Evaluation Of The Growth Performance Of Female Adolescents In Maceio - Brazil

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In memory of my mother

ABSTRACT

In Brazil, the majority of growth studies focus on children aged less than 10 years. Many reasons explain this trend. One of them seems to be related to the necessity of controlling the high infant mortality existing in developing countries. Another one could be related to the assumption that growth at adolescence is largely independent of the previous childhood process. Recent studies give some insight into the profile of the height gain of those who are growth retarded during adolescence. Nevertheless, whether puberty plays an important role for determining adult stature is still unclear.

This thesis evaluates the growth performance of female adolescents living in contrasting social conditions in Maceio - Brazil. It describes and analyses the morbidity pattern, occurrence of menarche, growth in height, weight, fatness, and dietary intake. Results indicate that the girls from the low income families had a higher incidence of illnesses, presented the tendency to menstruate later and had slower rates of linear growth in comparison to their counterparts. In addition, the analysis of the dietary intake shows that the low income girls group did not meet their energy and nutrient requirements.

CONTENTS

APPENDICES

List Of Figures

List Of Tables

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Introduction

In Brazil, the majority of growth studies focus on children aged less than 10 years. A consequence is that little attention has been paid to the growth performance of adolescents. Many reasons explain this trend. One of them seems to be related to the necessity of controlling the high infant mortality existing in developing countries. Another could be related to the assumption that growth at adolescence is largely independent of the previous childhood process. Thus, one might conclude that any growth deficit achieved at earlier ages would be immutable during the pubertal period.

Actually, for many years, the majority of studies in developing countries has aimed to monitor the "vulnerable groups", i.e., those individuals most considered to be at health risk. It is possible that such a strategy explains the knowledge gap in relation to the adolescent groups in these countries.

On the other hand,it is still unclear whether puberty plays an important role for determining adult stature. Some longitudinal studies such as those by Satyanarayana et al. (1980, 1981), Martorell, Rivera and Kaplowitz (1990), Bogin et al. (1989) and Bogin and MacVean (1992), give some insight into the profile of the height gain of those who are growth retarded during adolescence.

It is important to note that the study of the significance of growth retardation in human populations concerns the much debated question of the relevance of body size. In addition, to discuss body size implies to a certain extent to speak about the concepts with which "malnutrition" and "nutritional status" are approached (Payne, and Cutler, 1984).

This research intends to provide additional information on this subject by testing the hypothesis that the growth performance of girls living in different environmental and social conditions during adolescence leads to differential growth outcome. Therefore, this research extends into other factors than just height comparisons to accomplish a more complete understanding of the causes of development differences. The research covers the adolescence period from the age 9 to 13 years. The research subject is the growth performance of adolescent school girls from the Northeast region of Brazil, with separate consideration of girls from low and high income families.

The thesis is divided into three parts. **PART I** is composed of **Chapter 1** and **Chapter 2**. **Chapter 1** examines the theoretical background to the questions associated with linear growth, starting with the concept of growth in healthy subjects but stressing the points related to adolescence. It then examines factors associated with linear growth retardation and related debated issues. **Chapter 2** presents the general methods adopted for collecting and analyzing the data. Details concerning the general statistical procedures used are given in this section.

PART II shows the cross-sectional analysis of the data on enrolment to the study, with the aim of identifying the biological and social profile at the beginning of the study. **PART II** embodies **Chapter 3** and **Chapter 4**. **Chapter 3** covers the social background results, while **Chapter 4** demonstrates the biological profile results.

PART III presents the results of the follow-up study, and includes **Chapters 5, 6, 7, 8** and **9**. In **Chapter 5** the results on the occurrence of menarche during the study year are presented and discussed. **Chapter 6** displays the analysis of health condition of the study population regarding the incidence of reported morbidity. **Chapter 7** describes the performance of linear growth during the study year, related not only to annual height gain, but also to annual weight gain and skinfold thickness gain at specific sites. In **Chapter 8** a brief analysis of food consumption in both social groups is presented and discussed. Finally in **Chapter 9**, the overall findings of the study are integrated into a discussion.

PART I Growth Concepts, Literature Review And Methodological Approach

This **PART I** examines the theoretical background to the questions associated with linear growth in healthy and growth retarded individuals but stressing the points related to adolescence. It presents and discusses the general methods adopted for collecting and analysing the data.

Chapter 1

Linear Growth, Concepts And Previous Studies

This chapter comprises a review of the literature on linear growth in "healthy" and "growth retarded subjects". It outlines the most discussed issues, highlighting the study of growth performance at adolescence as a particular important strategy for achieving a better understanding of the whole linear growth process, especially in developing countries.

1.1 General Growth Concepts

The growth and development of living beings have been for a long time a central theme of discussion and investigation.
Regarding the nature of the human variability, as well as the sex differences in body shape, size and tissue structure, many studies have been developed in order to assess the complexity of human growth. By definition, "growth" is the progressive process related to all changes (including the attendant increases in size) of human organism from conception to maturity (Sinclair, 1989). As a progressive phenomenon "growth" is considered to be involved in a series of changes, related not only to the addition of material to achieve an increase in size, but also to incidental destruction, substitution, alteration and modification of cells and tissues.

Although this study focused on the question of linear growth, i.e., the growth related to height, some aspects of growth in weight and fatness are also considered together.

1.2 Growth At Adolescence

From the time of conception, living beings experience several progressive changes. Some of these mainly occur during the period before maturity is reached. The greatest rate of linear growth occurs before birth, in the early fetal period. At this time, which is around the fourth month, there is an acceleration in growth and the increment per day is around 1.5 mm. After this, there is a deceleration in the velocity of gain in size. Thereafter, under proper conditions, the child must grow regularly and progressively in height and weight until maturity is reached and the linear growth completed. For this reason, the evaluation of the growth rate of a child is considered one of the best indices of her/his general health (Tanner,1981).

"Puberty is the time of the greatest sex differentiation since the early intra-uterine months.There are changes in the reproductive organs and the secondary sex characters, in body size and shape, in the relative proportions of muscle, fat and bone, and in a variety of physiological functions." (Tanner, 1989 page 58)

It seems that such changes are mainly determined by glandular secretions which only start functioning during this period of life (Tanner, 1989, Buckler, 1987). Consequently a sequence of events will occur until maturity is reached and the linear growth completed. In girls, puberty is a period when important changes occur. Under the influence of female hormones produced by the growing ovaries, all sex organs begin to grow preparing the body for the menarche and subsequent reproductive phase.

1.3 Menarche

There is no fixed rule for the occurrence of the events of puberty, but Buckler (1987), aiming to illustrate the phenomenon briefly, ordered the events for a female adolescent into the following sequence:

development of breasts development of pubic and axillary hair growth spurt of the body as a whole **menarche**

The onset of menstruation is usually a very marked moment in the pubescence process. Derived from the Greek words "meno" (month) and "arkhe" (beginning),

menarche is defined as being the first menstrual period. The occurrence of **menarche** indicates that a girl has probably achieved a critical level in her sexual maturation and that her reproductive phase is supposed to have arrived. **Menarche** generally occurs after the pubertal spurt, when there is already a deceleration in the growth velocity of height (Tanner, 1989, Buckler, 1987).

1.4 The Growth Of The Body And Its Parts

The growth of the body and its parts as a whole, occurs continuously until maturity is reached, but not at the same rate nor do all parts stop growing at the same time (Sinclair, 1989; Tanner,1989). Because of this characteristic, the body does not present the same proportions throughout the growth period. This differential growth seems to be related to factors such as endocrine system action, differential response of tissues, and differential performance in the maturation stages, to name but a few (Tanner, 1989).

At puberty, there is an acceleration in the linear growth velocity namely "pubertal spurt". In girls, this height spurt usually occurs earlier than in boys, somewhere between the age of 10 and 13 years. Even considering that there is a huge variation in the magnitude of the pubertal spurt, which would lead to the observed differences in adult height, it is expected that "the amount of height added during the spurt is to a considerable degree independent of the amount attained before."(Tanner, 1989 page 66)

In addition, during this pubertal spurt the standing height increase is determined both by spurt in leg and trunk lengths. However, it is the spurt in trunk length which is the major contributor to the spurt in standing height. This occurs because the leg reaches its spurt before the trunk.

Gasser et al.(1991) studied longitudinally the growth in body, trunk, leg and arm length of 413 Swiss children in various phases namely infancy, the mid-growth spurt and pubertal spurt. They have found that the overall pattern seemed to be the same in all variables,i.e., "velocity drops sharply after birth followed by a kink between 7 and 12 months, and a more gradual decrease until the mid-spurt, which peaks around 7 years. In girls the pubertal spurt immediately follows the mid-spurt, while in boys a 'latency period' of approximately constant growth velocity precedes the pubertal spurt, which occurs almost 2 years later, and is more intense than in girls...When comparing linear variables the pubertal spurt turns out to be earlier for the legs than for the trunk, whereas the trunk has an earlier mid-spurt...The growth of the arms in many ways resembles more that of the trunk and not that of the legs."

More complete information about the issue can be found in Tanner (1989).

1.5 Fluctuations In The Growth Velocity

According to Tanner (1981) it is not very well understood yet how the normal rate of growth is regulated and controlled. However, some efforts have been made recently in order to study the dynamics and intensity of linear growth. In relation to this aspect, it is known that there are some phases in the growth period when the velocity increases (namely spurt), and others when the velocity drops. Such fluctuations (named by Tanner as "mini-spurts") occur in every ordinary individual, sometimes as a response to minor episodes of illnesses and at other times for unknown reasons.

Hummert and Goodman (1986) based on data derived from a longitudinal growth study of predominantly white, middle class, healthy and adequately nourished subjects, suggest that "...episodes of common childhood illnesses have neither a major impact on early childhood growth nor a lasting effect on long term growth potential in a well-nourished population living in a developed nation." (Hummert and Goodman. 1986 page 377)

1.6 "Catch-Up" Growth

The recovery phase in which there is an acceleration subsequent to a deceleration in the growth velocity, caused by an organic imbalance, is known as "catch-up" growth. Within this context, "catch-up" growth is mainly related to complete or partial recovery in imbalances in growth determined and detected during the infancy period (Tanner, 1981). It is still not clear how "catch-up" growth is regulated, but Tanner (1981, page 237) calls attention to the point that "The completeness and speed of catch-up may depend on the nature of the grow-retarding influence...".

The "catch-up" growth phenomenon has been much explored in developing countries, where a large section of the population may present different degrees of growth retardation caused by malnutrition. Although there is no doubt that "catch-up" occurs during childhood, there is a more recent controversy about the possibility of the occurrence of a "catch-up" in growth retarded individuals during the adolescence period. Nevertheless, before discussing this point, it is necessary to clarify the circumstances in which "catch-up" is reported to occur.

1.6.1 Occurrence Of "Catch-Up" Growth

Tanner (1989) suggests that "catch-up" growth may occur in two ways:

1 - In **true complete "catch-up"**, when there is an extra increase in the growth velocity, so that the original curve is attained. Once this point is reached, the growth continues in normal speed.

2 - In **complete "catch-up" with delay**, when there is an extra increase in the growth velocity but, it is not strong enough to allow the original curve to be reached at first. Thus, maturity is delayed so, at the end, complete "catch-up" is achieved.

These types of "catch-up" growth are shown in Figure 1.1. Curve A represents **true**

complete "catch-up" growth, while Curve B and C represent **complete "catch-up" with delay**.

