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# Biological Anthropology of Latin America Historical Development and Recent Advances

*Edited by*  
*Douglas H. Ubelaker and Sonia E. Colantonio*

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WASHINGTON, D.C.

2019

## ABSTRACT

Ubelaker, Douglas H., and Sonia E. Colantonio, editors. *Biological Anthropology of Latin America: Historical Development and Recent Advances*. *Smithsonian Contributions to Anthropology*, number 51, xiv + 385 pages, 24 figures, 67 tables, 2019. — Despite significant positive developments within topics of biological anthropology, archaeology, and related academic areas in Latin America, we noted a lack of coordination and communication among them. Available publications provide syntheses within different areas of biological anthropology, yet few have attempted integration of the distinct subfields. We decided to address the development and current issues of most major areas of Latin American biological anthropology in a single volume with chapters by distinguished, experienced scholars who live and work in Latin America, are knowledgeable about the topics, have published extensively on them, and who were recommended by specialists within six geographical regions of interest: Brazil and northeastern South America, Mexico, Central America, the Caribbean, northwestern South America, and southern South America. Six subdisciplines within biological anthropology were defined for academic coverage: (1) biodemography and epidemiology; (2) bioarchaeology and skeletal biology; (3) paleopathology; (4) forensic anthropology; (5) population genetics; and (6) growth, development, health, and nutrition. Though these six subdisciplines overlap to an extent, each offers a distinct history of development and presents unique issues to address. Chapters generally cover topics of history, the state of knowledge, methodological perspective, and areas in need of additional research. Although the text is in English, abstracts in English, Spanish, and Portuguese are included.

Cover image: Houses in the Caxiunã National Forest. Courtesy Hilton Silva.

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Published by SMITHSONIAN INSTITUTION SCHOLARLY PRESS  
P.O. Box 37012, MRC 957, Washington, D.C. 20013-7012  
<https://scholarlypress.si.edu>

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### Library of Congress Cataloging-in-Publication Data

Names: Ubelaker, Douglas H., editor. | Colantonio, Sonia, editor. | Smithsonian Institution Scholarly Press, publisher.

Title: *Biological anthropology of Latin America : historical development and recent advances* / edited by Douglas H.

Ubelaker and Sonia E. Colantonio.

Other titles: *Smithsonian contributions to anthropology* ; no. 51. 0081-0223

Description: Washington, D.C. : Smithsonian Institution Scholarly Press, 2018. | Series: *Smithsonian contributions to anthropology*, ISSN 0081-0223 ; number 51 | Includes bibliographical references and index. | Compilation copyright 2018 Smithsonian Institution

Identifiers: LCCN 2018003446

Subjects: LCSH: Physical anthropology—Latin America. | Epidemiology—Latin America. | Human remains (Archaeology)—Latin America. | Paleopathology—Latin America. | Forensic anthropology—Latin America. | Population genetics—Latin America. | Nutritional anthropology—Latin America.

Classification: LCC GN50.45.L29 B56 2018 | DDC 599.9098—dc23 | SUDOC SI 1.33:51

LC record available at <https://lcn.loc.gov/2018003446>

ISSNs: 1943-6661 (online); 0081-0223 (print)

Publication date (online): 13 December 2019

© The paper used in this publication meets the minimum requirements of the American National Standard for Permanence of Paper for Printed Library Materials Z39.48-1992.

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# Growth and Development, Health and Nutrition in the Southeast Region of South America

*Evelia Edith Oyhenart,<sup>1,2</sup> Silvia Lucrecia Dahinten,<sup>3</sup>  
and María Antonia Luis<sup>1</sup>*

**ABSTRACT.** We describe the history and current status of research in child growth and development, one of the main thematic units of biological anthropology in the South American countries of Argentina, Bolivia, Chile, Paraguay, and Uruguay. Although studies on the subject in most of the region are scarce (as is the case in Paraguay and Uruguay, and to a lesser extent Bolivia and Chile), research in Argentina has been substantially developed. Analysis of information gathered suggests that the process of growth and development is a complex network of socioeconomic and socio-environmental factors influencing biological conditions, such as nutritional status and population health. Accordingly, future epistemological strategies of the discipline should lie in promotion of interdisciplinary, multi-national, and regional studies.

**RESUMEN.** En este capítulo se describen la historia y la situación actual de los estudios sobre crecimiento y desarrollo infantil, uno de los núcleos temáticos centrales de la Antropología Biológica, en los países sudamericanos Argentina, Bolivia, Chile, Paraguay y Uruguay. No obstante, los estudios realizados en esta temática son escasos. Este es el caso de Paraguay y Uruguay y, con menor intensidad de Bolivia y Chile. Argentina en cambio, exhibe un importante desarrollo. El análisis de la información reunida permite afirmar que el proceso de crecimiento y desarrollo reconoce una compleja trama de factores socioeconómicos y socioambientales que influyen en condiciones biológicas como el estado nutricional y la salud de las poblaciones. En función de la complejidad mencionada es posible concluir que la estrategia epistemológica de la disciplina, con proyección futura, radica en la promoción de estudios interdisciplinarios y multicéntricos nacionales y regionales.

