarities, specially for men, in the expectation of life at other ages.

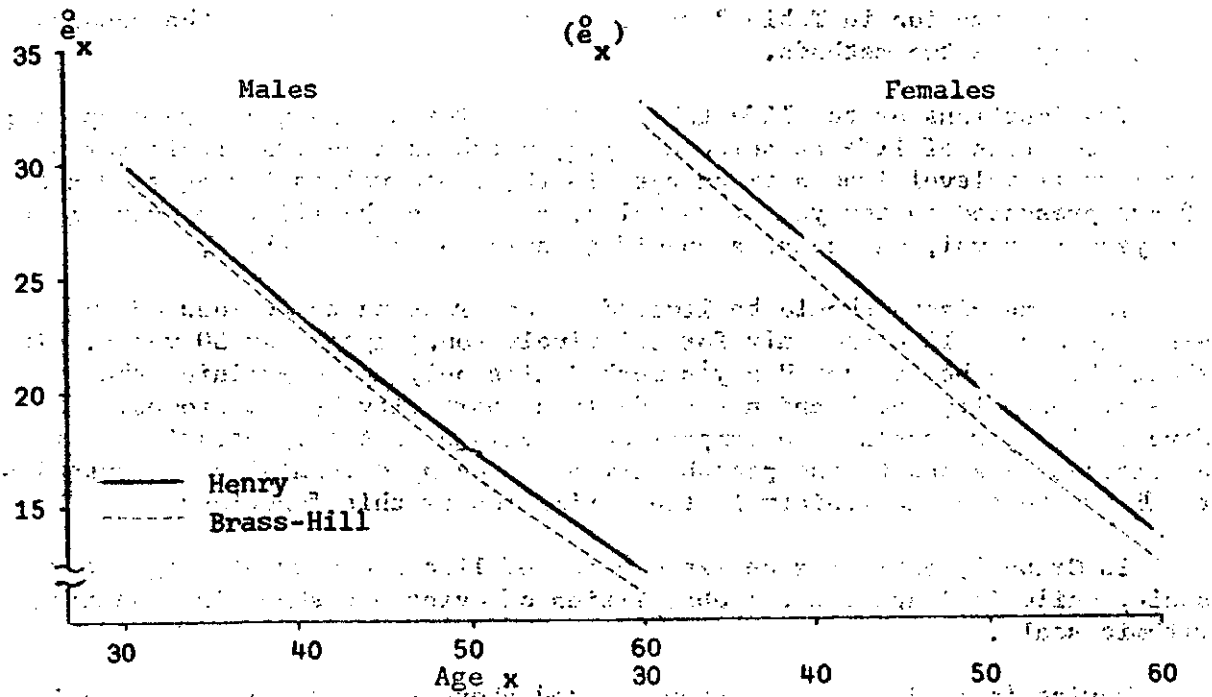
The comparison between the estimated probabilities of dying is much more exacting and reveals greater differences between the two series: those derived by the method of Brass-Hill show, in general, higher mortality, particularly in the case of women, than those drawn from the model life tables selected with the criteria given by Henry. Since they are based more closely on observed information than those derived from Henry's procedure, the results from Brass-Hill method should reflect more exactly the actual situation. Nevertheless, it cannot be said that they are of better quality. The two sets of estimates are supported by scarce observed data, affected by random errors, and, furthermore, in applying the two methods it has been necessary to make hypotheses (mean age of the parents and, in the case of the Henry's method, variance of age distribution of the parents) which are conjectural values.

#### 5. Conclusions

Data gathered from marriage records of the parish of Nuñoa, between 1859 and 1871, on newly married orphanhood, has permitted to derive estimates on adult mortality by sex which correspond to mid nineteenth century. The data collected seem to be consistent and have only one defect which is often found in modern-day data of this type: the incidence of maternal orphanhood in the youngest group considered, -people aged 15-19-, is apparently underestimated.