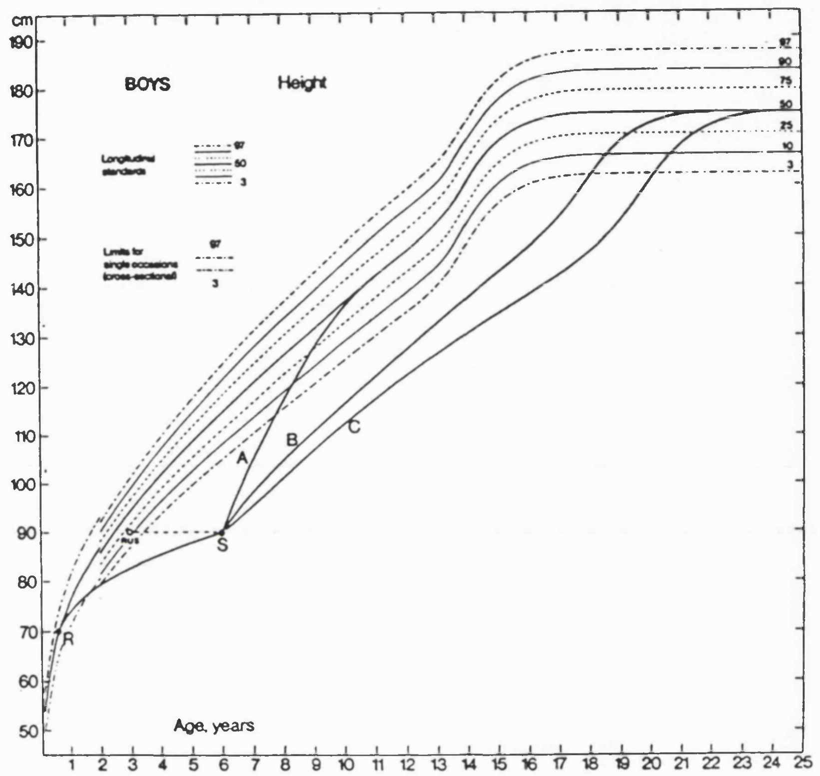

Figure 1.1 Types of "catch-up" growth.
Source: Tanner, 1989

However, it is still unclear whether "catch-up" growth can occur and/or completely compensate for the growth retardation of malnourished individuals. This is due to some evidence that "children starved early in utero through some imperfection of the placenta usually fail to catch-up completely." (Tanner, 1989 page 169-170)

1.7 Factors Influencing Linear Growth

It is well known that there is great variation in human growth (Eveleth and Tanner, 1976, 1990, Harrison and Schmitt, 1989). In addition, experience has shown that various factors can affect the rate of growth and development. Some of them are genetically controlled while others are recognized to be influenced by environmental circumstances (Bogin, 1988). In fact, both these factors do not seem to act separately but interact in their influences throughout the whole growth period. As a result of this interaction, different kinds of response can be generated. Some studies carried out in the last two decades in different developed countries, have shown that there were positive changes in the growth pattern of their children. All these studies have demonstrated that these results were justified mainly by the improvement of nutrition and health care conditions of these populations (Ferro-Luzzi et al.,1978; Akerblon,1978; Prokopec and Lipkova, 1978; Mariani et al.,1978; Eiben, 1978; Ling and King,1978).

Susanne et al. (1987 page 87) suggest that, "In normal, healthy and well-fed populations, body size is the expression of a genetic programmation ...In these populations, small size is genetically determined and is not related to negative functional or cognitive parameters. That cannot be the case in populations where the genetic factors become dominated by environmental stressors."

It seems that perhaps the question of the environmental influences on growth in developing countries is more related to the weight it assumes. Thus, even in developed countries common family environmental influences can not be excluded from the analysis context (Rona, 1981).
In addition, the real differences in adult height of different ethnic groups, existing all over the world, would lead us to think that the influence of genetic determinants on growth, can not be excluded (Waterlow. 1992).

In the case of developing countries, the influence of genetic factor itself does not seem to be a decisive factor in explaining the variation in growth performance. This assumption is based on the fact that the largest difference in stature in children at ages 5 to 7, attributed to genetics is about 3.5 centimetres, when compared to the NCHS reference (Martorell. 1988). In contrast, differences of about 12 centimetres or more, could be attributed to poverty conditions. The analysis of the influence of genetic factors on growth is beyond the aim of this research.

In this thesis, factors influencing growth of individuals of the same ethnic group but living in different social conditions are considered with particular attention to the environmental factors which can influence growth patterns.

Some studies indicate that the genetic contribution in any phase of growth (intra-uterine and postnatal) is not total but, to some extent, correlated with nutritional availability. By this it is meant that, during the growth process some phenotypic modifications can occur and these are due to physiological processes which are developed as a form of response to external stresses (Roberts,1985). Embodied in this statement is the fact that environmental conditions such as nutrition, disease, socio-economic status, urbanization level, physical activity, psychological stress, seasons of the year and climate are considered as the most important factors which can influence the rate of linear growth (Eveleth, 1978, Bogin, 1988).

Nevertheless, whatever is the cause of the disturbance in the rate of linear growth one thing must be borne in mind when considering the matter: "The more severe the growth-retarding influence, the longer it acts and the earlier in life it occurs, the worse the ultimate outcome....The further an animal is below its (own) growth curve when rehabilitation starts, the worse the ultimate deficit."(Tanner, 1981 page 237)

Figure 1.2 shows the probable interactions between environmental and genetic factors on growth according to Susanne (1987). Given the complexity of the issue, discussion is limited to linear growth as influenced by malnutrition and poverty. This focus is based on the fact that growth retardation is considered to be one of the most important health problems in Brazil.

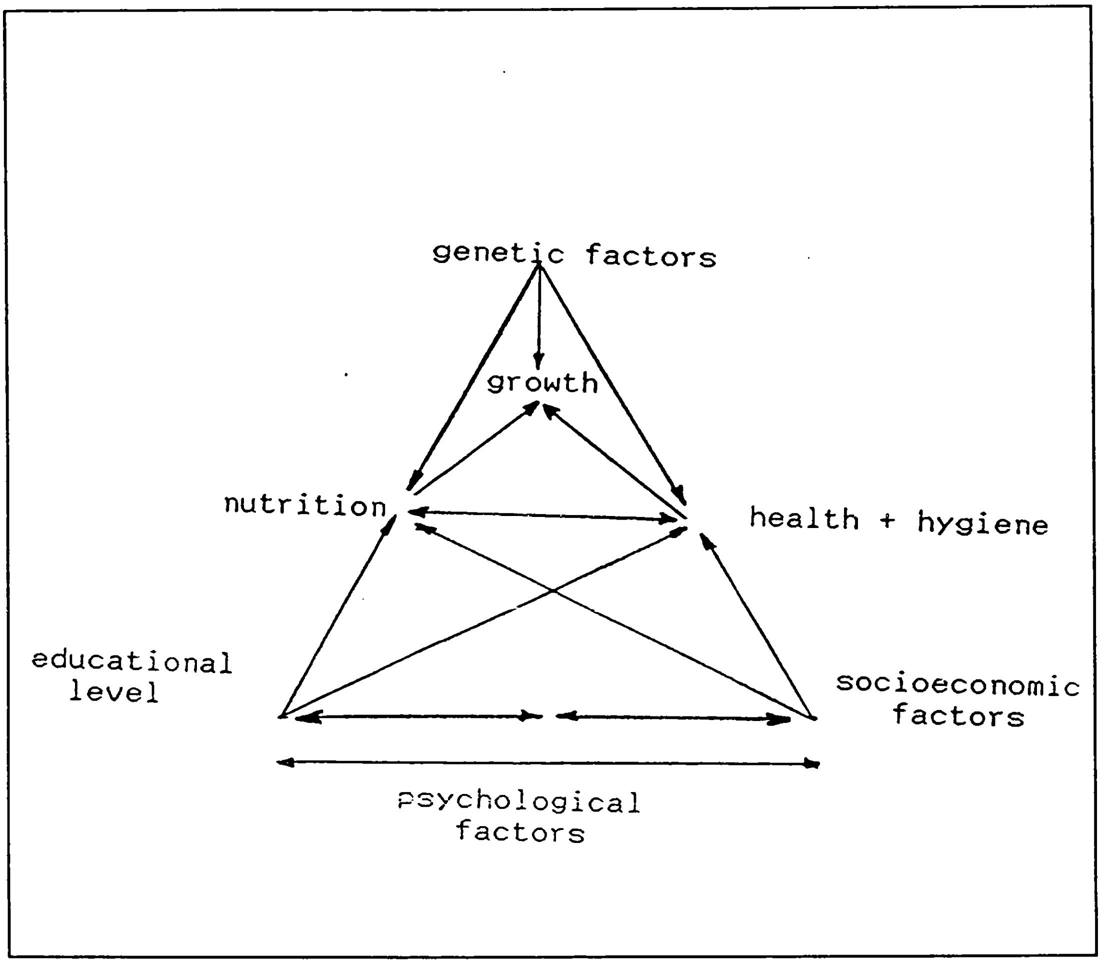

Figure 1.2 Interaction of environmental and genetic factors influences on growth
Source:Susanne, 1987

1.8 Growth Retardation

In developing countries, growth retardation appears as a form of biological response of the organism to the nutritional stress which is usually connected to factors such as poverty, infection and inadequate dietary intake (Martorell et al., 1988, Nabarro et al., 1988, Tomkins, 1988, Chandra, 1988, Ulijaszek, 1990).

These conditions are not uncommon in developing countries, where the distribution of wealth (land ownership, purchasing power), the absence of public services (as potable water, waste disposal systems,preventive and curative medical care), .as well as lack of educational opportunities have contributed enormously throughout the years to building the child and adolescent growth profile (Martorell, 1980, 1985, 1988; Bogin and MacVean,1981).

1.8.1 Nutrition And Infection

Before going further in this exposition, it is necessary to understand why children under 5 years of age usually are from the considered "vulnerable groups". In Latin "vulnerabilis", vulnerable means "susceptible of injury" or "exposed to damage". Therefore, it seems that the concept of vulnerability is linked to the susceptibility to resist infection.

One of the most important pathways through which the body controls or drives this resistance is called the **immune system**. Consequently, a failure in the immune system usually increases the vulnerability of the body to respond to the stress. There are two types of immune mechanisms: the non-specific, namely **innate** and the specific, namely **acquired** (Winwood and Smith, 1992).

The acquired immunity depends on two types of responses by the tissues: **humoral and cellular**. Both of them depend upon cells of the lymphoid system. According to Winwood and Smith (1992), "Nutritional and endocrine factors affect the health of the lymphoid system and therefore the adequacy of the acquired immune response."

Although the relationship between nutrition and infection is sometimes synergistic and complex, there is evidence that the effect of malnutrition on the immune system is much greater in childhood than in later life. This is because the intensity of the interaction between nutrition and infection, seems to be linked to the immune system maturation.

Passmore and Eastwood (1986, page 563) say that "At birth, the lymphoreticular system is very immature and its functional capacity limited. Maturation is slow and is completed only after several years....Malnutrition and undernutrition delay the development of immunity response..."

Therefore, it is expected that at least up to the age of 5 the child is able to mature her/his own immune system. However, it is not clear what happens afterwards, i.e, whether the childhood background, in terms of repeated episodes of infection during the early years of life could be associated with future increased susceptibility to get ill. In addition, one must recognize the influence of the social environment on the malnutrition / infection relationship in the context of a malnourished individual (Waterlow, 1992).

Thus, in developing countries, attention has been focused particularly on the groups considered to be more vulnerable to the risk of infection that could lead to a growth retardation.

1.8.2 Growth Failure

Two situations have been defined to illustrate the process of growth failure: in the first, the individuals are identified as "failing to grow", and in the second, as those having "failed to grow" (United Nations, 1990). The implication of this terminology is that it is necessary to identify at what age the individual can be said to have moved from the first situation to the second, i.e., at what age the linear growth retardation effect is irreversible. Such a point can only be identified if the linear growth retardation process is fully understood.