**RESUMO.** Neste trabalho, descrevem-se a história e a situação atual dos estudos sobre o crescimento e o desenvolvimento infantil, um dos núcleos temáticos centrais da Antropologia Biológica em países da América do Sul, como a Argentina, a Bolívia, o Chile, o Paraguai e o Uruguai. Contudo, os estudos realizados sobre a temática na região são escassos. Este é o caso do Paraguai e do Uruguai e, em menor medida, da Bolívia e do Chile. A Argentina mostra um desenvolvimento significativo. A análise da informação recolhida permite afirmar que o processo de crescimento e desenvolvimento reconhece uma complexa teia de fatores socioeconômicos e socioambientais que influenciam as condições biológicas, tais como o estado nutricional e de saúde das populações. Dependendo da complexidade mencionada, pode-se concluir que a estratégia epistemológica da disciplina, com projeção de futuro, reside na promoção de estudos interdisciplinares e multicêntricos nacionais e regionais.

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## INTRODUCTION

Juan Comas was one of the first anthropologists interested in the history of anthropology, particularly biological anthropology, a discipline concerned with quantitative bibliographical and statistical methods (Comas et al., 1971). Comas surveyed researchers in this discipline and found two main tendencies: physical anthropology, with strictly biological purposes and objectives, and biological anthropology, with emphases on environmental and cultural factors, which are essential to explain evolutionary processes and differentiation in human populations.

Globally, the discipline of biological anthropology has developed greatly in the last thirty years. In Latin America, one of the most important advancements was the creation of the Latin American Association of Biological Anthropology in 1989 in Santiago, Chile. The purpose of the Association was to encourage studies and research for the advancement and diffusion of expert knowledge in biological anthropology throughout the continent, and to promote these scientific advances with similar associations and researchers worldwide (Carnese and Pucciarelli, 2007).

However, according with Rodriguez

the progress of Biological Anthropology in Latin America should refer to the contributions of physical anthropologists integrating interdisciplinary academic and research teams, that is, with anthropological training in the biological and cultural fields. Further, any attempt to include all Latin American countries could be thwarted by the scarcity and, occasionally, the lack of information thereon (Rodriguez, 1996:79).

In this sense, the history of the process of child growth and development in the region shares the general characteristics of biological anthropology. For instance, studies performed in Bolivia and Chile provided scarce information, whereas those in Uruguay and Paraguay dealt with child growth and development from a biomedical approach, far from the biological, social and cultural view of biological anthropology. In Argentina, such an approach was more complex, since child growth and development were tackled as a set of socioeconomic and socioenvironmental factors affecting biological conditions, such as nutritional status and population health.

Accordingly, we describe herein the history and progress of studies in the area of child growth and development as a core concept of biological anthropology in the South American countries of Chile, Bolivia, and Argentina.

## CHILE AND BOLIVIA

The scientific characterization of the differences between Andean and non-Andean peoples began more than a century ago, and efforts to understand the anatomical, biochemical, and physiological bases of their adaptation have increased in the last

half century. However, these studies were based on medical research. The early stages of biological anthropology began with multinational studies.

The Multinational Andean Genetic and Health Program was organized in 1972 in the Department of Arica, Chile. It involved professionals from Bolivia (University of San Andres), Chile (University of Chile, University of Tarapacá, and the National Health Service), Ecuador (Central University of Ecuador), Peru (University of San Marcos), and the United States (universities of Michigan and Texas, and the Mayo Clinic). The objectives of this program were to appraise the impact of differences in atmospheric oxygen pressure, temperature, and humidity upon disease in inhabitants of 14 villages and localities in northern Chile and western Bolivia, the disabilities of the Aymara, and the role of genetic variation in the adaptation to altitude hypoxia (Mueller et al., 1978a,b; 1979; Schull and Rothhammer, 1990).

The Quechua Indian Project was started by Paul T. Baker from Pennsylvania State University. He studied residents of the Nuñoa District, Peru, mainly in the Quechua highlands, living at altitudes of 4,000–4,800 m (Baker, 1969; Baker and Little, 1976). From 1964 to 1976, this project was continued by the International Biological Program (IBP) developed by the International Council of Scientific Unions. Human biologists, biological anthropologists, epidemiologists, and physiologists from more than fifty countries carried out research under the Human Adaptability Section, coordinated by Joseph Sidney Weiner in London (Weiner, 1965). Weiner's research included in the IBP proposed the study of human growth and development, physique and body composition, physical fitness, climate tolerance, genetic constitution, and nutritional status. Other defining characteristics of the IBP human adaptability research were standardization of methods, multidisciplinary projects, international cooperation, and a concern for human health issues. Some observers have suggested that this research contributed to the ongoing transformation of physical anthropology and related fields from a largely descriptive to an analytical science (Little and Garruto, 2000).