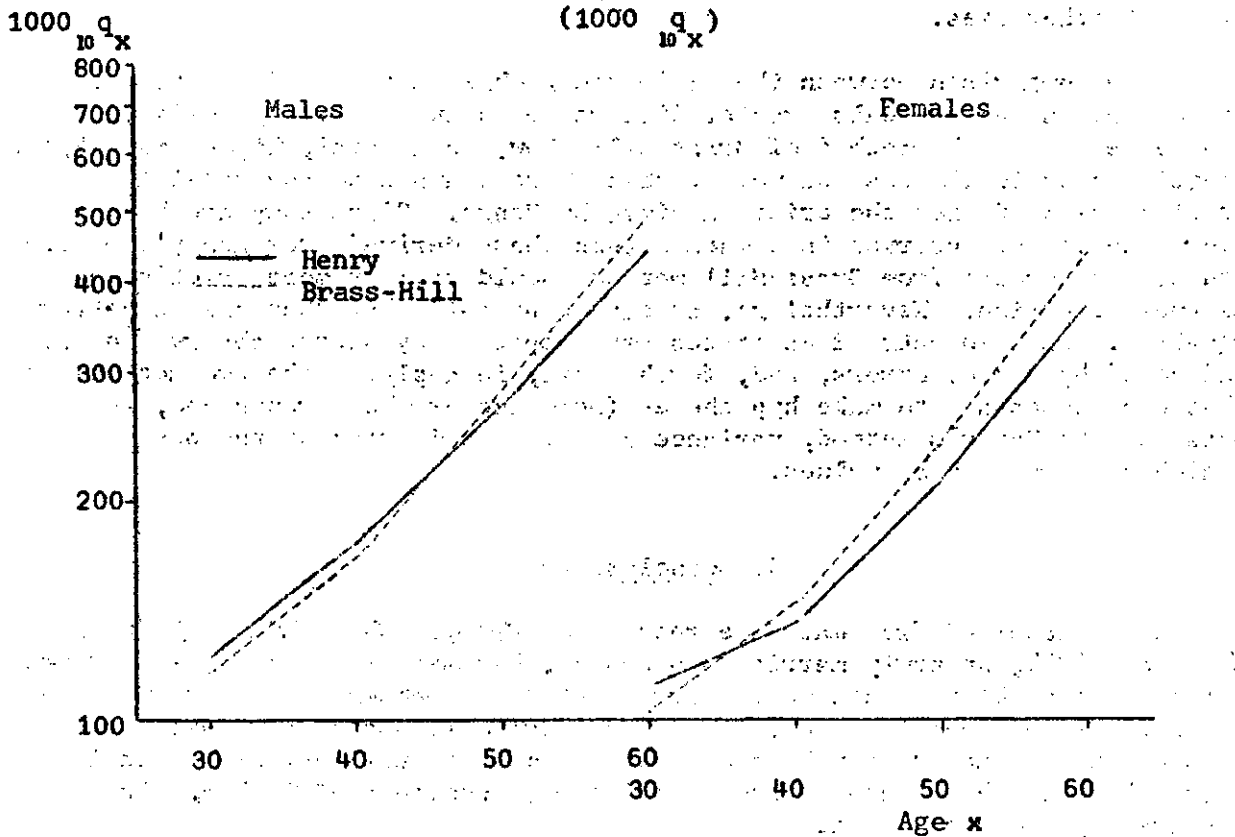
Graph 1

EXPECTATION OF LIFE AT AGE X



Graph 2

PROBABILITY OF DYING WITHIN 10 YEARS



Source: Table 2.

The above statement on the good quality of the data is based upon the plausible estimates which are derived showing that male mortality is higher than female's and placing the level of mortality in the expected order of magnitude.

In addition, independent confirmation on reliability of the estimates obtained here, is the fact that they are of approximately the same order of magnitude as those derived for a longer period, but also including part of the nineteenth century. In a recent publication <sup>17/</sup> the mortality among members of religious orders in Santiago between approximately 1757 and 1867 was estimated. These estimates, by sex, are presented in Table 3, together with the values of expectation of life drawn from European life tables in the nineteenth century and the values estimated in this paper based on the information on orphanhood.

The figures in the table show that the mortality of the group studied here was very similar to that registered in other populations in the same period; It is interesting to find that, although the group of religious members previously studied was probably not representative of the total population of Chile, both groups present similarity in their mortality level.