It seems that, initially, such a timetable was established around the age of 2 to 5 years. This would lead us to conclude that after the age of 5, the individual had already "failed to grow", i.e., their height deficit in relation to a reference standard was already established. This assumption has stimulated several investigations in this area, seeking evidence whether or not this height deficit could be reversed after this age during later childhood or during the adolescence. But the results have not been conclusive. As can be seen from the following list there are different findings, some of which are contrasting:

1 - It is possible for a partial "catch-up" growth to occur in females (Satyanarayana et al., 1981) but not in males during adolescence (Satyanarayana et al., 1980).

2 - There is no "catch-up" during this period either in females or in males (Billewicz and McGregor, 1982).

3 - There is no "catch-up" for boys nor for girls, but the height difference in girls increases from childhood to adulthood (Bogin et al., 1992).

4 - Differences in rate of growth between social groups increase during the adolescent spurt in boys and girls, and limit the possibility of "catch-up" growth (Bogin et al., 1989).

5 - There is no additional height deficit in boys during puberty, although pre-puberty height deficit is carried through to adulthood (Satyanarayana et al., 1989).

6 - The growth is normal after 5 years of age, regardless of the degree of stunting. and, there is no "catch-up" growth during adolescence either in males or in females (Martorell et al., 1990).

7 - There is "catch-up" in males and females in late childhood and adolescence (Brown and Townsend, 1982).

It is important when considering such results to note that they are related to different ethnic populations and therefore a genetic contribution must be present. Nevertheless. the elucidation of whether later childhood and/or puberty play a role for determining adult stature depends on extensive investigations still to be carried out in this area.

1.8.3 Stunting, General Concepts

Stunting means a significant slowing in skeletal growth (WHO, 1986, Keller, 1988). The occurrence of stunting may signify the existence of a relatively long time of deficiencies or continued and repeated imbalance in the diet as well as the intervention of other factors, such as infections and malnutrition (Keller, 1988). As the process of gain in height is considered to be slower than the gain in body mass, it has been claimed that stunting may not be established nor reversed rapidly. In addition to this, the prevalence of stunting in developing countries seems to increase after the second year of life (WHO, 1986), with values ranging from 20% to 70% (Keller, 1988).

1.9 The Question Of Body Size

In addition to what was previously described, the study of growth retardation in developing countries concerns a very polemic question, the significance of body size. The heart of the discussion seems to be the implication of the outcome for social and health policies. The interpretation of the relationships among malnutrition, stunting, adaptation, and the probable repercussions of such issues over the public health policy-making is not simple, however, some points must be considered. There are considerable differences of opinion among experts, and two distinct views at least are found to prevail over the discussion. The first one led by Seckler (1982) and Sukhatme (1982) argues that the individual can adapt the body's requirement to intake, in order to survive in an adverse environmental condition without any functional impairment. In this context the term adaptation is seen as a "strategic metabolic and functional retreat" by which the individual survives and lives "small but healthy". Based on this assumption they argue that the question of undernutrition must not be overestimated as it has been by governments and that nutrition programmes must be more restricted.

In contrast, Waterlow (1985, 1986, 1989), Gopalan (1983, 1988), Spurr (1988a, 1988b), Van Lerberghe (1988), Beaton (1985, 1989), Martorell (1985), and Martorell et al. (1988) argue that, in order to survive in an adverse environment, the individual's organism can adapt its metabolism to the current condition, but this does not mean that this adaptation presents an acceptable level of functional capacity nor has it been achieved without any kind of cost. It seems that within this approach "adaptation" is referred to more as a process rather than an absolute "state of being". For instance, in this context, during the process of adapting to environmental constraints the individual can present a development impairment as a response to this stress (Waterlow, 1985). This ability to respond and consequently to survive does not however provide enough information about the implication of this adaptive response nor to the respective quality of life (Carareto, 1990). Thus, if the deceleration of linear growth, stunting, is considered as an adaptation this does not mean that it is a successful adaptation since there is some evidence of a link between stunting and subsequent risk of dying (Van Lerberghe, 1988), and stunting and duration of infection (Martorell, 1985). In addition, Gopalan (1988) has an interesting discussion on the question about its implications for the Public Health policy. It seems, that these opposing perspectives are based on different theoretical approaches. Payne and Cutler (1984) and Payne (1985) detail the baseline for such controversy by demonstrating the main differences between these theoretical models, namely "genetic potential" and "individual adaptability".

According to Payne and Cutler (1984 page 1486), the main characteristics of the "genetic potential model" are:

1 - "That the body is a system which is not only self-regulating, but self-optimizing. For each individual there is a preferred state characterized by a unique set of values of the variables which describe the system components (weight, height, blood levels, etc.)".

2 - The interindividual differences are determined by genetic constitution.

3 - "Malnourished states can be detected and graded for severity by the extent of deviation of one or more state variables from the preferred levels."

The implications for accepting this model are: first, in this model, only the absence of recognisable disease does not imply that the individual experiences good health. Second, the genetic potential is accepted as being the optimum state. Third, based on this second assumption, well-off populations would provide better estimations of normal values for biological variables such as body dimensions, growth rates etc., and consequently nutrient requirements can be estimated. And finally, the comparison of populations can be made in relation to these references.

The characteristics of the "individual adaptability" model start from the same point, i.e., the body is a self-regulating system; however, in contrast to the "genetic potential" model, there is no optimum state, i.e., "the body can adapt to a range of different diets and environments ..." Therefore, the state of nutrition, the amount of food needed to maintain that state are the outcome of the relationship between the individual and his or her environment."(Payne, 1984 page 1489)

Consequently, with an enlarged capacity for adjusting, there is no necessity to define requirements. The amount of food required to maintain the adapted individual will be determined by the relationship between the individual and the environment. In this sense, a growth retarded person is an adapted individual, who will need less food to maintain its equilibrium.

Distinction must be made however, between a technical matter and an ethical question. Professor Waterlow (1986) emphasises this point by saying that "... in reply to those who maintain that stunting is a satisfactory adaptation one might invoke the UN declaration of Human Rights that everyone has a right to develop their full genetic potential."

1.10 Growth Studies Outside Brazil

It can be said that at the present stage of world urbanization, the social conditions of developing countries, as well as the quantitative increase of human populations, have stimulated the analysis of different patterns of growth performance in rural and urban areas. In this sense, several studies concerned with this issue were developed along different approaches such as:

1 - Studies considering Rural-Urban comparisons
2 - Studies considering linear growth among migrants to urban areas
3 - Studies considering intra-Urban and intra-Rural individual's linear growth performance
4 - Studies considering linear growth related to socio-economic status

1.10.1 Rural-Urban Differences

The rural-urban differences of growth performance are analyzed especially in relation to the body weight and size by Spurgeon et al.(1984) and Steele and Spurgeon (1983). The Steele and Spurgeon (1983) study was related to rural and urban black girls, aged 8 to 9 years, and the Spurgeon et al. (1984) study was related to rural and urban Nigerian boys, aged 8 to 9 years.

In both studies the authors found that the rural individuals were shorter than their urban counterparts. but the authors did not explore more carefully the causal factors for such differences. Hence, these reports can be considered as being of a descriptive nature only.

1.10.2 Growth Among Migrants To Urban Areas

This approach explores mainly the biological consequences of human mobility, namely migration, to the question of growth. In this context, the link between rural to urban migration and the individual's linear growth becomes a much discussed point. However, the literature sometimes seems to be ambiguous about the issue. Some studies find that migrants are taller and heavier than those who do not migrate (Yarbrough et al., 1975; Bogin & MacVean, 1978), others show migrants as the shortest in comparison to those of the new urban environment (Macbeth and Boyce, 1987; Mjones, 1987; Bogin and MacVean, 1981), while others disclose results in which migrants present similar anthropometric dimensions to the sedentary population (Malina et al., 1982).

Another point related to this approach is that, when considering the influence of migration event on the linear growth, some factors must be investigated carefully such as:

1 - Origin of migration
2 - Parental migration status
3 - Age of migration
4 - Socio-economic status of the family

Actually, in considering all of the above factors, the existence of two distinct situations, at least, should be better elucidated. This amounts to saying that, if the first studies argued the positive correlation between larger size and the probability of migrating (theory of physical selection of migrants), the last studies demonstrated that the opposite situation also occurs. This can be observed especially in developing countries, where the decision to migrate is mainly associated with the necessity of improving the quality of life.

1.10.3 Intra-Urban And Intra-Rural Growth Performance

This approach analyses the individual's growth performance in an urban or rural context. In such a case, some variables such as socio-economic status, cultural practices and ethnic differences have been linked to the results (Wagstaff et al., 1987; Corlett, 1986; Malina et al., 1980; Bailey et al., 1984; Bogin et al., 1984). The majority of these studies are descriptive and do not extend the analysis of the causal factors of the observed differences between the groups studied and the standard reference values for growth status.

In contrast to this, Malina et al.(1980) and Bogin et al.(1984) expanded the analysis, paying careful attention to the environmental context. Therefore, variables such as water and sanitary facilities, available health care in the community, nutritional environment and even economic conditions, were pointed out to have a decisive influence on growth.

1.10.4 Growth Related To Socio-Economic Status

In this approach, the individual's growth performance is considered in relation to her/his socio-economic status. The results are widely known, especially in the developing countries. All these studies are unanimous in demonstrating that the growth pattern is directly related to the individual's socio-economic status. The poorer the individual, the larger the statural deficit (Martorell et al., 1988; Lasker & Mascie-Taylor. 1989; Mascie-Taylor & Boldsen, 1985; Bogin & Mac-Vean, 1978; Ryan et al., 1990; Rona & Chinn, 1984).

1.11 Growth Studies In Brazil

In Brazil, the majority of growth studies are focused on children less than 10 years. This occurs mainly because malnutrition is widely identified in the childhood age-

groups of the poorest regions of the country.
Traditionally, when some growth retardation, namely stunting, has been found to occur, it is usually identified as having a close connection with protein-energy malnutrition (PEM). In addition, it is widely accepted by the majority of Brazilian nutrition researchers that PEM in Brazil is an effect of poverty, since its occurrence is always strongly associated with low income, poor dietary intakes, low standard of housing, poor living conditions and frequent events of infectious diseases (Batista Filho et al.,1981 , Campino, 1986 , Freitas et al., 1987 , Monteiro et al.,1986 , Neto et al.,1987 , Ferreira and Ott, 1988 , Anjos,1989 , Monteiro et al.,1989, Desai et al., 1981, INAN, 1990, Monteiro et al., 1991).
The results can be resumed as follows:

1 - PEM in Brazil is strongly associated with a low socio-economic level, and also with poor living conditions such as absence of sanitation, bad housing, deficient health care etc.;
2 - There is a remarkable height deficit in poor children at the end of the childhood, especially in those from the poorest regions of the country;
3 - This developmental impairment is identified more as stunting than wasting;
4 - The high prevalence of PEM in Brazil, as associated with infectious diseases, may explain the occurrence of stunting;
5 - The slowing of growth seems to appear only after the first months of life.

The review presented here only refers to a fraction of the literature on PEM related to stunting as far as Brazil is concerned. Particular attention however, has to be paid to some details of the cited points.

Monteiro et al. (1992), based on recent data derived from the PNSN (1989) - national survey - show that in Brazil, the prevalence of malnutrition, stunting and wasting, in children aged up 5 years differ. For instance, it was found that in boys, the prevalence for stunting was 16.3% while for wasting it was 2.4 %. In girls, the prevalence for stunting was 14.5 % while for wasting it was 1.7 %.