From the end of the IBP until the present day, a number of research trends have emerged, such as the Tsimane' Amazonian Panel Study (TAPS). Researchers included mostly cultural and biological anthropologists from the Bolivian Center of Research and Social Integrated Development (a local nongovernment organization specializing in developing investigations among native Amazonians in Bolivia), Northwestern University, the Autonomous University of Barcelona, University of Georgia, Cornell University, International Crops Research Institute for the Semi-Arid Tropics, and Brandeis University (Leonard and Godoy, 2008).

The issues addressed and the main researchers engaged in biological anthropology in Bolivia are summarized as follows:

- A. Functional adaptation at high altitude (Frisancho et al., 1995, 1997; Beall, 2007; Frisancho, 2013)
- B. Physical growth and development of children living at high altitude (Mueller et al., 1978a; Haas et al., 1980;

Stinson, 1980, 1982, 1983; Greksa et al., 1984; Greksa, 1990; Bennett et al., 2008)

- C. Body size and shape (Stinson, 1985, 1990)
- D. Growth, nutritional status, body composition, and parasitic infections (Stinson, 1980, 1982, 2009; Haas, 1981; Haas et al., 1982; Foster et al., 2005; Tanner, 2005; Tanner et al., 2009; 2014a,b; Godoy et al., 2010a; Undurraga et al., 2012)
- E. Growth in relationship to the environment (Godoy et al., 2008a,b)
- F. Chest and lung morphology (Greksa, 1986; Frisancho et al., 1995, 1997)
- G. Health in the adult population (Godoy et al., 2006, 2010b; Tanner et al., 2013)

In Chile, studies on growth and human development have not differed historically from those in other South American countries. Research is mainly concerned with the tradition of biological anthropology, recognized as a pre-scientific stage by Rothhammer and Aspillaga (1996) that would have ended in 1882. The first population studies of modern human beings were carried out by Carlos Henckel. He contributed anthropometric information about indigenous groups from Chile, among other data, to the *Handbook of South American Indians* (Henckel, 1950).

The Anthropology Center was founded at the University of Chile in 1954, and it became the Anthropology Department in 1960. Bioanthropological studies improved under the leadership of Juan Munizaga, who furthered his knowledge in the field at the Smithsonian Institution (Rothhammer and Aspillaga, 1996). Lines of research developed during those years were concerned with erythrocyte molecular markers in indigenous populations, bioarcheological studies, and biological relationships among pre-Hispanic populations from Chile. After his return from the United States, Munizaga and Roberto Rona started researching growth and development (Rona, 1972; Rona and Pierret, 1973; Rothhammer and Llop, 2004), which Rona continued in London (Rona and Altman, 1977). At the request of Corporación de Fomento de la Producción (CORFO), Munizaga carried out a comprehensive bioanthropological study of the populations from Chiloe Island that included growth data (Munizaga, 1978). Around the same time, physicians and nutritionists began research on growth at the Center of Nutrition, Growth and Development, under the direction of Alfredo Patri (Patri et al., 1973). One of Patri's most relevant disciples was Carlos Valenzuela, who focused his consolidated medical research in human growth in Chile, with an emphasis on sexual dimorphism (Valenzuela 1975, 1997; Valenzuela et al., 1978; Valenzuela and Avendaño, 1979).

Within the Multinational Andean Genetic and Health Program, the most important publications were related to growth in high altitude populations (Mueller et al., 1978a,b; 1979; Palomino et al., 1978). This research has continued (Rothhammer et al., 2015).

## ARGENTINA

In the first years of the twentieth century, particularly in Buenos Aires, research on growth and development focused on pediatric medicine, with an emphasis on typology (Agüero et al., 2012). In this context, anthropometry was used for assessing the characteristics of the “average school child” of a city or region. The first research work on schoolchildren from Argentina was Paulino Fernández's doctoral thesis about school hygiene (Fernández, 1880), and the first anthropometric study was on the anthropometric characteristics of Argentinean schoolchildren (Cassinelli, 1916). A year later, Cassinelli published a more ambitious paper about the physical and psychological development of schoolchildren aged 6–14 years (Cassinelli, 1917). These founding publications were followed by the anthropometric studies of schoolchildren carried out by Sisto (1918) and Garrahan and Bettinotti (1922). In the latter study, the authors stated that their results did not have absolute value and that their objective was to catch the attention of teachers and physicians who should assess whether a child is in normal or deficient physical condition.

During 1943 and 1944, Perlina Winocur published her studies on preschool children and schoolchildren from the twenty districts of Buenos Aires. These works were outstandingly modern compared with those of her predecessors. Not only were sample size and selection important, but also the accurate statistical treatments were applied (Winocur 1943; 1944). Her studies allowed the establishment of a weight and height band within the normal range against which it was possible to compare the measurements of children from the Buenos Aires (Soprano, 2009).

