

ETHICAL ISSUES IN THE HISTORY OF AUXOLOGICAL RESEARCH

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Abstract: Being a branch of bio-medical anthropology, auxology has made important contributions to the scientific knowledge, its findings influencing decisions taken during different moments in the history of humanity. This paper is a synthesis of the most relevant research presented in a chronological manner, from antiquity to the present, emphasizing the ways it raised ethical awareness in different contexts and a wide range of issues from improving living conditions during industrial revolution or fighting racism, to contemporary problems like migration and globalization.

Keywords: auxology, ethics, history.

INTRODUCTION

The study of the human growth and development across time and space contribute to a better understanding of the history of human species overall. In this approach one has to consider the continuous pressure and influence of a large variety of genetic as well as environmental factors that shape the individual. At the same time, the large body of data resulting from these studies is relevant for research in different scientific areas as: pediatrics, preventive medicine and hygiene, bio-medical anthropology in order to assess the health and quality of nutrition of a given population etc.

A synthesis of the large amount of data accumulated until today with regards the growth and development as well as monitoring the accompanying phenomena is realized among the discipline of auxology. Auxology is defined as a holistic approach to the human growth and development in relation to evolutionary biology, biocultural factors, internal or external factors such as genes, hormones, physical, economic and social environment etc. (Bogin, 1999) [1].

According to Tanner (2010)[2], there are three reasons, not always distinct, about doing research in

the field of auxology, reasons that could be classified as: social, medical and intellectual.

Among those the social motivation, as it happened in other areas of science, had not always been legitimate from an ethical standpoint. An example is the oldest set of measurements in auxology, of the Marine Society of Great Britain, that were made on young recruits in order to be able to be easily recognized and punished in case they deserted. Much later, starting with the 19th century, the studies of growth served a humanitarian cause. The results of the research from this period had been used as evidence in the continuous struggle for social reform. Not surprisingly, the research during this amount of time, had taken place in areas that were affected by the industrial revolution.

On these occasions, it had been observed that children working in factories had always heights smaller than the others. This was not necessarily due to the work they were doing, but rather because of the fact a child having to work in a factory was a sign of family poverty, as well as poor home and nutritional conditions (Roberts, 1876)[3].

These studies had contributed to the adoption of reforms that will improve to a specific extent the conditions of life of children and youth living in the

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19th century. Even in 1970's, the kids of those who were not part of the working class were taller compared to the others, regardless of age. However, recent studies from Sweden and Norway had shown that, in a genetically homogenous population, the social class differences from the standpoint of children growth, could be eradicated.

On the other hand, the medical motivation in auxological research, aimed to emphasize the anomalies or retards regarding growth in individuals or distinct populations. Due to the high incidence regarding the mortality, it was considered that doing what is right in order for a healthy growth will also give a higher resistance to the large number of infectious diseases to which the children were exposed.

Auxology had contributed to the development of a new approach to human in relation to the society. The modern biology no more sees the people as creatures occupying specific layers in society that were pre-established at birth, as in the fatalist and extremist approaches of the past. Now days we acknowledge the fact that the human individual is, to a great extent, the result of the interaction between the genotype and the environment that is under a continuous change. There is no other place that better proves this, than in the studies specific to auxology that took place over the centuries.

The huge body of knowledge had been accumulated over a period of 3 000 years, but the study of human growth and development on scientific grounds has a history of approximatively 300 years, acting as a mirror of the human condition (Boas, 1949) [4]. At the same time, the scientific evidence produced had influenced taking of decisions that affected the life of societies in different moments of human history.

The first corroboration of the biological age at puberty with the legal age dates back to the antiquity. Accordingly, the Justian code of the Roman law acknowledges that the age of puberty (14 years) is the age starting at which individuals get legal responsibility while their parents can no more be hold responsible for what their children do. At first, this law was applicable only for boys, later being extend to girls too. In the case of girls, the legal age was established to be 12 years old, probably in order to stimulate early marriage and, thus, to ensure chastity (Amundsen, 1969)[5].

During the Middle Age, Isidor of Sevilla, one of the greatest scholars of his time, will be against the roman law that fixes the age of puberty to a specific age (14 years old) (Sharpe, 1964)[6]. Therefore, we

understand that, during middle age, the variability of age at menarche was acknowledged.