The evaluation of the two national surveys in Brazil, ENDEF (1975) and PNSN (1989), indicates that, during the 1970-1980 decades there was a significant reduction in the prevalence of malnutrition related to weight-for-height (wasting) in children aged up to 5 years (Monteiro et al., 1992). According to the authors, in boys the reduction was from 18.7 % in 1975 to 6.8 % in 1989, while in girls the reduction was from 18.1 % in 1975 to 7.4 in 1989. This means that from 1975 to 1989 the Brazilian malnourished population decreased from 2,222,843 to 1,167,347.

One of the reasons contributing to such an improvement, was the economic situation existing in the 1970 decade. This is evident from the large change in the percentage of individuals living in "absolute poverty", i.e., with a per capita income of less than 1/4 of the Brazilian official minimum wage (to be defined in Chapter 2) from 1970 to 1980. In 1970, 54.1 % of the Brazilian population lived in "absolute poverty" while in 1980 it decreased to 25.7%. However, this trend was not linear, and in 1988 the percentage increased to 32.5%.

The distribution of the individuals at "absolute poverty" differs across the country. Between 1985 and 1988 the percentage according to the regions were: North 23.5 %, **Northeast 52.5 %**, Southeast 17.0 %, South 21.2 % and West-Centre 25.3 % (Monteiro et al., 1992).

Figure 1.3 gives recent information about the prevalence of malnutrition in Brazilian children aged up to 5 years (Monteiro et al., 1992) in different regions of the country. As can be seen, the Northeast and the North regions of Brazil have the highest prevalence of stunting, and have the less favourable condition found in the rural area.

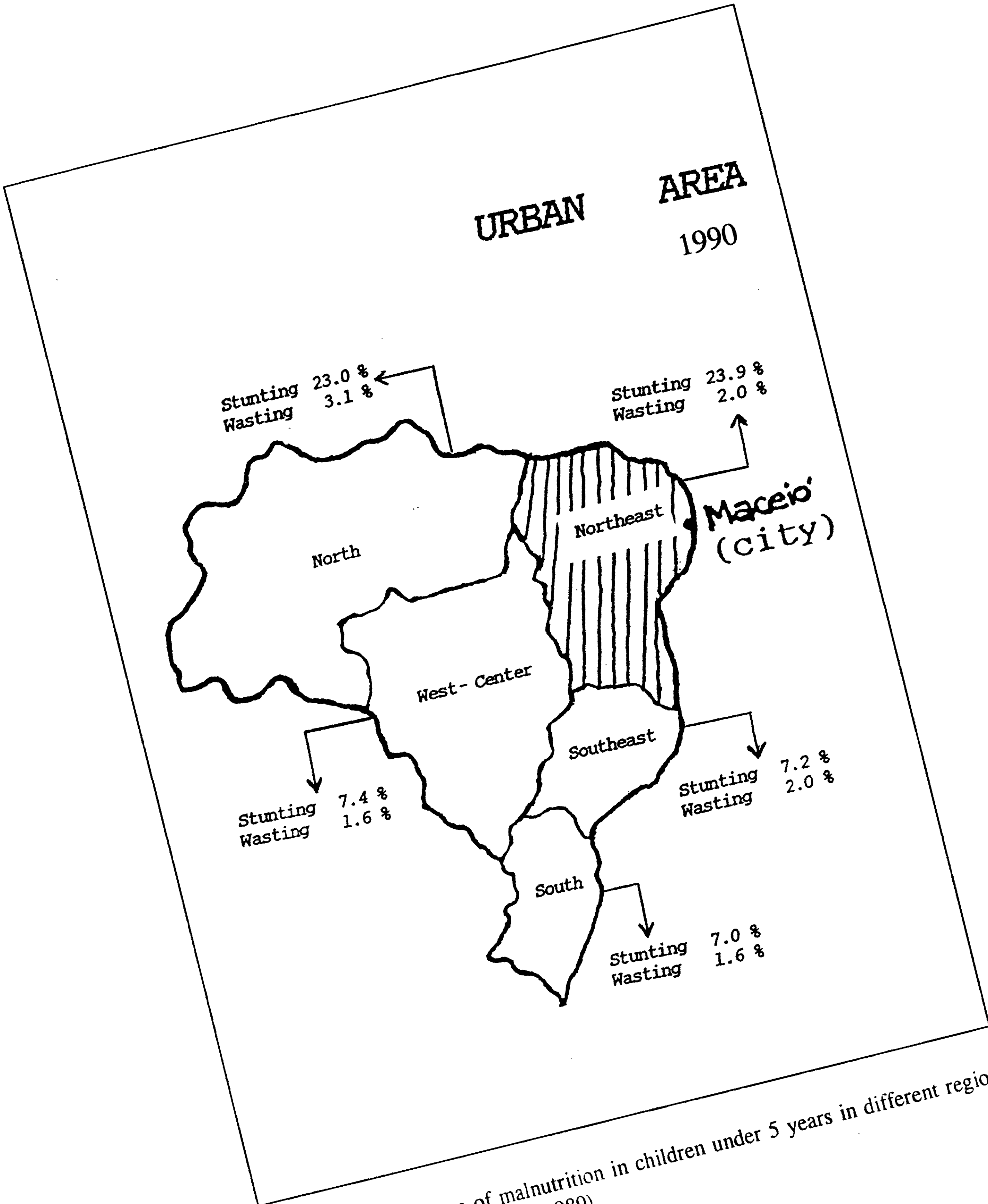

Figure 1.3 Prevalence of malnutrition in children under 5 years in different regions of Brazil (PNSN - 1989)
After: Monteiro et al., 1992

On the other hand, the access to health services, education, water and safe sewage systems increased linearly from 1970 to 1988. Figure 1.4 shows the evolution of these services in the **Northeast** region from 1970 to 1988.

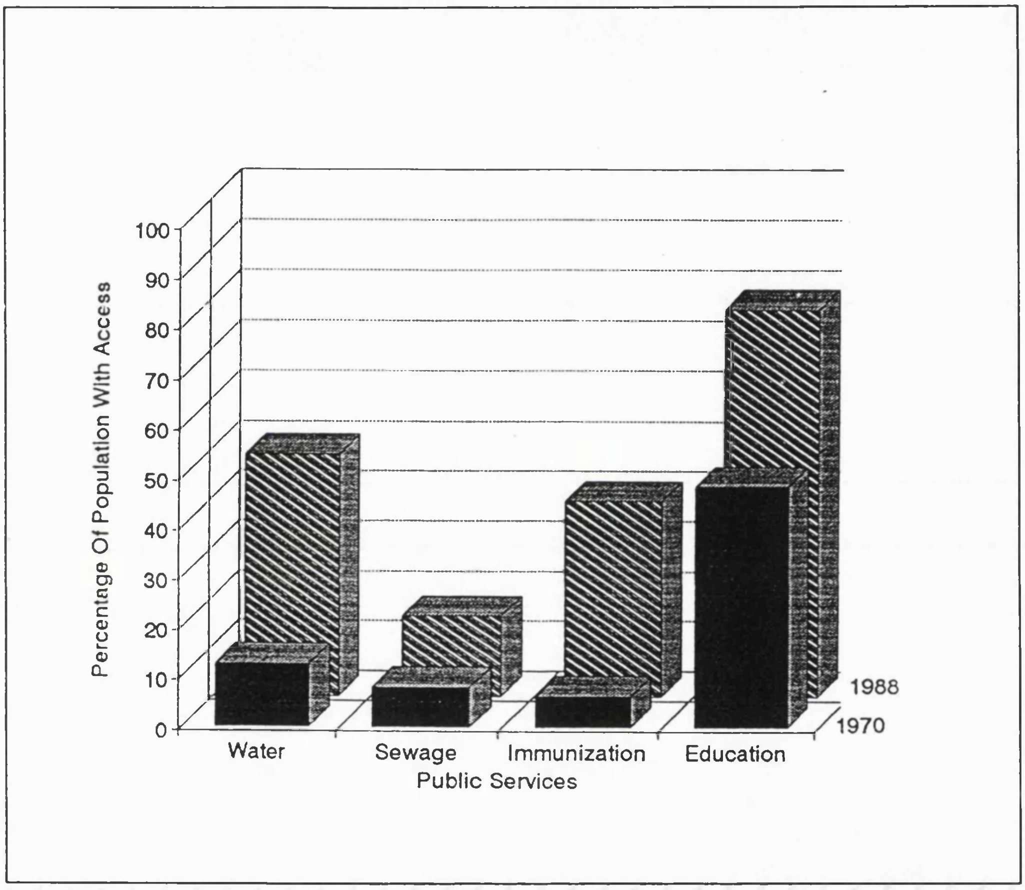

Figure 1.4 Selected economic indicators of development for the **Northeast** region during the 1970 and 1980 decades
After: Monteiro et al., 1992

The prevalence of malnutrition, stunting and wasting, in Brazil is similar to other countries of South America. Figure 1.5 shows how malnutrition, stunting and wasting is distributed in South America. Although the figure comprises results for different years, it helps to indicate the trend in this continent.

Figure 1.5 Prevalence of stunting and wasting in South America according to Monteiro et al. (1992)

Another important point is the Brazilian secular trend for linear growth. Monteiro et al. (1993) state that there is an indication of a positive secular growth trend for the Brazilian population. The authors found that from 1952 to 1967 there was an increase of 1.0 cm per decade, and from 1967 to 1982 the increase was 2.4 cm per decade. This trend was observed for both sexes of the five regions of the country and, from different income levels. According to the authors, such increments are comparable to the Japanese children born after 1950. Nevertheless, one point still persists immutable: the height deficit detected in Brazilian children in relation to the NCHS reference at 7 years seems to remain at adult age. Table 1.1 presents the mean height deficit of the Brazilian population at 7 years of age and at adult age.

Table 1.1 Mean height deficit (cm) of Brazilian population at age 7 and at adult age in relation to the NCHS*

	Males		Females	
Birth Year	age 7	adult age	age 7	adult age
1951-1953	-	8.5	-	7.4
1966-1968	7.3	7.2	6.6	6.4
1982-1983	3.7	-	2.9	-

* Source:Monteiro et al., 1993 page 5

The decrease in the height deficit seen in the last period (1982-1983) can be due partially to the values of attained height derived from the most developed regions of the country such the South and Southeast regions. Evidence of this assumption can be seen in the distribution of prevalence of stunting among Brazilian children aged up to 5 years in different regions of the country.(see Figure 1.3)

In addition, Figure 1.6 gives information about the prevalence of stunting in the young Brazilian population aged between 20 and 25 years (PNSN, 1990).