An important stage in the development of physical anthropology began at the National University of La Plata School of Natural Sciences and Museum when Milcíades A. Vignati incorporated the use of morphoscopic and morphometric techniques and the typological method of comparative anatomy. He began researching on the American fossil man in the context of paleopathology and somatic anthropology. In 1944, Manuela García Mosquera de Bergna, a student of Vignati, wrote her doctoral thesis on the cephalic index, height, and proportions in schoolchildren from La Plata (García Mosquera de Bergna, 1944). Her approach was based on the traditional physical anthropological methodology developed by Herman Ten Kate and Roberto Lehmann Nitsche at the end of the nineteenth century, and by Vignati in 1930. García Mosquera considered that neither the lifestyle, social conditions, nor eating habits of the child could “modify any organic character permanently and visibly” when determining the descriptive characteristics surveyed in schoolchildren (Soprano, 2009:73).

In line with international scientific progress in the 1960s, some paradigmatic changes began to take place in Argentine anthropology, and these were the origins of modern biological anthropology. The discipline became integrated in the curriculum at the School of Natural Sciences and Museum as a result of changes introduced to the bachelor's degree in anthropology, allowing

biological anthropology to be offered as one of the three major fields of anthropology. This, together with the emergence of new anthropological leadership, consolidated strong intellectual and institutional discontinuities between Vignati's physical anthropology and the new biological anthropology (Soprano, 2009).

In the same decade, the Growth and Development Center was created in the city of La Plata. The first results of the research were published in 1966 by physician Marcos Cusminsky and anthropologist Lilia E. Chávez de Azcona. Their longitudinal study of child growth and development in La Plata (Cusminsky et al., 1966) was awarded the Fernando Schweitzer Prize in 1972. Cusminsky was recognized not only for the excellence and accuracy of his research but also for the training of human resources. One of his disciples, Luis Manuel Guimarey, continued the task at La Plata city in the Children's Hospital "Sor María Ludovica."

Scientific research continued in the 1970s at the Museum of La Plata in the Anthropology Division directed by Chavez de Azcona. In 1974, Susana Ringuet carried out a comparative auxological study between two populations of different ancestry and presented it as her doctoral thesis supervised by Alberto Marcellino. Her study samples were from San Antonio de los Cobres (Salta) and La Plata city (Buenos Aires) and resulted in a number of publications (Ringuet, 1972, 1974, 1977).

In 1976, the academic renovation was abruptly interrupted by the military dictatorship. During this process, Argentine institutional functioning deteriorated, particularly at universities. Massive numbers of layoffs of researchers from the National Scientific and Technical Research Council (CONICET) and university professors occurred. The anthropology career track was terminated in the universities of Rosario, Mar del Plata, and Salta, and changes in the syllabus were introduced at the University of Buenos Aires. In the National University of La Plata, anthropology became a postgraduate course and the syllabus was replaced by a heterogeneous set of subjects, completely unaligned with the new paradigm (Carnese and Pucciarelli, 2007).

In 1983, the return of democracy was accompanied by the reintegration of several professors and researchers to the universities. The career track was reopened in the universities in Rosario and Salta and it was introduced in the universities of Jujuy and Olavarría. At the University of Buenos Aires, Alberto Rex González, as advisor of the Culture Secretariat of the Nation, reorganized the Section of Biological Anthropology in the Institute of Anthropological Sciences. As a result, new lines of research in population genetics, demography, and growth were developed (Carnese and Pucciarelli, 2007).

In 1984, Marta G. Mendez presented her doctoral thesis about morphological and physiological variations in infant through adolescent populations of different socioeconomic levels, at the National University of La Plata School of Natural Sciences and Museum, supervised by Alberto J. Marcellino. Then Mendez, together with Susana Alicia Salceda, carried out studies on child growth in different regions of the country (Mendez, 1984; Salceda and Mendez, 1987; Mendez et al., 1997; Salceda et al., 1997). Marcellino, together with other researchers, continued this line of research at the Department of Anthropology,

National University of Córdoba School of Exact, Physical, and Natural Sciences (Marcellino and Colantonio, 1999, 2010; Demarchi and Marcellino, 1999; Demarchi et al., 2001; Colantonio and Marcellino 2002; Bajo et al., 2007).

In 1990, at the National University of La Plata's School of Natural Sciences and Museum and the Engineer Fernando Noel Dulout Institute of Veterinary Genetics, María Cristina Terreros presented her doctoral dissertation about the effect of malnutrition on the response to mutagenic agents, supervised by Fernando Dulout. Later, Gisel Padula together with specialists in genetics analyzed the contribution of protein-calorie malnutrition to increases in the frequency of chromosomal structural alterations (Terreros, 1990; Padula and Seoane, 2008; Padula et al., 2009).