At the same time, Isidor rejects the existing tradition that used to divide the human life cycle into seven stages, claiming that there are six stages in reality. According to him, the six stages are: *infantia* (from birth to 7 years); *pueritia* (between 7 and 14 years); *adolescentia* (between 14 and 28 years); *juventus* (between 28 and 50 years); *gravitas* (between 50 and 70 years) and *senectus* (at 70 years).

During this period of time, the older belief according to which the physical appearance is related to the predominance of a specific humour in the body, was reinforced. Vincent de Beauvais notes that the ages divide into four parts: *phlegma* during childhood, then *cholera*, until 28 years of age. Then follows *sanguis*, until 60, and finally *melancholia*, corresponding to the old age.

Bartholomeus Anglicus, an English monk, divides the human life cycle into seven stages that he names in chronological order using the following terms: *infantia*, *puericia*, *adolescentia*, *juventus*, *senectus* and *senium*.

Living most of his life among the villagers from the mountain region, Guarinoni observes that the girls from these areas usually reach the menarche at an older age with respect to the ones living in the cities or those coming from aristocratic families, thus recognizing the fact that age of menarche is influenced by a diverse range of environmental factors.

In most cases, women living in towns already have a few children while those from the country have their first period, at the same age (Wurst, 1964)[7].



Figure 1. Drawing from the 15th century representing the seven stages of life, from *De proprietatis rerum* (Lyon, 1491)- Wikipedia.

These observations had been confirmed by studies in the 20th century on individuals from agrarian communities in the mountain regions of underdeveloped countries, such as New Guinea (Eveleth, Tanner, 1976[8]). Even in 60's, in Europe there still was a difference of nearly a year regarding the age of menarche between girls living in cities and those from villages in the mountain of Austria and Slovenia (Wurst *et al.*, 1961)[9]; (Wurst, 1964)[10].

The antiquity is also the time when body proportions are studied and the science of anthropometry is born. The painters and sculptors of antiquity and middle age were in need of data regarding diverse body proportions in order to produce their art. At the same time, from antiquity to Renaissance the belief that the act of the divine creation of man is defined by numbers, proportions and harmony, was well established. Thus man represented the micro-cosmos which, at its turn, was part of the universal macro-cosmos obeying to the same laws of form and beauty.

Such an approach could be seen in the tradition of the Hindu and Buddhist artists (Tagore, 1921)[11] and probably, even at the Egyptian of antiquity (Iversen, 1955)[12]; (Muller, 1973)[13].

The first book which describes the human body proportions, entitled *De architectura*, is the one of Vitruvius. His work had a great impact on the thinking in Renaissance and went well beyond the field of architecture.

The first person that invented an instrument for measuring the human body is Leon Battista Alberti (1404-1472). The main part of this instrument, named *exempeda*, was inspired by the principal of functioning of the astrolabe used by navigators and astronomers in order to measure the distance between different celestial objects. Alberti will also revitalize the old

anthropometric practice of Greek-roman sculpture as well as the theory of proportions (Panofsky, 1968) [14].

The invention of the term “anthropometry” is attributed to Johann Sigismund Elsholtz (1623-1688) the first physician who takes measurements of the human body. Johann Georg Bergmuller (1724-1785), a German fresco painter, is the one who describes for the first time in his book entitled “*Anthropometria*”, a law of geometrical growth of the child's body. According to the author, the age at which women reach their final height and body proportions is 21, while for men it is 24.

Christian Friedrich Jampert is the first person who publishes a table of measurements related to the growth of the human body. Jampert measured a cohort of children of ages between 1 to 25 living in the royal orphan house of Berlin. The measurements such as arm length, head circumference, torax and shoulder circumference, were performed every day, at the same hour.

One of the main drives behind measurements of the human body related to growth and development was the need of such data for the army, and not necessarily because of the endeavour from the medical or artistic field. Tall men were to be preferred in the army, not only because they were stronger, but also due to the fact that they were able to cover a larger area while marching or they could be more effective in the use of bayonet in the battle.

During the 18th century, having a battalion of tall soldiers was an asset for many European chiefs of state. For these reasons, careful inspection and selection of young men for the army was of great importance.