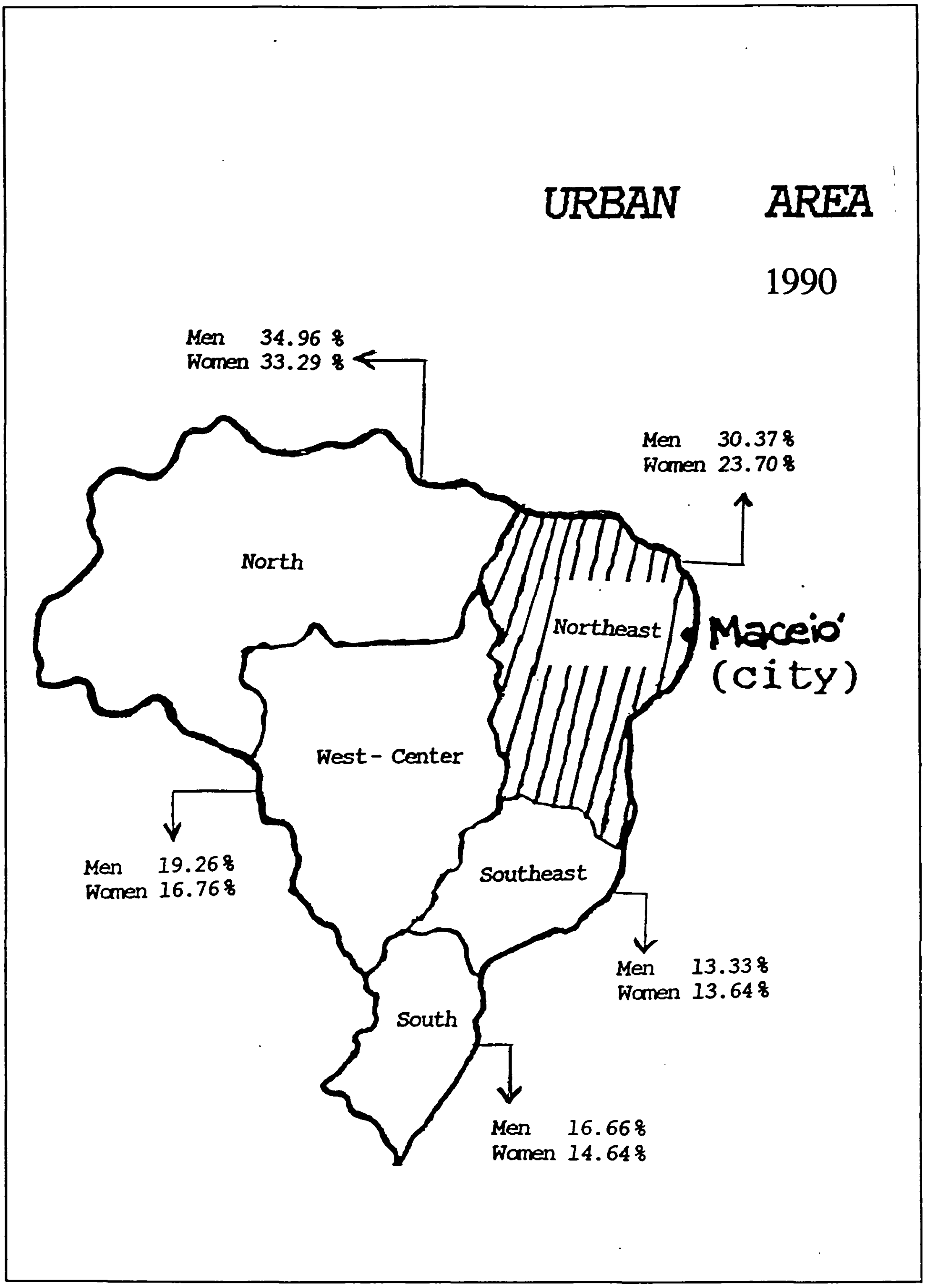

Figure 1.6 Prevalence of stunting in the young Brazilian adult population (20 - 25 years)

Once more the North and **Northeast** regions have the highest levels of stunting. It is interesting to note, that although the height deficit in relation to the NCHS reference is similar at age 7 and the adult age (see Table 1.2) the prevalence of stunting is higher in the adult group (see Figure 1.6) than in the children under 5 (see Figure 1.3).

1.12 Statement Of Purpose

All previous findings in Brazil demonstrate that the available information already provides some useful insight into the health condition of the population. Based on this information, political decisions have been formulated and new strategies have been planned. However, if on one hand this approach allows the monitoring of the vulnerable groups, on the other it excludes one important population parcel, for instance the adolescents. This gap constitutes an important lack of information, not only in Brazil but in developing countries as a whole, which has been frequently indicated by the scientific literature every time there is a necessity of speaking about adolescents (WHO,1985 and 1986).

Particularly in the case on Brazil at least one question remains unanswered. It is detected that there is evidence of linear growth retardation (stunting) in Brazilian children, when they complete early childhood. Does this fact carry any additional risk or repercussion in the adolescent group?

Very little is known about this subject in Brazil. In addition, it seems clear that the study of growth retardation in Brazil must explore the puberty period as well. This approach is pertinent to the actual stage of Brazilian development, not only for the valuable information that would advance the comprehension of the linear growth process but also because there is a large parcel of the young population in Brazil who live in extremely poor conditions.

In view of all that has been considered above, this thesis evaluates the growth performance of the individual during the phase of the adolescence period between 9 and 13 years. It must be borne in mind when considering the results, that the analysis of the data was done in the light of the "genetic potential" model approach. The study was developed in Maceio, the capital of Alagoas - a Brazilian state.

The aim of this study is as follows:

1 - To assess by anthropometry the "nutritional status" and "physical growth status" of female adolescents of different social classes.
2 - To compare longitudinally the growth performance of both social groups in relation to their respective "growth status".
3 - To assess the age of menarche occurrence in both social groups and to study its interaction with anthropometric and social factors.
4 - To assess the morbidity pattern of both social groups and to investigate its interaction with anthropometric and social factors.
5 - To assess dietary patterns of both social groups and to explore its interaction with anthropometric and social factors.

The reasons for such a purpose is based on factors such as:

1 - Alagoas is a state from the Northeast region of Brazil, which is one of the poorest regions of the country with the highest prevalence of stunting. Maceio as the most important urban setting of the state, seems to be an adequate site for the study.
2 - The present type of study has not yet been attempted either in the city or in the state. Therefore, the result of this study seems to be an opportune contribution to provide information about variation in growth performance of adolescents of different social classes and "growth status".

1.13 Hypotheses

The hypotheses being tested were the following:

Hypothesis 1

Studies carried out in the last decade have demonstrated that when a parcel of poor children complete childhood, they have a height deficit identified as stunting. This amounts to saying that some poor children will enter the period of adolescence with a height deficit already in relation to their well-to-do counterparts.

Prediction

It would be expected that at the beginning of the first phase of the adolescence period, the poorest individual would tend to present a height deficit in comparison to her/his well-to-do counterpart, as well as in comparison to the Brazilian National Reference and the NCHS standard reference.

Data Collected To Test This Hypothesis

1 - Social data

This data was collected by applying a social questionnaire (see APPENDIX A).

2 - Anthropometric data

Body measurements were made on the individual, in order to assess attained size as well as the nutrition profile (see Chapter 2)

Hypothesis 2

It has been suggested that after age 5, the growth rate is independent of the degree of growth retardation established in the individual and therefore, as the growth at adolescence has normal characteristics, it does not present a "catch-up" pattern.

Prediction

It would be expected to find similar increments among girls of distinct social classes over the period until cessation of growth

Data Collected To Test This Hypothesis

1 - Longitudinal anthropometric measurements

Annual increments were calculated based on the longitudinal anthropometrical measurements

Hypothesis 3

It has been claimed that adolescents of lower socio-economic level, who are growth retarded, enter the pubertal spurt later than their well-to-do counterparts, hereby causing a delay in their menarche.

Prediction

It would be expected that poor adolescents would enter the pubertal spurt later than their well-to-do counterparts, with a delay in the onset of the menarche.

Data Collected To Test This Hypothesis

1 - Age at menarche

The age of menarche was recorded in a prospective and retrospective view.

Hypothesis 4

It has been claimed that the leg/trunk length can be an important indicator of earlier or later puberty.

Prediction

It would be expected to find different values for trunk/leg length proportions between individuals of different maturation levels, and especially in those with some degree of growth retardation.

Data Collected To Test This Hypothesis

1 - Anthropometric data (sitting / standing height ratio)

Hypothesis 5

Some reports suggest that the food intake level is strongly related to the income level of the family, but in Brazil such deficit is more energy than protein-related.

Prediction

It would be expected to find adolescents in the poorest sector of the population with a deficient food intake level, as well as a deficient intake of energy.

Data Collected To Test This Hypothesis

1 - Dietary intake

Hypothesis 6

It has been suggested that the social environment influences the relationship between malnutrition and infection in a poor malnourished child, and that the impact of infection is greater on weight gain than on growth in standing height.

Prediction

If this trend continues throughout the adolescence, it would be expected to find: first, a higher incidence of illnesses in girls who live in a poor environment. especially in those growth retarded and second, a decrease in weight gain but not to such an extent in height increment.

Data Collected To Test This Hypothesis

1 - Reported morbidity

2 - Weight and standing height gain

Chapter 2

General Methods

This section covers the details related to the methodological approach adopted for developing this thesis. It provides details about the methods for assessing the subjects and for analysis of the collected data. First details are presented concerning the **setting** where the study was developed, then the aspects related to the **study group**. After this, the methods are described by which the data were collected.

2.1 The Setting

This research was carried out in **Maceio**, the largest and most important city of the Alagoas State (see Figure 2.1).

Figure 2.1 The Maceio city

Maceio is considered the central area of the State for socio-cultural and economic activities. Alagoas is a Northeastern state of Brazil. It lies on a latitude of 10 degrees south. In Maceio, as well as in the Northeast Region, the climate is predominantly warm and humid and is tropical.

There are two seasons: the summer, when the temperature reaches high values without rain (from September to February) and winter, when the temperature falls a little and it rains significantly (from March to August).

The weather does not vary greatly during the year nor does the day temperature. The Dry Bulb Temperature (DBT) rarely reaches 34 degrees C and the minimum average in "winter-time" is around 22 degrees C, and the relative humidity of the air is around 81%.

2.1.1 Population Structure

In order to characterize the composition of Maceio's population, data from the United Nations (1982) were used. Table 2.1 shows the age-sex-structure of the population.

It is important to notice that the analysis of within-population differences regarding biological parameters is a quite difficult issue, especially when this population is as racially mixed as that of Brazil. All over the country there were different kinds of migration flows according to the economic development of the various regions. In the Northeast region the population is regarded to be composed from a mixture of Portuguese whites, African negroes and Brazilian indians. Consequently, given the complexity of the "nordestinos" ethnicity, the separation of races was difficult and therefore, the universatility of the differences detected in this thesis should be interpreted with caution.

Table 2.1 Population percentage distribution by sex and age

	1 9 9 0		
Age Group	Both Sexes	Males	Females
0 - 4	13,1	50,6	49,4
5 - 9	12,0	50,5	49,5
10 - 14	11,1	50,5	49,5
15 - 19	10,2	50,5	49,5
20 - 24	9,5	50,4	49,6
25 - 29	8,6	50,3	49,7
30 - 34	7,3	50,2	49,8
35 - 39	6,1	50,1	49,9
40 - 44	5,0	50,0	50,0
45 - 49	3,9	50,0	50,0
50 - 54	3,3	50,0	50,0
55 - 59	2,7	49,8	50,2
60 +	6,9	49,6	50,4

Adapted from United Nations (1982).

As seen from the table, children up to 9 years of age, and adolescents from 10 to 19 years, constitute 46,4% of the whole Brazilian population, their values being 25,1% and 21,3% respectively.

According to Fundacao Estadual de Planejamento Agricola de Alagoas (CEPA/AL), in 1980 the active economic population represented 33% of the whole population. Such data reflect the existence of a large dependent sector. It may be, however. that these data only reflect the official employees of the state, and of course of Maceio. Anyway, the lack of job opportunities. especially in rural areas, also seems to stimulate the migration to urban areas.

2.1.2 Population Dynamics

It is well known that population dynamics vary according to human movements, namely migration, as well as through fertility and mortality (Frenk et al., 1987; Bogin, 1981). In this sense, it can be said that the spatial evolution of the population, rural and urban can be explained by migration phenomenon.