The conceptualization of biological anthropology was thus recovered in the anthropology career track of the National University of La Plata—that is, the study of processes rather than things that enabled the recognition of thematic units characterizing the objectives of each disciplinary boundary. In this sense, Pucciarelli (1989) stated that biological anthropology studied all the processes of differentiation among human populations resulting from the dynamic and systemic interaction between intragroup variations and the context of specific environmental factors. Two essential elements emerged from this definition: biological variation, expressed through multiple intra- and interpopulation differentiation processes, and interaction with the environment, necessary to understand such processes. Thus, modern biological anthropology is primarily concerned with ecological studies. Further, this definition allowed the delimitation of the following thematic units: (1) evolution; (2) adaptation; (3) ontogeny; and (4) phylogeny. It also resulted in these characteristic combinations of the discipline: (1a) ontogenetic evolution, comprising the study of individual growth and development as part of intra- and interpopulation variations; (1b) phylogenetic evolution, covering the biological aspects and criteria necessary for the understanding of human evolution; (2a) ontogenetic adaptation, including phenotypic changes that cannot be passed on to descendants because they do not affect individual genetic constitution (we refer to physiological or extragenetic adaptation); and (2b) phylogenetic adaptation, comprising genetic and adaptive processes of existing and extinct populations. In summary, this is the theoretical framework that characterizes current biological anthropology in Argentina.

An important milestone for the development of biological anthropology was the creation of the Argentine Association of Biological Anthropology (AABA), during the First National Meeting of Biological Anthropology held in La Plata in 1993. This meeting contributed to strengthening national research groups, integrating with international groups, and formulating interinstitutional projects. In addition, the AABA produces *Revista Argentina de Antropología Biológica*, a nationally and internationally renowned journal (Carnese and Pucciarelli, 2007).

This institutional context favored the contact of the biological anthropology research team from UBA with researchers from UNLP and later with those at the Centro Nacional Patagónico (CENPAT, CONICET) to promote studies on growth and

development in indigenous and cosmopolitan populations (Guimarey et al., 1993, 1995; Pucciarelli et al., 1993, 1996; Carnese et al., 1994; Torres et al., 1999, 2000; Oyhenart et al., 2000). Likewise, those links extended to other provinces and cities in Buenos Aires province. For instance, research in the Municipio de la Costa (Buenos Aires Province) established the phenotypic modifications induced by environmental factors, especially nutrition (Bolzán and Guimarey, 1992a, 1992b).

In 2002, Evelia Oyhenart organized a research team at the School of Natural Sciences and Museum (at UNLP) and IGEVET (at UNLP-CONICET), School of Veterinary Sciences, whose main objective was the study of human growth resulting from biological-environmental interactions, considering the environment as a set of biophysical, socioeconomic, and cultural factors. The studies that were carried out in the provinces of Buenos Aires, Entre Ríos, Mendoza, and Misiones are described below.

#### BUENOS AIRES PROVINCE

The first research was carried out in the city town of Brandesen to determine the nutritional status of schoolchildren at social risk. Subsequently, the analysis was deepened by extending the original sample to children from urban areas and incorporating the analysis of intestinal parasitism in preschool children; these analyses were performed by parasitologists from the Center of Study on Parasites and Vectors (CEPAVE, UNLP-CONICET; Oyhenart et al., 2006; Cesani et al., 2007, 2010, 2013; Zonta et al., 2007).

Parallel studies were performed in La Plata city in a sample of 6,351 schoolchildren aged 3–15 years. Results showed a high prevalence of excess weight, obesity, and central fat distribution patterns in children living in both favorable and unfavorable residential conditions. Undernourishment, although present to a lesser extent, was more prevalent under less favorable socioenvironmental conditions (Oyhenart et al., 2005, 2007, 2012; Torres and Oyhenart, 2009; Bergel Sanchís et al., 2011; Torres 2012). The La Plata population analysis progressed towards a more thorough study of schoolchildren from eleven communities. The results showed a marked heterogeneity in child nutritional status and parasitic infections, depending on the socio-environmental characteristics of residence. Whereas parasitism and infant undernourishment coexisted in communities with deficient environmental conditions and parents of low educational level and without formal employment, the prevalence of excess weight among children was higher in communities with less coverage of basic urban services but with parents of higher educational level and having formal employment (Oyhenart et al., 2013).

#### ENTRE RÍOS PROVINCE

In this province, studies focused on (a) nutritional status and body composition in children aged 3–6 years; (b) socioenvironmental conditions of residence; (c) practices and representations about health and family nutrition; (d) practices and representations about children's nutrition and physical activity; and (e)

perception of food security (with respect to access) at home. The possible association among malnutrition, socioenvironmental conditions of residence, and practices and representations about food were also investigated. Three areas could be distinguished: urban, periurban, and rural. The results indicated that the higher the socioeconomic level and more adequate the environment where families lived, the higher the perception of food security regarding access, as well as higher prevalence of infant excess weight. In the periurban areas, characterized by unstable incomes, the levels of parental education and health coverage were low, families were large, overcrowding was high, the perception of food insecurity at home was higher, and the prevalence of malnutrition and excess weight much higher. Finally, the rural areas, characterized by production of food for self-consumption and by local social dynamics promoting greater social cohesion and inter- and intra-support nets, provided a more protective environment for infant growth (Bergel Sanchís et al., 2012; Bergel Sanchís, 2014). As a complement, a parasitism follow-up study was carried out during 2010 and 2011, which revealed that 58.6% of children were parasitized by at least one species of parasite, with *Enterobius vermicularis* and *Blastocystis hominis* being the most prevalent ones (Zonta et al., 2013).