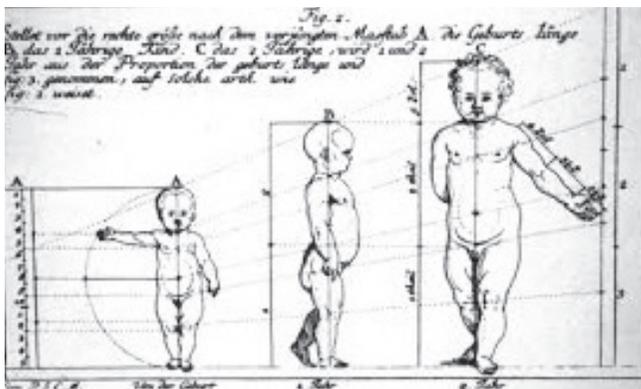


Figure 2. Bergmuller's scheme representing a child at birth, and at 1 and 2 years of age, respectively (1723), www.columbia.edu



Figure 3. Goethe's drawing illustrating the procedures of measurement of the recruits for the army of the duke of Sachsen-Weimar (1779), www.deutsche-digitale-bibliothek.de.

Goethe himself, had also been involved, even though not very enthusiastically, in the process of measurement of military recruits, as a part of his duties to the duke of Sachsen-Weimar. To Goethe we owe an important drawing for the history of auxology that describes in much detail the technical aspects of the anthropometrical measurements.

The first organized set of anthropometric data comes from the norwegian army, dating the year 1741 (Kill, 1939)[15]; (Udjus, 1964)[16]. In the Great Britain first measurements were taken in 1755 by the British Royal Navy, while in other European countries they started a bit later- Finland, 1768; France, cca.1800; Holand, 1820; Baden, 1840 etc.

During the first half of the 20th century, Adolphe Quetelet (1796-1874) is one of the prominent personalities in the field of science and public health. Besides his valuable contributions in the fields of geology, meteorology, mathematics and arts, he undertook extended studies on the subject of growth of children.

Quetelet performed two important researches; one concerning height, in 1831, and another one concerning height and weight, in 1832. The results of his studies were published for the first time at the Royal Academy of Bruxelles (Quetelet,1831)[17], (1833)[18] and reproduced later in his most important book, *Sur l'homme et le developpement de ses faculties*, published in Paris in 1835, which was very much appreciated at that time.

During the 19th century there is a new approach to the studies regarding growth, that stems from the reaction of scientists to the extremely precarious situation of the poor people and their children. This new approach developed around the general idea of public health.

Such growth studies initiated by the promoters of this new discipline through measurements in schools and clinics gave rise to the developments of an auxology of epidemiological nature. Its aim could be defined as using the data from growth studies in order to search and establish the optimal conditions for maintaining health in a given environment. This practice had started in Great Britain, later being adopted by other European countries such as Franca and Belgium.

There is also another side, less humanitarian, that gave rise to such undertakings. Following the continuous battles in Europe as well as the associated famine and disease, the rules of nations of the 18th century became very preoccupied by the problem of

power and human resource. There was a great need of men in order to fight in battles but no country possessed the exact data related to how many people it had. As healthy and strong men were needed, the first censuses indicated the existence of a very large number of men in poor health, undernourished due to the subnutrition (Anon, 1918)[19]; (Davenport, 1920)[20]). This finding lead to the theory according to which, such men will give rise to an inferior population, while the strong and healthy men where engaged in military campaigns. Another hypothesis stated that the weak men will not be able to procreate at all and then, there will be no people to take active part in the army.

Sweden was the first country in the world which, under the king Adolphus Frederick (1710-1771), had realized the first census involving its national population in 1748, while the resulting data was kept as secret of state for a while (Rosen, 1955) [21].

At the beginning of the 19th century, the rural population had been attracted more and more into the new industrial cities that were developing in Europe. The industrialization revolution gave birth to large cities formed around large factories that used coal as a source of energy. In these cities adults and children were living in extremely poor condition. Around 1850, nearly half of the population in Great Britain lived in the urban environment.

With regards the agrarian areas, the situation of the economy there, was similar to that of an underdeveloped country of today's world. Thus, the industrialization brought a visible improvement of economy and intensification of work, as well as a negative impact on the poor population.

The most important document related to the issue of the growth and development of children who worked in factories during the industrialization period, was produced after a call of the Great Britain's parliament in 1833, to analyze the real situation of these children (Parliamentary Papers, 1833)[22]. Thus, two relevant reports were produced in 1833 de J.W. Cowell, and in 1837 by Horner [23], respectively.

The first height and weight measurements were made on a total number of 1 933 children with ages between 9 and 18, most of them working in factories found in the Manchester industrial area. These kids were going to school only once a week, on Sundays.