Table 3

## EXPECTATION OF LIFE AT AGES 30, 40, 50 AND 60 IN SELECTED LIFE TABLES

Life table	Expectation of life at age:			
	30	40	50	60
Orphans: Ñuñoa (1869-1871)	<u>Men</u>			
- Method of Henry	30.0	23.5	17.4	12.0
- Method of Brass-Hill	29.7	23.0	16.5	11.0
Members of Chilean religious orders (1757-1867)	29.0	21.9	16.1	11.6
Sweden (1816-1840)	30.3	23.7	17.6	12.1
Netherlands (1816-1825)	27.6	21.9	16.4	11.6
England and Wales (1841)	33.1	23.5	17.5	12.0
Orphans: Ñuñoa (1869-1871)	<u>Women</u>			
- Method of Henry	32.7	26.2	19.6	13.4
- Method of Brass-Hill	31.7	24.7	18.1	12.2
Members of Chilean religious orders (1757-1867)	32.3	25.7	19.7	14.6
Sweden (1816-1840)	33.4	25.4	19.6	13.2
Netherlands (1816-1825)	30.7	24.8	18.7	12.8
England and Wales (1841)	34.3	27.7	21.1	14.4

<sup>17/</sup> Arretx, Carmen, Mellafe, Rolando, Somoza, Jorge L., op. cit.

## APPENDIX

1. Necessary hypotheses to apply the methods

The application of the procedures developed by Henry and Brass-Hill to derive mortality estimates from data on orphanhood according to age of the population investigated, requires one or two demographic indices that are unknown in the population studied here: the mean age of the parents and the variance of the age distribution of the parents. It was necessary, therefore, to adopt working hypotheses considering different sources: stable population models, estimates derived for another Latin American country,<sup>1/</sup> and data on Chile from different periods of the twentieth century:

The following hypotheses were finally adopted:

Table 1

HYPOTHESES ADOPTED ON THE MEAN AND THE VARIANCE OF  
THE AGE DISTRIBUTION OF PARENTS

Sex	Mean (M)	Variance ( $\sigma^2$ )
Male	35	70
Female	27.5	50

These estimates are not very reliable. Fortunately, the results obtained from the two methods do not depend too much on the accuracy of the estimates of the mean and the variance of the age distribution of the parents.

If new information becomes available in the future, permitting to improve the estimation of the mean and the variance of the age distribution of parents, it will be possible to recalculate the estimation of mortality. However, it is not likely that the present results will be significantly modified with such calculation.

2. The procedure proposed by Louis Henry

Let  $c(x)$  represent the age distribution of parents at the time their children are born. If a child is presently exact age  $a$ , and if we suppose that his parents do not experience a different mortality than that of the total population, i.e., that the same life table survivorship probability from age  $x$  to  $x+a$  is applicable to them, then the probability of a person with exact age  $a$ , of having a parent alive that will be designated, following Henry,  $\bar{S}_a$  is equal to

<sup>1/</sup> Somoza, Jorge L., "Fertility Level and Differentials in Argentina in the Nineteenth Century", Population Section, Milbank Memorial Fund., Conference N° 3.

$$\bar{S}_a = \int_u^v c(x) \cdot \frac{l_{x+a}}{l_x} \cdot dx \quad (1)$$

where  $u$  and  $v$  are, the earliest, and latest ages, respectively, of the reproductive period.

If we accept, what seems reasonable given the age groups under consideration, that the probability  $l_{x+a}/l_x$  can be expressed by a second degree polynomial in  $x$ , that is to say:

$$\frac{l_{x+a}}{l_x} = S_0 - \alpha x - \beta x^2 \quad (2)$$

where  $S_0$ ,  $\alpha$  and  $\beta$  are constant, we have:

$$\bar{S}_a = S_a(\bar{x}) - \beta \sigma^2 \quad (3)$$

where  $\bar{x}$  is the parents mean age and  $\sigma^2$  is the variance of this age distribution.

$$\text{Mean age} \quad \bar{x} = \int_u^v c(x) \cdot x \cdot dx \quad (4)$$

$$\text{Variance} \quad \sigma^2 = \int_u^v (x-\bar{x})^2 \cdot c(x) \cdot dx = \int_u^v x^2 \cdot c(x) \cdot dx - \bar{x}^2 \quad (5)$$

Using the United Nations model life tables, by sex, with levels of expectation of life at birth between 20 and 50 years (both sexes) Henry has calculated the value of the parameter  $\beta$ , defining the second degree polynomials which reproduce, in each life table, the values of  $l_{x+a}/l_x$  for  $x = 25, 35$  and  $45$  for males, and  $x = 20, 30$  and  $40$  for females. He made the computation for three values of  $a$ : 15, 20 and 25 years.