#### MENDOZA PROVINCE

In this province, the infant-juvenile populations were studied in the departments of General Alvear and San Rafael. In General Alvear, the categorical principal components analysis (catPCA) was used for the first time to avoid a priori urban and rural categorization. Thus, the study was carried out on subpopulations defined as a function of the socioenvironmental characteristics of residence of each child. The results indicated that although the prevalence of excess weight was similar in all groups, that of obesity was higher in children from middle-income urban areas, and undernourishment was more prevalent in rural areas. Body composition changes were observed in both undernourished and obese children. These results were interpreted in relation to the deepening of structural poverty and impoverishment of non-poor sectors as a result of unemployment and underemployment as consequence of the Argentine economic crisis (Oyhenart et al., 2008a, 2010). In San Rafael, children from the urban area showed higher excess weight whereas children from the periurban area showed stunting together with high intestinal parasitism. The socioenvironmental variables that most influenced the nutritional status of children were low maternal education level and deficient environmental sanitation (Garraza et al., 2011, 2014; Garraza, 2013).

#### MISIONES PROVINCE

The studies in this province included research in the indigenous Mbyá Guaraní communities as well as in the urban and rural populations of Aristóbulo del Valle. The results indicated that indigenous populations lived in conditions of extreme poverty and were among the most marginalized in this country.

Severely stunted growth and parasitic infection were still quite common among Mbyá children; almost half of them were affected by both of these conditions, which were accompanied by significant changes in body composition and proportions (Oyhenart et al., 2003; Navone et al., 2006; Orden and Oyhenart, 2006; Zonta et al., 2010, 2011).

However, similarities in the prevalence of stunting between rural and middle urban groups indicated that cities were not healthier than rural environments. On the contrary, the finding that rural groups presented the lowest prevalence of excess weight reinforced indications that poverty and malnutrition were progressively moving from rural into urban areas. In addition, rural children still had more diverse and healthier diets favored by the consumption of homemade products (e.g., via orchards, animal husbandry), placing them at an earlier stage of the nutritional transition (Zonta et al., 2014).

The research group currently directed by Evelia Oyhenart continues biocultural and interdisciplinary studies regarding the characterization of growth patterns and nutritional status of infant–juvenile populations of different socioeconomic and socioenvironmental contexts of Argentina, with an emphasis on variations in body composition and proportions and sexual dimorphism.

#### CATAMARCA PROVINCE

Growth studies in Catamarca began in the early 1980s, when the health ministry of the province requested the intervention of a biological anthropologist to assess the nutritional disposition of children in relation to assistance offered by the Program of Social Nutritional Promotion. The research was carried out during 1982–1984 in the context of an institutional project designed and supervised by Delia Lomaglio titled “Anthropometry of Schoolchildren from Catamarca,” of the Government of Catamarca, Ministry of Social Welfare. The anthropometric measurements included weight, height, sitting height, and head circumference of 2,142 school-aged children from urban and rural areas from different geographical regions within the province. This information became the first growth database in Catamarca. Results were presented in two workshops in 1983: “The Food Problem in Latin America and the Caribbean” (Lomaglio et al., 1983) and “Nutritional State of Children in Argentina” (Lomaglio, 1983), both held in Buenos Aires and published in *Archivos Argentinos de Pediatría* (Lomaglio, 1985).

From that moment, a research track was developed at the University of Catamarca, which has continued under the Center of Studies of Biological Anthropology (CEABi) since its creation in 1993, directed by Lomaglio. Currently the multidisciplinary team of CEABi carries out research in the field of nutritional epidemiology, including markers, analysis techniques, and evolution of body composition, excess weight and obesity, body image perception, disorders in food behavior at different stages of ontogeny, growth and nutrition, and environmental effects on growth and nutritional condition of human groups, with special

emphasis on high-altitude populations (Lomaglio, 1992, 1997, 2012; Lomaglio et al., 2007; Mesa et al., 2013; Candelas et al., 2015; López Barbancho et al., 2015).