Basically, according to Frenk et al. (1987), the phenomenon of migration can be divided into 5 types as following:

1 - Rural-to-Urban
2 - Rural-to-Rural
3 - Urban-to-Rural
4 - Urban-to-Urban
5 - International

The different types of migration identify the change of origin and destination. It is important to note that the most prevalent type of migration in Latin America over the past three decades has been the Rural-to-Urban migration (Frenk et al., 1987; Bogin, 1984). It has been claimed that the decision to move can be induced by many reasons as for instance:

1 - Economical
2 - Political
3 - Environmental questions
4 - Educational opportunities
5 - Family ties
6 - Improvement of health status

It seems that these causes are likely to vary mainly with factors such as region, period of time and particular condition of the family or of the individual. There is however. a general agreement that in Latin America, the decision to move is motivated by a combination of causes such as economic, educational etc. (Frenk et el., 1987). This is the case in Brazil.

According to IBGE (Instituto Brasileiro de Geografia e Estatistica) data, in 1980 the population of Alagoas was about 1,989,700 inhabitants, of which 49.2% were in urban areas and 50.7% in rural areas. Table 2.2 shows the spatial evolution of the population of Alagoas as well as of the Northeast Region and Brazil.

Table 2.2 Spatial population's evolution of Alagoas, Northeast region and Brazil

	Alagoas %		Northeast %		Brazil %	
Population	1970	1980	1970	1980	1970	1980
Urban	39.8	49.3	41.8	50.7	55.9	67.2
Rural	60.2	50.7	58.2	49.3	44.1	32.8
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

Adapted from IBGE (1983)

The population of Maceio in 1980 was estimated to be 370.000 inhabitants, and its spatial evolution is expected to run, throughout the years, in the same way as the Brazilian population.

2.1.3 Socio-Economic Conditions

The economic structure of Maceio is characterized by the predominance of the tertiary sector, i.e., the commercial and public service sectors. As mentioned previously, a large percentage of the population earns up to 3 official minimum wages (OFMW) per month. Table 2.3 shows the value of the evolution of the Brazilian OFMW in cruzeiros and in U.S. dollars during the study year.

Table 2.3 Value of the Brazilian OFMW in Cruzeiros and Dollar during the study year

Month/ Year	Dollar/Cruzeiro (conversion)	OFMW in Cruzeiro (Cz$)	OFMW in Dollars (US$)
Oct 1990	84.22	6,425.14	76.29
Nov	106.95	8,329.55	77.88
Dez	144.71	8,836.87	61.07
Jan 1991	170.06	12,325.60	72.48
Feb	220.14	15,895.50	72.21
Mar	223.43	17,000.00	76.09
Apr	238.93	20,000.00	83.71
May	260.95	20,000.00	76.64
Jun	284.70	23,132.00	81.25
Jul	312.23	23,132.00	74.09
Aug	346.57	36,292.00	104.72
Sep	393.76	42,000.00	106.66

Adapted from Suma Economica (Jan 1992)

A "basic basket" was instituted in April 30th 1938 by the Federal Law-Decree 399 which established the National official minimum wage (OFMW). According to the governmental policy, the official minimum wage (OFMW) should give the working class the opportunity of achieving the minimum conditions of living standard. This means that, they should be able to buy at least the "basic basket" for food, and some additional items such as medicine, habitation (rent) and transport. In 1981, the Planning Secretary of the Alagoas State modified the "basic basket" and fixed the food portion of the OFMW to 48.57 % leaving the remainder for other needs.

In Alagoas, the price of the "basic basket" for food is determined by the government based on a list of some regional food for a monthly consumption of one individual. It is important to note that such data reflect the specific level of Brazilian life conditions. However, the resulting value of the official minimum wage (OFMW) is considered to be insufficient to cover the basic necessities of the population. Some of the reasons responsible for this unbalance may be: inadequate economic policies and the high inflation level in the country to name but a few (see Table 2.4).

Table 2.4 Percentage of annual accumulated Brazilian inflation

Month / Year	Accumulated Inflation % (12 Months)
March / 1987	86,20
March / 1988	387,92
March / 1989	1113,29

Adapted from Suma Economica (1990)

The reality of the "basic basket" is very different to what the 48.57 % rule for food is supposed to be. According to the Alagoas Secretary of Planning (SEPLAN) in **July 1991** the official minimum wage was **Cz$ 17,000,00** and the food in the "basic basket" for **one person** was **CZ$ 15,360.60**. This means that in July the cost of the food in the "basic basket" for **one person** represented **90.36 %** of the total OFMW. It is expected that at Alagoas State level, and consequently in Maceio, such data must have some repercussions.

In addition, it is believed that the serious life conditions in the rural area of the state, as well as its landowner structure, has stimulated migration to urban areas, especially to Maceio. When poor rural people leave the countryside to go to the city, they end up living in slums on the periphery (Desai et al., 1980). Tables 2.5 and 2.6 illustrate the size distribution of properties in the rural area of the state, as well as the respective percentage of occupied land.

Table 2.5 Landowner structure of Alagoas: size of property and respective number of properties

YEAR	TOTAL NUMBER PROPERTIES	WHOLE AREA	UNTIL < 2 ha P	A	2 TO < 10 ha P	A	10 TO < 50 ha P	A	50 TO < 500 ha P	A	500 TO < 2000 ha P	A	2000 TO < 5000 ha P	A	5000 TO< 10000 ha P	A
1970	431	34.649	107	108	142	599	110	2716	62	9170	7	9013	2	6516	1	6527
1975	382	34.915	82	77	109	536	96	2233	81	11143	11	11210	3	9716	-------	

SOURCE: FIBGE - censo agropecuario (1980)

Table 2.6 Landowner structure of Alagoas: size of property and respective percentage of occupied land (1975)

Size Of Property	Number Of Properties	Occupied Land %
< 2 ha	24.5	0.2
2 to 10 ha	28.5	1.5
10 to 50 ha	25.1	6.4
50 to 500 ha	21.2	31.9
500 to 2000 ha	2.9	32.1
2000 to 5000 ha	0.8	27.8

Adapted from FIBGE (1980)

As can be seen, the "latifundios" (big properties) occupy the majority of the cultivable lands of the state. It has been stated by the IBGE (cense agropecuario), that in 1975 there was a decrease of about 20 % in the number of small properties.

2.1.4 The Health Indicators

It can be said that the magnitude of health conditions in Maceio seems to express the socio-economic conditions of the city. Thus, although the city presents a comparatively high index of infant mortality (around 54.1/1000 live-births), this index is the lowest of the state, in comparison to other towns of the rural area (see Table 2.7).

Table 2.7 Infant mortality's coefficient of Maceio and other towns of Alagoas in the period of 1983/87

Town	Infant Mortality Coefficient/1000 live-births 1983	1984	1985	1986	1987
Maceio	70.8	71.5	57.3	60.5	54.1
Pilar	99.7	87.0	168.8	168.1	160.1
Coqueiro Seco	84.2	157.9	126.7	100.5	111.8
Boca Da Mata	53.1	96.7	68.4	90.4	66.1

Adapted from FUSAL (1988)

Among the main causes of infant and child mortality in Maceio, the infectious diseases occupy the first place. In the infant group, aged less than 1 year, the perinatal diseases occupy the second place. According to the Alagoas Health Secretary (FUSAL), this can be explained by the deficient pre-natal assistance in the childbirth (parturition), as well as in the puerperal period. Also in the infant group, the respiratory infections and malnutrition occupy the third and fourth places respectively in this age group.

In children aged from 1 to 4 years the second most prevailing cause of mortality is the respiratory infection. The nutritional disorders (malnutrition), are in third place. It is possible that the third place for malnutrition occurs mainly because the most apparent symptom is the one which is registered. For instance, a malnourished child with symptoms of respiratory infection is registered as respiratory infection and not malnutrition. There are no available data about the nutritional profile of older children nor of adolescents in the state.

It is important to note that the above mentioned diseases, especially intestinal diseases, have been identified to be strongly influenced by the nutritional status of the individual(Tomkins, 1988). Hence, the Health authorities of Alagoas have recognized that, although the nutrition disorders appear in third place, it seems probable that in reality the nutritional picture may be more serious.
In addition, the complexity of such diseases makes it difficult to clinically diagnose

the cause of death. Anyway, the infant and child indices reflect the precarious conditions of the health sector, not only of the city but also of the state, as well as the poverty conditions of the population.

2.2 The Study Group

In order to select the sample subjects, the first step is to characterize the group or population, according to the purpose of the study. In this sense, given the aim of studying the growth performance of individuals at the beginning of adolescence, the population was the adolescents.

According to experts present in a meeting promoted by OPS in Washington D.C. USA (see Bol. of Sanit. Panam., 1989), adolescence is defined as being the "life's second decade, understood as the period between 10 and 19 years of age". This period is also divided into two phases as:

1 - First phase or initial adolescence, as being the period between 10 and 14 years.

2 - Second phase or true adolescence, as being the period between 15 and 19 years.

As it would be necessary to observe some sign of maturity, it was decided to work with girls, in order to avoid any problem in rating the time of puberty (see Jordan et al., 1975). In addition, girls at the age 9 were included. Hence, this investigation concerns school girls aged from 9 to 14 years, i.e. in the first phase of adolescence. They are native from the State of Alagoas and residents of Maceio.

Once located, to participate in the research, the subject had to present a birth certificate or any official document to prove her age. In urban areas, the official registration of a child occurs within the first four months after birth, for the parents to have the right of receiving the "child benefit". However, the situation in rural areas may not be the same.

2.2.1 The Sample Size

In order to determine the sample size of girls in each social economic status group for this investigation, the following formula by Armitage (1971) was used:

$$N > 2 \times \frac{(1.96 \times SD)^2}{d}$$

Where N = sample size

1.96 = confidence level of 95%

SD = standard deviation of the variable - 6.3 cm (see explanation below)

d = absolute difference in the values of the variable for the two groups being compared - 6.0 cm

The standard deviation was estimated by determining the average of the standard deviations for height of adolescent girls, aged from 9 to 14 years, from India (Hauspie et al., 1980) and Spain (Hernandez et al., 1988).

Thus, N > 51 subjects in each social group. 20% was added with the aim of avoiding significant losses in sample size. Hence, the total number should be greater than 62 subjects in each social group. The final sample was 352 subjects, being 145 from the high income group and 207 from the low income group.

2.2.2 The Strategy For Sampling

In order to define the strategy for sampling from a given population, it is important to consider operational factors such as resources and time available (Lemeshow, 1990). Considering the precarious field conditions of Maceio, and the limitation of human and financial resources, the "cluster sampling method" was used with an adaptation. This was in order to avoid overlooking certain groups, which is possible in a "simple random sample", and to adjust some field limitations.

By "cluster sampling method" is meant any sampling plan that uses a frame consisting of clusters of enumeration units (Lemeshow, 1990). Thus, the following steps were taken:

Step 1 - Selected a list of districts of Maceio

Step 2 - Selected a sample of schools in the districts

Step 3 - Selected a sample of classrooms within each of the schools selected at the second stage

Step 4 - Took every adolescent girl within the classrooms selected in the third stage

2.2.3 The Sample Subjects Assessment

The assessment of the schools did not occur as intended. First, from the four largest private, fee paying schools from Maceio, two schools refused to participate in the study. Therefore, the assessment of the high income family girls for this study had to be developed in the two remaining schools.

Second, during the period established to start the study, all of the public schools, free paying, provided by the State government were already on strike for three months, with no clear end in sight. Because of this, only the public schools provided by the District government were available for the investigation. Consequently, the assessment of the low income family girls was carried out in two schools of this group. These two factors probably introduced bias in this study.

After the initial contacts with the schools' headmasters, the assessment of the sample subjects consisted of the following steps:

1 - The subject was located within the school

2 - In this first contact with the adolescent the aims of the research were explained and a letter was given for the parents, which permission was asked for the girl to participate in the investigation (see APPENDIX B).