The results of these studies had risen awareness and measure were soon taken which aimed to protect

children working in factories. As the century was unfolding, there was a significant improvement of the working conditions in factories, partially also due to the introduction of new machines and technologies. Still there was a lot more to do with regards the working conditions: 8 years old children had to leave their homes without having breakfast, at 5.30 in the morning during winter, in order to be present at work at 6. Pregnant women had to work until two weeks or even two days before giving birth, while most of them were returning to the factory within one month afterwards, leaving the newborn in the care of another member of family or taking him to work as well.

This report led to the enactment of the 1874 law changing the age of part-time employment in textile factories from 8 to 10 years, and the minimum age of full-time employment from 13 to 14 years. Also, lunch and rest time increased to two hours out of the 12 hours of work per day. The three studies mentioned are a conclusive proof of how auxology research could cause changes in social conditions in a given historical context.

Francis Galton asked the management of the newly established Institute of Anthropology, in 1873, to finance a national program of anthropometric measurements that was to take place in schools of all kinds.

The year 1872 marks the beginning of anthropometry studies in the United States, as well. Doctor Henry Bowditch is the one who will measure a number of 13 female and 12 male individuals who were relatives, annually, for a period of 25 years (Bowditch, 1872, 1877). [24],[25]

Galton's studies in the United Kingdom and Bowditch's studies in the United States will pave the way for an impressive number of longitudinal and transversal studies of auxology in schoolchildren in the years to come: Pagliani in Italy, 1877, 1879 [26]; Hertel in Denmark, 1885 [27]; Carlier in France, 1892 [28]; Kosmowski in Poland, 1895 [29]; Peckham, 1882 [30] and Porter, 1893[31] in the USA, and others.

The large number of research on height and weight in schools has been carried out by public health institutes, with the aim of drawing general eloquent conclusions on their factors and effects in different circumstances on growth and development. For example, one finding was that the process of raising children in crowded homes is slower than children with better conditions in this regard.

At the same time, longitudinal growth studies can also be used to monitor the evolution of children's

individual health. One of the pioneers of this type of study is the French military doctor Paul Godin (1860-1935). Godin is the first scientist to use classification stages to describe the degree of development of secondary sexual characters, a method that is standardized today. It uses five stages for pubic hair and five for axillary hair.

Godin is also the one who introduces the term "auxology" in the study of human growth and development, in 1919 in his article entitled "La methode auxologique". It seems that Godin took this term from the physiologist G. Bonnier who referred to growth initially exclusively in the process of plant growth (Bonnier, 1900)[32]. The etymology of the word is of Greek origin- auxein = to enlarge, to increase.

Franz Boas (1858-1942) is another reference figure in American anthropology. Although he is best known for his contribution to other fields of anthropology, Boas was also interested in the issue of growth and development. Thus, Boas is the one who realizes for the first time that during childhood, some individuals are more advanced on their way to maturity than others - what today we call the acceleration, respectively growth retardation. Boas also introduced the concept of physiological age.

Boas is also the initiator of the first longitudinal growth study in America, on schoolchildren in Worcester. At the same time, Boas produced the first national standards for height and weight for North American children (Boas, 1898)[33]. For this, data were used from a total of 90,000 children from six US states.

Another study by Boas that is worth mentioning is the one commissioned by the United States Emigration Commission, which aimed to determine whether the influx of immigrants from Europe leads to a process of physical deterioration of the North American population. This research, initiated by Boas and his collaborators in 1908, consisted of measurements of height, skull circumference, bizygomatic diameter, and in some cases and weight, on a number of 18,000 emigrants to America and children of born emigrants in America.

The conclusions were that the height was slightly higher for children born in America than those who had emigrated here and the two diameters of the head were a few millimetres larger (Boas, 1912) [34]. Later studies found that such differences disappear after the first or second generation of kids born in the new land.

Between 1900 and 1930 a consistent literature appeared related to the increase and modification of the proportions in fetuses. A large-scale study of this was conducted by Scammon and Calkins at the University of Minnesota in 1929. They measured 400 fetuses with lengths ranging from 2 to 54 cm.

The 19th century also brings an update of questions and studies related to the age of menarche. It is not surprising that the first studies of this kind, in the nineteenth century, began in Manchester which was the center of the industrial revolution, they were initiated at the same time as Cowell and Stanway made the first measurements of height and weight.