#### CHUBUT PROVINCE

Systematic studies in the infant–juvenile populations from Chubut began in 2001 when Silvia Dahinten developed the Project Biedma (PROBIEDMA) project in the Research Unit of Anthropology and Archeology (CENPAT–CONICET). The main objective of the project was to study the growth and nutritional status of schoolchildren from the Department of Biedma (Chubut), with emphasis on the city of Puerto Madryn. The results showed a high prevalence of excess weight or obesity and provided the starting point for a health intervention plan based on physical education activities as part of the program “Healthy Municipalities” of the National Health Ministry (Dahinten et al., 2001, 2005; Dahinten and Zavatti, 2003; Botterón et al., 2005). Interestingly, this population presented more excess weight compared with other populations (Dahinten et al., 2011a, 2011b). On the other hand, the secular trend in height of the adult male population from Chubut was studied using primary sources of information. Apart from height, the personal data, skills, jobs, and education level of 4,185 individuals born in 1909, 1919, 1929, 1939, and 1949 were obtained and analyzed. The results indicated an average positive secular trend in height at provincial level (+4.08 cm) between the first and last studied years. At the regional level, significant secular differences were detected, with an annual increment of 0.09 cm on the coast and 0.04 cm on the plateau and cordillera. Further, skilled workers showed steady height increments compared with unskilled ones. The same applied for literate and illiterate individuals. The secular variation in height clearly reflected the incidence of the eco-geographical, socioeconomic, demographic, and nutritional conditions of the region (Dahinten et al., 2008; Gavirati et al., 2013). This phenomenon was comparatively analyzed with the military district of another province, Jujuy. The sample included 8,262 and 3,707 individuals recruited in Jujuy and Chubut, respectively, from 1910 to 1950. Results showed that average height was greater in Chubut soldiers, reflecting that this phenomenon was far from being homogeneous at interprovincial level (Dahinten et al., 2012a, 2012b).

#### FORMOSA PROVINCE

Since 1997, the Program of Reproductive Ecology of the Argentinean Chaco (ProERCA) has developed research activities, mainly in the province of Formosa. The program is directed by Claudia Valeggia and is aimed at contributing to the understanding of biological, ecological, and sociocultural factors that affect fertility in Great Chaco populations. Within this context, ProERCA carried out several growth studies in children from birth to puberty in the Qom (Toba) and Wichí communities of Formosa. The first studies on infant growth were carried out

in a peri-urban Qom population and centered on the evaluation of weight curves from newborns to two-year-old children using health center records (Valeggia et al., 2002). This study confirmed that the nutritional status of Qom children was optimal until about seven months of age, when typically the weaning process was begun. A more recent study on food after weaning (Olmedo and Valeggia, 2014) showed that complementary food was of scarce nutritional value in these populations, thus accounting for the worsening of nutritional status in these children.

In addition, various studies compared the growth of indigenous children from different ethnic groups with that of children from the same ethnic group but living in different environments (rural vs. periurban; Valeggia et al., 2005; Valeggia, 2010; Lagranja et al., 2015). At present, ProERCA is finishing a longitudinal follow-up study that began in 2010 with a group of Qom children (newborn and weaning stage) and a group of Qom girls during puberty transition. This study will provide detailed longitudinal data for a variety of growth correlations such as diet, physical activity, parasitic load and infectious diseases, family and social environment, and sociocultural aspects of these transitions.

#### JUJUY PROVINCE

Research on growth and human development began in the mid-1980s in the Genetic and Bioanthropology Section of the Institute of Altitude Biology (National University of Jujuy) with José Dipierri's study funded by CONICET. Dipierri analyzed the influence of altitude above sea level on both birth weight and menarche age in Jujuy, and then also the secular trend and regional variation of adult male height with data provided by the Argentine Army from 18-year-olds performing their compulsory military service.

Dipierri et al. (1992) and Alvarez et al. (2002) found regional variation in birth weight, with average weight lower in the highlands (Puna and Quebrada) than in the lowlands (Ramal and Valle). In 2008, Grandi and Dipierri analyzed the trend of different birth weight categories in Argentina during 1999–2002, observing a negative secular trend of average weight, with an increment of low (<2,500 g) and very low (<1,500 g) weight and a decrease of normal weight ( $\geq 3,000$  g).

Furthermore, Bejarano et al. (1996) evaluated the secular trend of adult height in soldiers during 1860–1960, verifying existence of a positive differential regional trend, with the highest values in the lowland regions (Valle and Ramal). Analysis of variance of surname (autochthonous/foreign), geographic altitude (regions), time (1860–1960), and height of Jujuy soldiers examined at Jujuy Military District revealed that, independent of year or geographical region, individuals bearing foreign surnames were significantly taller than those with an autochthonous surname, and regardless of ethnic group, the association between average height and geographical altitude was inverse (Bejarano et al., 2009).

Data from the First Height Census carried out in Jujuy in 1993 allowed analysis of height variations in primary schoolchildren aged 6–9 years from the four geographical regions. In both

sexes and in all age groups, children from Puna and Quebrada were significantly shorter than those from Valle and Ramal, and, at 6 years of age, the average height of children from Jujuy was significantly greater than the national standard (Dipierri et al., 1996). Height variations in schoolchildren aged 6–9 years with reference to the environment (rural/urban) and geographic altitude indicated that infant growth in Jujuy populations would be influenced by geographic altitude, regardless of environment (Dipierri et al., 1998).