Following Lotka,<sup>2/</sup> Henry considers that the parents mortality does not conform exactly to the above assumption. Males are exposed to the risk of dying from conception to the birth of their children, females immediately after giving birth to a child are exposed to a higher mortality than that shown in life tables (especially in populations with a high mortality level). As a result, he proposes an adjustment of about one percent, in order to take into account these additional risks. If we represent with  $P(a)$  the probability of a person, with exact age  $a$ , of having a surviving parent, then its value, as a function of the relations examined above, is given by:

$$P(a) = 0.99 \cdot \bar{S}_a \quad (6)$$

The empirical values, the observed proportions having a parent alive, are given by quinquennial age groups. We will represent with  ${}_5P_a$  the proportion in the age group  $a$  and  $a+5$ , having a parent alive. Henry proposes to estimate the value of  $P(a)$ , the observed proportion of persons with exact age  $a$  having a surviving parent, by means of the relation:

<sup>2/</sup> Lotka, Alfred J., "Teoría analítica de las asociaciones biológicas", Centro Latinoamericano de Demografía, Santiago de Chile, 1969.

$$P(a) = 1/2 ({}_5P_{a-5} + {}_5P_a) \quad (7)$$

This is the main observed data which are used to derive a function of the life table, that is, the probability of a person at the exact age  $\bar{x}$ , of surviving to the exact age  $\bar{x}+a$ , which Henry expresses as  $S_a(\bar{x})$ .

According to the above, we can write:

$$\bar{S}_a = P(a)/0.99 = S_a(\bar{x}) - \beta\sigma^2 \quad (8)$$

$$\therefore S_a(\bar{x}) = P(a)/0.99 + \beta\sigma^2 \quad (9)$$

In this expression we know or have estimated:  $P(a)$ , the observed data,  $\bar{x}$ , the mean, and  $\sigma^2$ , the variance, of the age distribution of parents. The only unknown element is the parameter  $\beta$ . To estimate this, Henry proposes the approximate expression:

$$S_a(\bar{x}) = P(a)/0.99 \text{ approximately} \quad (10)$$

which permits an approximate value of  $S_a(\bar{x})$  to be derived and, with it, to look for the corresponding value of  $\beta$  in the model life tables of the United Nations. Once  $\beta$  is known, it is possible to apply the relation (9) and thus determine the value of  $S_a(\bar{x})$ . Henry takes as the estimate of the adult mortality level the model life table corresponding to that given value of  $S_a(\bar{x})$ . This level is normally determined by interpolation between the values tabulated by Henry, mentioned above.

### 3. Application of the procedure of Henry to the data of Nuñoa

<u>Male</u>						
Mean age (fathers) ( $\bar{x}$ )				35		
Variance ( $\sigma^2$ )				70		
Exact age (a)		20			25	
Proportion not orphaned (per 1000)	${}_5P_{a-5}$	573			679	
Proportion not orphaned (per 1000)	${}_5P_a$	679			455	
Proportion not orphaned (per 1000)	$P(a)$	626			567	
Probability of surviving (per 1000)		632			573	
	$S_a = P(a)/0.99$					
	$S_{20}(35)$	Level	$\beta$	$S_{25}(35)$	Level	$\beta$
	(per 1000)			(per 1000)		
Model table	569	30	0.220	524	35	0.300
Model table	639	35	0.295	593	40	0.395
$S_a = S_a(35)$ approximately	632	34.5	0.287	573	38.6	0.367
$\beta\sigma^2$		20			26	
	$S_{20}(35)$	Level		$S_{25}(35)$	Level	
	(per 1000)			(per 1000)		
Model table	639	35		593	40	
Model table	699	40		653	45	
$S_a(35)$	652	36.1		599	40.5	