It seems that there are three reasons that led to an update of studies related to menarche in the nineteenth century. The first was the same as the one that led to the sampling of children's height and weight: to see if the type of work performed, the type of food and social conditions are reflected in the data obtained, and to use these data as an argument for adopting social reforms.

The second impulse that led to the study of the menarche's age was born of the concern about overpopulation, stimulated especially by the recent observations at that time, of Malthus. The third reason seems to be clinical and is part of the effort to understand the causes of infertility. For example, amenorrhea was one of these symptoms and in order to be diagnosed correctly, it was necessary to know the age range at which menarche could normally occur.

The twentieth century is characterized by the appearance of the first large-scale longitudinal studies, conducted on a massive number of individuals. These studies were initiated in the United States and have greatly contributed to the auxological literature. The research was interdisciplinary including a variety of specialists: doctors, psychologists, anthropologists and others, open to a holistic approach to the child.

Between 1918 and 1928, a number of 1,300 radiographs of the hands and wrists of children from birth to the age of 17 were taken in order to accumulate data for estimating the physiological age as close as possible to reality [35-37]. On this occasion, the time of the first appearance and the fusion of the epiphyses were studied and the carpal area was estimated by the method of planimetry.

The first longitudinal studies of European auxology took as an example and were based on the experience of the United States, with the difference that while the American ones were made from

the perspective of the psychology of growth and development, the European ones were born in a medical context. . The research that followed was naturally based on the first ones, such as the so-called Harpenden study (Tanner, 1948) [38]. This large-scale study was initiated in 1948 and coordinated by Tanner and Whitehouse. To this end, Whitehouse also designed a new set of anthropometric instruments that are easier to use and more accurate, such as the so-called Harpenden anthropometer or a new type of caliper.

James M. Tanner is, without doubt, the most prominent figure of the twentieth century in the field of human growth and development. A professor at the Institute of Child Health and the University of London, Tanner has promoted the study of growth and development, and his work has resulted in a series of books and monographs that address complex issues related to human growth and development. His book, "Growing in Adolescence," (1955 and 1962) systematized data on normal and pathological growth and development, collected in the first half of the twentieth century. Along with collaborators such as Reginald Whitehouse, Tanner has published some of the most widely used modern references to height and weight gain, stages of sexual maturation, and skeletal maturation.

An important category of European auxology studies has addressed growth and development from the perspective of growth physiology and growth dysfunction. The need for new research to allow a better understanding of the physiological mechanisms of growth and, implicitly, of the phenomenology that leads to slowdown or retardation of growth arose from the evidence of the large number of children with reduced height for various reasons. Some of them suffered from treatable dysfunctions, while others needed a diagnosis, prognosis or genetic counselling.

In this context, auxology has made its own contribution to a better understanding of the phenomenology of growth and development and its factors. Also, the range of pathologies in patients studied longitudinally using modern techniques of biochemistry, radiology and histology has placed the auxology in a new light.

For example, investigations in children with endocrine dysfunction have led to elucidation of the mechanisms that control the specific aspects of puberty in normal children (Grumbach, 1978) [39]. Longitudinal studies in children with chromosomal

mutations, such as Turner syndrome, have contributed to the enrichment of normal knowledge, showing that in the absence of estrogen secretion the growth spurt at puberty cannot be achieved in girls (Brook et al., 1977)[40].

Another characteristic of the twentieth century is the research of the genetics of growth and development. This became possible with the rediscovery of Mendelian principles in 1900, as well as the description of the structure of the DNA molecule in 1952.

The most recent research in auxology is the studies conducted on the entire population or part of it, on children and young people, respectively, of a country. They were designed to highlight regional differences, socio-economic differences, ethnic differences in multiethnic societies, as well as the secular trend phenomenon. In some national studies, longitudinal and transverse methods have been combined. One such an example of a follow-up study is the one taking place in Great Britain since 1946 (The National Survey of Health and Development).

A study of particular importance was conducted in the Netherlands in 1970. Its aim was to study the effects of a short but very difficult period of a period of famine through which passed the population of the central Netherlands between October, 1944 and May, 1945, as a consequence of the war. The research continued until the 19-year-old men entered the military service.

Such kind of modern studies had started in many European countries emphasizing once more the important role of auxology and its contribution and involvement about taking the right decisions related to current contemporary issues such as globalization and migration, as well as to better understanding of the implications such phenomena can have on individuals and society.

Conflict of interest

The authors declare that they have no conflict of interest.

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