From 2000 to the present, studies concentrated on the analysis of growth, development, and nutritional status of Jujuy populations through the combined interpretation of hematological and anthropometric indicators. The evaluation of anemia and iron deficiency in pregnant women and their newborns living at 1,200 m above sea level indicated the prevalence of anemia in 67% of term pregnant women and 46% of their newborns, with iron reserves in newborns being independent of maternal ones (Buys et al., 2001). On the other hand, Bejarano et al. (2003) reported that average hematocrit values in the age groups 4–6 years and 10–22 years coincided with those of the reference group fitted for altitude, regardless of age, sex, and socioeconomic level. However, Buys et al. (2005) determined the prevalence of anemia and iron deficiency in a population of 2,405 12-year-old schoolchildren living at 1,200 m above sea level, and although anemia prevalence was very low and did not constitute a population risk, iron deficiency was remarkable.

Using several criteria, Bejarano et al. (2005) analyzed the prevalence of malnutrition and its evolution during 1995–2000 in schoolchildren from San Salvador de Jujuy, observing an increased prevalence of both excess weight/obesity and undernutrition, thus confirming the nutrition transition paradigm. On the other hand, Alfaro Gomez et al. (2008) analyzed the growth pattern of children from Jujuy living at 1,200 m above sea level by means of the height and weight percentiles calculated with the LMS method (Cole and Green, 1992). Comparisons with the international references (CDC and WHO) showed that growth and nutritional conditions of Jujuy populations should be evaluated with the WHO reference as this more accurately reflects the growth pattern.

Currently, studies on growth patterns and nutritional status and their relation with nutritional status based on anthropometric and biochemical indicators (hematological and metabolic profiles) in infant through juvenile populations living at different altitude levels are in an advanced stage of implementation. The characterization of somatotype and fat distribution patterns in children, teenagers and adults, the analysis of growth rates at different ages, and the evaluation of body image perception and satisfaction in teenagers and its relationship with disorders in food behavior are underway. Also, the geographic scope of analysis extended to populations from other provinces and even across the country. Finally, the progress of knowledge on several aspects of growth and human development due to DNA technological advances has opened numerous analysis perspectives that are intended to be implemented soon.

## COLLABORATIVE STUDIES CARRIED OUT IN ARGENTINA

In 2005, different research teams began the task of coordinating the techniques, methodologies, and references used in Argentina in order to compare the prevalence of malnutrition in different regions. For instance, a team supervised by Evelia Oyhenart, José Dipierri, Delia Lomaglio, and Silvia Dahinten, analyzed the nutritional status of the infant through juvenile population from six Argentinean provinces using the same methodologies to obtain variables that could be contrasted. The sample included 15,011 schoolchildren, aged 3–18 years, and the results indicated that the prevalence of malnutrition showed regional differences with clinal variation; thus, malnutrition decreased from north to south, and the chance of being overweight or obese was higher in the south and lower in the north. The prevalence of malnutrition was consistent with the socioenvironmental indicators. The northwest region showed the lowest levels of economic activity, the highest rates of poverty and indigence, the highest rates of maternal–infant mortality and the worst sanitary conditions (Oyhenart et al., 2008b).

Later, researchers of the Complutense University of Madrid (Spain) joined this group to calculate weight-for-age (W/A) and height-for-age (H/A) percentiles of schoolchildren from Argentina employing the LMS method, and to compare the obtained percentiles with those of international and national references. Their results indicated that the weight and height distribution in schoolchildren from most regions of the country differed from that of national and international references. A new national reference based on internationally recognized methodological criteria should be established to adequately reflect the biological and cultural diversity of the Argentine populations (Oyhenart et al., 2014).

## CHALLENGES AHEAD

Since its earliest stages, biological anthropology has been characterized by a dynamic development that propels it into the future. The strategy to renew this dynamism should be the promotion of multicenter and interdisciplinary investigations in order to make consistent comparisons for properly characterizing growth, development, and infant through juvenile nutritional status. Accordingly, some actions should be taken. First, biological anthropologists should be trained in the following fields: (a) Research and development, to promote and define multidisciplinary national strategies to study the growth and development of children and young people in relation to the socioeconomic and sanitary conditions in which they and their families live; (b) Teaching, to design biological anthropology curricula for all educational levels, to correlate graduate and postgraduate teaching with the current needs of society, and to develop collaborative agreements with national and international colleagues; (c) Outreach to the community, to promote the implementation of active policies and the commitment of the public health sector,

governmental authorities, universities, and local citizens, who will work together to discover viable solutions.

## ACKNOWLEDGMENTS

We thank our colleagues for providing relevant information for this chapter; Adriana Di Maggio for assistance with English language translation; and María Cristina Muñe for editing the manuscript.

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