3 - If the parents and girls agreed, then the first measurement was made.

4 - After the body measurements, at four times during the year, a 24-hour dietary recall questionnaire was applied (see APPENDIX C.1).

5 - At the last activity there was an appointment with the subject's parents, in the household or whenever they were at the school. This appointment had the aim of applying a social questionnaire (APPENDIX A). On this occasion, some body measurements were made on the mother. Initially this anthropometric measurement was planned to include the fathers as well. But, because of the high number of father refusals, only the mothers were considered.

Given the large number of adolescents to be examined each day during the research period, and considering that only the main investigator was responsible for this activity, the measurements on mothers were made in the evenings and during weekends throughout the year.

2.2.4 The Sample Subjects Distribution

The subjects were divided into 2 groups according to their socio-economic level, high income (Group A) and low income (Group B). The socio-economic level was determined by the household income, i.e., according to the number of official fixed minimum wages (OFMW) earned in the household. The choice to classify the individual's household income by the official minimal wage (OFMW) was based on three reasons. First, it is a method widely used by Brazilian researchers. Second, it is a simple way of identifying the purchasing power of such a household. Third, it can be used as an index of socio-economic status. The subjects were grouped into the low income, Group B, when the household income was between 0.0 and 3.0 official minimum wages, and in the high income, Group A when the household's income was more than 18 official minimum wages.

The choice of classifying subjects into only two socio-economic levels was justified by the fact that in Maceio, according to data of Instituto Brasileiro de Geografia e Estatistica (IBGE, 1980), 82.6% of the population engaged in the tertiary sector during the year of 1980 earned around 3 official minimum wages. The established gap between 3 and 18 official minimum wages would therefore be enough to characterize distinct social backgrounds. Other socio-economic conditions of the sample were also investigated because it has been claimed that some indicators, such as housing and sanitation, are generally associated with height deficit in children (Keller, 1988).

2.3 The Survey Design

It has been claimed that growth velocity may suffer seasonal influence. In this sense, experience has shown that a longitudinal study seems to be most effective in estimating the growth variance (Little et al., 1988 a). Hence, this research was longitudinal, i.e., comprised sequential measurements throughout the year.

This research was a pure longitudinal study, all the sample subjects being measured on every single occasion (Goldstein, 1979). The measurement of the subjects was done in intervals of one month over 12 months. Therefore, the field research was planned to run for 12 months and 15 days from September 1990 to September 1991.

2.4 Indices To Be Used

According to WHO (1986) indices are a combination of measurements (weight, height) used to describe a given situation. An index is a standardized measurement which is used for comparison purposes. For instance, height-for-age is an index of growth performance. When an index is used with a cut-off point it becomes an "indicator". According to WHO (1986 page 930) "an index may be thought of as a biological concept" of the combined measurements as this case of height and age, while "indicators represent further derivations of use in social/medical decision making at population level" (WHO, 1990 page 8). In this thesis, to evaluate the "nutritional status" and the "physical growth status", the following variables were used:

1 - anthropometry - standing height, sitting height, weight, skinfold thicknesses

and arm circumference

2 - socio-economic condition - origin, income and housing conditions

3 - signs of puberty - occurrence of menarche

4 - morbidity pattern - incidence of reported morbidity

5 - dietary intake - calories and nutrients

2.4.1 The Anthropometric Assessment

As is well known, anthropometry has been a much used method for assessing nutritional status and physical growth in individuals (WHO, 1986, Cameron, 1985, Frisancho, 1984 and 1990, Dowler et al., 1982, Hamill et al., 1979).

For this sample, anthropometric assessment comprised the basic measurements:

1 - Height (standing and sitting)

2 - Weight

3 - Skinfolds (Triceps, biceps, subscapular and suprailiac)

4 - Upper arm circumference

Figure 2.2 shows the location where the body measurements were made.

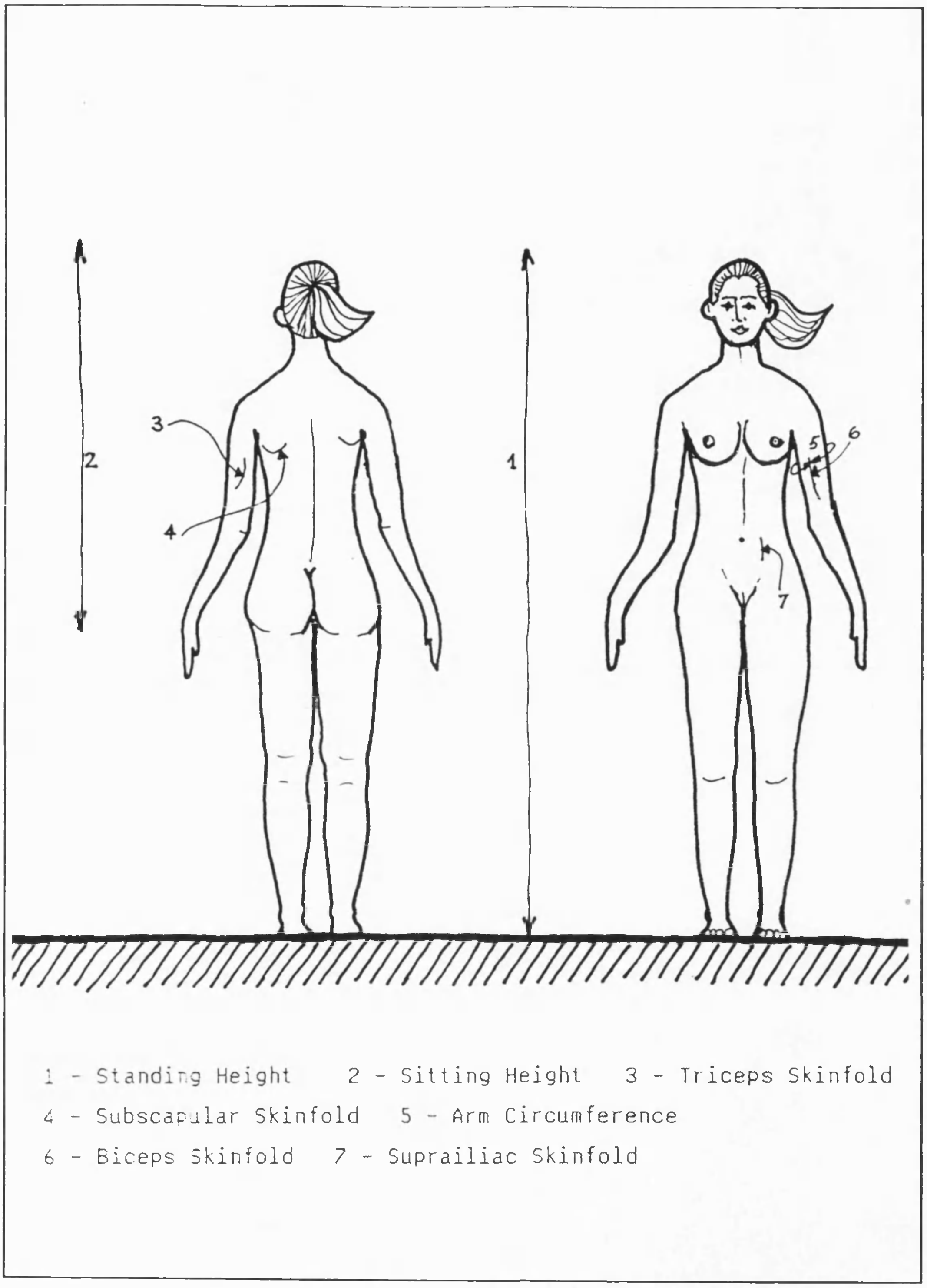

Figure 2.2 The location of the body measurements

2.4.2 The Measurer

All body measurements were made by the main investigator.

2.4.2.1 The Reliability Of The Measurement

The reliability of the measurement is an important aspect to be observed during data collection (Cameron, 1978. Frisancho. 1990, Ulijaszek. 1992). In this research, the quality of the measurements was controlled by the following steps:

1 - All measurements were made three times

2 - The arithmetic mean was then calculated, and the derived value was considered as being the representative value for the subject.

Consequently, once the measurements were made, their degree of reliability were assessed by using the **technical error of measurement (TEM)** and the **coefficient of reliability (R)**, as indicated by Frisancho (1990), which are:

$$TEM = \sqrt{(\Sigma d^2)} / 2N$$

where Σd^2 = sum of the squared differences of measurements (replicates)

$2N$ = number of pairs

$$R = 1 - (TEM^2 / s^2)$$

where s^2 = square of the intersubject variance

In this thesis, TEM is related to the **intraexaminer technical measurement error** and is compared with the reference values suggested by Frisancho (1990). According to Frisancho (1990 page 29), the coefficient of reliability (**R**) "indicates the degree to which a given measurement is error free" and ranges from 0 to 1. However, there is no available reference to this coefficient.

The TEM and R were calculated for three months of the study year (October, March and September) using measurements of 352 subjects. Table 2.8 shows TEM and R for the anthropometric variables in these respective months.

Table 2.8 Intraexaminer technical measurement error and coefficient of reliability means

Variable	October		March		September		Reference
(unit)	TEM	R	TEM	R	TEM	R	TEM
Height (cm)	0.44	0.95	0.43	0.95	0.39	0.94	0.69
Sitting-height (cm)	0.43	0.96	0.35	0.97	0.31	0.96	0.53
Triceps (mm)	0.66	0.98	0.62	0.97	0.42	0.97	0.80
Biceps (mm)	0.65	0.98	0.44	0.98	0.12	0.99	-
Subscapular (mm)	0.64	0.98	0.65	0.97	0.27	0.98	1.80
Suprailiac (mm)	0.60	0.99	0.60	0.98	0.29	0.98	-
Arm circumference (cm)	0.46	0.91	0.46	0.92	0.46	0.94	0.35

Frisancho (1990 page 29) states that "If the examiner's TEM comes close to the reference value in a series of repeated measurements and if there are no biases in measurement then the measurements can be considered accurate". It can be seen from Table 2.8 that, in general the TEM values of this thesis tended to be lower than the reference values, with the exception of the TEM values for arm circumference (which were higher). In addition, there was a tendency to decrease the TEM values with the advance of the study, i.e. from the first month to the last one. The combination of the respective TEM and R values across the months shows that the anthropometric measurements of this thesis were at least 94 % error free. This can be an indication that the measurements were accurate.

2.4.3 The Measurement Procedure

This section describes in detail, how the body measurements were made in the field. As a reference, the field techniques and equipments recommended by Cameron (1978) were used.

2.4.3.1 Weight

Equipment : An electronic scale (Filizola) with capacity of 110 kg and accuracy to 0,1 kg, bought in Brazil.

Field Technique :

1 - The subject must remove, prior to measurement, shoes and the excess of clothes. As the examination was done at school, the subjects used the same clothing, each time throughout the year they had to be measured. Thus, there was no seasonal variation in the weight of the clothing (Frisancho, 1984). Nevertheless, to overcome the limitation of weighing clothed subjects, a deduction of the average weight of clothes was performed before the statistical analysis:

2 - The individual was asked to stand on the scale;

3 - The individual would wait until the scale pointer stopped moving;

4 - The investigator made the reading;

5 - The investigator had to ensure that the pointer was at zero before and after every weighing. By doing this, the investigator was checking that the scale was working correctly.

The scale was checked for accuracy daily using test weights and was calibrated when necessary by the Instituto de pesos e medidas do Brazil. If necessary, fine adjustments were made weekly or monthly.

2.4.3.2 Standing Height

Equipment : The Free Standing Height measure on a solid base, 0-2 m with 3 sections.