Female

Mean age (mothers) ( $\bar{x}$ )				27.5		
Variance ( $\sigma^2$ )				50		
Exact age (a)		20			25	
Proportion non-orphaned (per 1000) ${}_5P_{a-5}$		915			825	
Proportion non-orphaned (per 1000) ${}_5P_a$		825			545	
Proportion non-orphaned (per 1000) ${}_5P_a$		870			685	
Survivorship probabilities (per 1000) $\bar{S}_a = P(a)/0.99$		879			692	
	$S_{20}(27.5)$ (per 1000)	Level	$\beta$	$S_{25}(27.5)$ (per 1000)	Level	$\beta$
Model table	859	50	0.225	647	35	0.320
Model table	890	55	0.210	708	40	0.350
$\bar{S}_a = S_a(27.5)$ approximately	879	53.2	0.215	692	38.7	0.342
$\beta\sigma^2$		11			17	
	$S_{20}(27.5)$ (per 1000)	Level		$S_{25}(27.5)$ (per 1000)	Level	
Model table	890	55		708	40	
Model table				764	45	
$S_a(27.5)$	890	55		709	40.1	

4. The procedure proposed by William Brass

The method developed by William Brass and set forth in a paper with Hill's cooperation, consists in estimating life table survivorship probabilities for some age intervals from orphanhood information of adjacent age groups.

More precisely, if  ${}_5P_{N-5}$  and  ${}_5P_N$  represent the proportion of people aged between  $N-5$  and  $N$ , and between  $N$  and  $N+5$ , respectively, whose mothers are alive at the time of the survey, the female probability of surviving from age 25 to age  $25+N$ ,  $\frac{l(25+N)}{l(25)}$  is:

$$\frac{l(25+N)}{l(25)} = W(N) {}_5P_{N-5} + (1-W(N)) {}_5P_N \quad (1)$$

where  $W(N)$  is a weighing factor derived (and tabulated) by Brass and Hill according to certain assumptions which depend on the mean age of the mothers ( $M$ , in the notation of Brass). Knowing the mean age of the mother and the values of  ${}_5P_N$  for two adjacent quinquennial age groups, the calculation of  $l(25+N)/l(25)$  follows straight forward. The values thus obtained, one for each adjacent pair of quinquennial age groups, normally should be adjusted to eliminate random deviations.

A similar procedure is employed in the case of male population (paternal orphanhood) duly taking into account that the exposure to the risk of dying of a man is the period between conception and birth of his child. As the mean age of the father can vary much more than that of the mother, two alternative values for the mean age are considered (32.5 and 37.5 years)

instead of only one, as was done when dealing with the female population (25 years). The mean age of fathers is represented by letter B. The formula for estimating male survivorship takes the form:

$$\frac{l(B+N+2.5)}{l(B)} = W(N) {}_5P_{N-5} + (1-W(N)) {}_5P_N \quad (2)$$

in which the meaning of each symbol should be clear, since the expression is basically similar to (1) examined above.

DERIVATION OF A TABLE BASED ON PATERNAL ORPHANHOOD INFORMATION.  
BRASS-HILL PROCEDURE

First part: Computation of the survival probability

- Fathers mean age  $M=35$
- Base age .....  $B=32.5$

Age groups $i$	Proportion not orphaned $P_i$	Central age $N$	Weighting factors $W(N)$	Probability $1(32.5+N)/(32.5)$
15-19	0.573	20	0.861	0.588
20-24	0.679	25	0.877	0.651
25-29	0.455	30	0.779	0.390
30-34	0.160	-	-	-

Second part: Computation of the life table parameters. Adjustment of the survival probabilities

- Standard life table: Brass general Standard Life Table  $a/$
- Value of the probability of surviving from 0 to age 32,5  $1s(32,5)=0,6376$
- Logit of this value  $Ys(32,5)=0,2824$

Age $x$	"Observed" Values $l(x)$	"Standard" Values $Y(x)$	"Standard" Parameter $Ys(x)$	Parameter $B(x)$	$l(x)$ Adjusted	$l(x)/l(32.5)$ "Observed" Adjusted
32,5	0.6826	-0.3829	-0.2824	-	0.6376	-
55	0.6171	-0.2386	0.0832	1.47	0.4189	0.588
60	0.5563	-0.0212	0.2100	0.92	0.3460	0.651
65	0.3727	0.0832	0.3746	1.27	0.2615	0.390

Average of the values of  $B(x)$   $B = 1.22$

Supposing  $1s(32.5)=1(32.5)$  results  $A = 0.0621$

Third part: Resulting life table

Expressed in logit scale:  $Y(x) = 0.0621 + 1.22 Ys(x)$

Age $x$	$Ys(x)$	$Y(x)$	$l(x)$	${}_5L_x$	$T(x)$	${}_0e_x$
30	-0.3150	-0.3222	0.6557	3,1865	19.4755	29.70
35	-0.2496	-0.2424	0.6189	2.9950	16.2890	26.32
40	-0.1817	-0.1596	0.5791	2.7835	13.2940	22.96
45	-0.1073	-0.0688	0.5343	2.5405	10.5105	19.67
50	-0.0212	0.0362	0.4819	2.2520	7.9700	16.54
55	0.0832	0.1636	0.4189	1.9122	5.7180	13.65
60	0.2100	0.3183	0.3460	1.5187	3.8058	11.00
65	0.3746	0.5191	0.2615	1.0937	2.2871	8.75
70	0.5818	0.7719	0.1760	0.6805	1.1934	6.78

$a/$  Brass, William, Métodos para estimar la fecundidad y la mortalidad en poblaciones con datos limitados, (Selección de trabajos), CELADE, Series E, N°14, Santiago, Chile, 1974.

DERIVATION OF A LIFE TABLE BASED ON MATERNAL ORPHANHOOD INFORMATION.  
BRASS-HILL PROCEDURE

First part: Computation of the survival probability

- Mothers mean age  $M=27.5$

Age groups $i$	Proportion not orphaned $P_i$	Central age $N$	Weighting factors $W(N)$	Probability $l(25+N)/l(25)$
15-19	0.915	20	0.880	0.904
20-24	0.825	25	0.964	0.815
25-29	0.545	30	1.018	0.546
30-34	0.480	-	-	-

Second part: Computation of the life table parameters. Adjustment of the survival probabilities.

- "Standard" life table: Brass general Standard Life Table  $a/$
- Value of the probability of surviving from 0 to age 25  $l_s(25) = 0.6826$
- Logit of this value  $Y_s(25) = 0.3829$

Age $x$	"Observed" Values		"Standard" Parameter	$l(x)$	$l(x)/l(25)$		
	$l(x)$	$Y(x)$	$Y_s(x)$	Adjusted	"Observed"	Adjusted	
25	0.6376	-0.2824	-0.3829	0.6826	-	-	
45	0.3749	0.2556	-0.1073	0.52	0.904	0.797	
50	0.4151	0.1715	-0.0212	0.75	0.815	0.729	
55	0.2487	0.5528	0.0832	1.38	0.546	0.648	

Average of the last two values of  $B(x) = 1.07$

Supposing  $l_s(25) = l(25)$  results  $A = 0.0268$

Third part: Resulting life table

Expressed in logit scale:  $Y(x) = 0.0268 + 1.07 Y_s(x)$

Age $x$	$Y_s(x)$	$Y(x)$	$l(x) =$	$5L_x$	$T(x)$	$^o e_x$
25	-0.3829	-0.3829	0.6826	3.3323	23.9174	35.04
30	-0.3150	-0.3102	0.6503	3.1705	20.5851	31.65
35	-0.2496	-0.2403	0.6179	3.0022	17.4146	28.18
40	-0.1817	-0.1676	0.5830	2.8172	14.4124	24.72
45	-0.1073	-0.0880	0.5439	2.6045	11.5952	21.32
50	-0.0212	0.0041	0.4979	2.3505	8.9907	18.06
55	0.0832	0.1158	0.4423	2.0478	6.6402	15.01
60	0.2100	0.2515	0.3768	1.6878	4.5924	12.19
65	0.3746	0.4276	0.2983	1.2817	2.9046	9.74
70	0.5818	0.6493	0.2144	0.8585	1.6229	7.57

$a/$  Brass, William, Métodos para estimar..., op.cit.

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Arrex, Carmen.  
Mortality estimates in a  
Parish of Santiago form  
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Ñuoca, 1866-1871

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