Field technique :

1 - The subject had to remove, prior to measurement, shoes and socks;

2 - The individual had to stand erect, with her heels, buttocks and shoulders in contact with the vertical backboard of the equipment, feet together, hands and arms relaxed with the palms facing medially, and the head positioned in the Frankfort plane ("Look straight ahead");

3 - The individual was instructed by the investigator to "take a deep breath, stand tall, and relax". Assistance and demonstration were given when necessary.

The measurements were made in field condition (at the school) at the same time of the day, i.e.. considering the school teaching period, morning or afternoon.

2.4.3.3 Sitting Height

Equipment : The same as for standing height. In addition, an accessible table at the school was used to complement the model to measure sitting-height.

Field technique :

1 - The subject had to remove shoes and socks prior to measurement ;

2 - The individual had to sit, as far back as possible on the measuring table, so that the back of the knee joints was at the front edge of the table;

3 - The subject had to sit erect with the head in the Frankfort plane.

2.4.3.4 Skinfolds

Equipment : The skinfolds were measured with the Holtain Tanner - Whitehouse calliper, having a pressure of 10g/mm over a range of 0-48mm.

Field technique : Triceps skinfolds

1 - The subject had to stand with her back to the investigator and her arm relaxed with the palm facing the lateral thigh;

2 - The triceps skinfolds was measured at a marked mid-point in the mid-posterior line of the left upper-arm between the acromion and the olecranon processes.

Field technique : Biceps skinfolds

1 - The subject had to stand facing the investigator, with the arm relaxed on the side with the palm facing forwards;

2 - The biceps skinfolds was measured over the biceps, around 1 cm above the line marked for arm circumference

Field technique : Subscapular skinfolds

1 - The subject had to stand with her back to the measurer;

2 - The subscapular skinfolds was measured directly below the inferior angle of the left scapula, in line with the natural cleavage of the skin, with the arms and shoulders relaxed

Field technique : Suprailiac skinfolds

1 - The subject had to stand sideways with her arms folded;

2 - The suprailiac was measured vertically about 1 cm above and 2 cm medial to the anterior suprailiac spine

2.4.3.5 Upper Arm Circumference

Equipment : The meter Micromatic steel tape (manufac-tured by Mabo-Stanley of France).

Field technique :

1 - The subject was asked to standed erect with the left arm complete relaxed and extended by her side;

2 - The upper-arm circumference was measured to the nearest millimetre with the metallic tape;

3 - The measurement was taken midway between the tip of the acromion and the olecranon process (Frisancho and Tracer, 1987; Frisancho, 1984).

2.5 Validation Of Indices

The assessment of nutritional and growth status of adolescents is a quite difficult task, because of the large variability of the body composition and the variable timing of the pubertal growth spurt (WHO, 1986). Hence, the choice of the indices to be used in this kind of research, poses many problems and limitations. The following body indices were considered:

1 - Weight/Height^2 or Body Mass Index Of Quetelet (BMI)

2 - Height For Age

3 - Skinfolds (Triceps, Biceps, Subscapular, Suprailiac)

4 - Upper Arm Muscle area and Upper Arm Fat Area

2.5.1 Body Mass Index Of Quetelet (BMI)

In children, the weight/height is a much used index of current nutritional status. Its use in assessing individuals at the adolescence period is quite complicated because of the large variation in body composition at this phase of life. Nevertheless, for lack of an alternative index, the BMI (Wt/Ht^2) was used, not only because it includes both fat and lean tissues (James et al., 1988), but also because it seems to be a simple way of assessing nutritional status of individuals above the age of 10 years. The values obtained were compared with those provided by Frisancho (1990) as a reference.

2.5.2 Height-For-Age

The index height-for-age was used because it seems to reflect overall social conditions (WHO, 1986), and also as a measure of the previous pattern of growth. In this thesis it is referred as "growth status". In addition, sequential measurements of height throughout the year were made with the aim of identifying the adolescent's growth velocity, as well as to show any seasonal effects on it. In data analysis the NCHS references were used to express the results.

2.5.2.1 The Use Of NCHS As A Reference

In trying to describe the human condition, anthropometry has been a widely used method. But this method has been subject to episodes of controversy. Because of the necessity of understanding and analyzing such measurements, some indices have been used as indicators of health or sickness. Results have been based on statements of what is considered as a good or bad nutritional condition.

As stated in Chapter 1, one model which has been adopted to deal with nutrition and growth is the genetic potential model. According to Payne (1984), through this framework, the body is considered a self-regulating and a self-optimising system in which there is a "preferred" state considered to be "optimal" for each individual. If the individual is not stressed by continued adverse environmental conditions, or by constraints on diet, she/he would always leave and return to this "optimal" state. Even considering that individuals do differ in genetic constitutions, the "normality" of this "preferred" state is based on values of system components such as weight, height etc., which are believed not to differ significantly from one population to another. A "non-optimal" state is characterized when the individual is not capable of returning to their "preferred" state.

Based on this assumption, the adoption of a reference based on a well-nourished and supposedly healthy population was crucial, in order to build up a pattern of "adequate nutritional status" for comparative use. As a consequence, a lively debate has been going on over the merits of using a single international set of reference values, eg., NCHS (according to WHO (1983) and United Nations (1990)), in assessment of risk, as against the use of a local standard as a reference. It has been argued that the NCHS reference is based largely on data of well-fed populations and therefore may not be adequate to the reality of the developing countries (Kandiah & Wikramanayake, 1988, Tagai Ayatollahi & Carpenter, 1991).

On the other hand, it has been argued that the growth potential is the same whatever is the ethnic group. Therefore, if such a potential were not achieved, this was because some environmental factor had influenced growth (Waterlow, 1977, Habicht et al., 1974, Graitcer & Gentry, 1981, WHO, 1986a).

2.5.2.2 The Use Of NCHS In Brazil

In Brazil, the use of the NCHS standard was adopted as a reference by the National Health Ministry (INAN, 1990). The justification for this decision was that the comparison between the Brazilian reference, named Marcondes Class IV (well-fed sample population), and the NCHS demonstrated similar height and weight values at all ages (INAN, 1990).

However, this value judgment must be viewed cautiously, since the elite group in countries like Brazil may not be ethnically representative of the population as a whole (WHO, 1986).

2.5.2.3 The Adolescent And The NCHS Reference

In the case of adolescence, this reference is not clearly recommended. That is because of the great variation in the timing of the adolescent growth spurt. Although the height-for-age and weight-for-age references are provided by the NCHS, values for weight-for- height are not included. This gap was to some extent fulfilled by the consultation (WHO, 1986) which provided an alternative reference based on American children data. However, "there are no clear recommendations about the acceptable range of weight for height" ((FAO/WHO/UNU, 1985 page 25) over this period of life.

It is possible that one way to overcome this problem is to examine the combination of the indicators weight-for-age and height-for-age in order to have a picture of the nutritional level of the girls, since the former is a widely recognized indicator of PEM and the latter is usually related to past episodes of PEM (WHO, 1983).

2.5.2.4 The Cut-Off Point To Be Used In This Study

When describing the nutritional situation it is important to have defined the purpose of the research and also who might be considered at risk, because this would facilitate the choice of cut-off points (United Nations, 1990). As previously pointed out, this study particularly concerned the question of nutritional status related to height-for-age, and its relationship with growth performance. Therefore questions would be examined related to stature and not only to acute stages of PEM.

A complementary point connected to this issue was that this study was conducted during adolescence, where there is great variation in timing of pubertal spurt. So, considering the previous discussion about the use of NCHS as a reference, the results of height-for-age and weight-for-age are expressed as Z-scores, in comparison with NCHS, only as a way of presenting a brief biological profile of the sample population. Secondly, the conventional cut-off point of -2.0 SD from the median reference is maintained, although some attention will be paid as well to the group located between -2.0 and -1.0 SD.

Since this decision can be arbitrary (WHO, 1983; United Nations, 1990), it was made in an attempt to avoid over- or under-estimating nutritional levels through Z-score analysis.

2.5.3 Skinfolds

In order to have an index of body fat (Himes, 1980; Buckler, 1979), the triceps, biceps, subscapular and suprailiac skinfolds sites measurements were utilised, using Frisancho (1990) as a reference. One point has to be considered: it is important to note that the data provided by Frisancho were derived from the right arm, while this study data were collected from the left arm. However, in view of the limited alternatives available, Frisancho's data are used as a reference.

The decision to use skinfolds as a measure of body fatness was based on the fact that it is a good measure of the amount of stored energy (Frisancho, 1990). According to Himes (1980, page 10), "The rationale for measuring subcutaneous fat thickness as an indicator of nutritional status is that the subcutaneous fat represents fairly total body fatness, and that body fat is representative of accumulated caloric nutriture. Subcutaneous fat thickness is therefore, a morphological manifestation of nutritional status."

Hence, using this statement as a justification, the skinfolds (triceps, biceps, subscapular, suprailiac and sum of four skinfolds) were used as measures of the lipid reserves of the organism, which are easily reduced by low caloric intake or caloric deficiency. Also, body fatness seems to be positively correlated with stature from birth until adolescence (Himes, 1980). As an increase in fatness is expected during adolescence, especially in girls, the use of these indices is pertinent. Moreover, some studies have demonstrated that the percentage of body fat is well reflected by triceps skinfolds in boys and girls of all ages (Cronk and Roche, 1982).

2.5.4 Mid-Upper Arm Circumference

The mid-upper arm circumference was used for calculations of **upper arm muscle area** (UAMA) and **upper arm fat area** (UAFA). The upper arm muscle area was used as an indicator of body muscle and protein reserve. The upper arm fat area was used as an estimation of fat reserves. For the data interpretation, the standards of Frisancho (1990) were applied, although bearing in mind the limitation of the result for different arms. The upper arm muscle area was calculated from the measurements of the upper arm circumference and triceps skinfolds by the following formula:

$$\text{Upper arm muscle area (UAMA)} = \frac{[C - (Ts \times \pi)]^2}{(4 \times \pi)}$$

where: C = arm circumference

Ts = triceps skinfolds

$$\text{Total upper arm area (TUA)} = \frac{C^2}{(4 \times \pi)}$$

where: C = arm circumference

Upper arm fat area = TUA - UAMA

2.5.5 Dietary Intake

Nutritional and food surveys are important means of estimating the dietary status of populations and of an individual. Used in a wide variety of research approaches, dietary intake is employed as an indirect method of nutritional status evaluation. With this purpose, dietary data allow specific knowledge of food consumption at the individual and population levels and the identification of cultural food habits.

In general, the household is the most frequently investigated subgroup unit, because it can permit extrapolation to population intake estimates (Quandt, 1987). However, individual intakes can not be merged into such a strategy, given existing variations in intrahousehold distribution of foods.

In this study the data were collected at the individual level. Food intake was assessed in order to estimate calorie and nutrient intakes. In addition, the most widely used methods of dietary assessment for individuals are described, stressing the questions connected with a 24 hour recall and adolescent nutritional requirements.

2.5.5.1 Limitations Of Dietary Survey Methods

Although the dietary survey is one of the most frequently used means of assessing the nutritional status of a population (Kretsch and Fong, 1990), the assessment of individual dietary intake is usually controversial.
A likely explanation for such a controversy is that there is not only a marked difference from one person to another in respect to their pattern and level of food consumption, but also an intra-individual day-to-day variation in food energy and nutrient intake (Todd et al., 1983, Sempos et al., 1985, Marr and Heady, 1986, Basiots et al.. 1989. Borrelli et al., 1989). One implication of such daily variation is a reduction in the precision of procedures for assessing diet (Basiots et al., 1987, Bingham, 1991). Consequently, according to the aim of the study, some attention has to be paid regarding the choice of method and its strength.

2.5.5.2 Methods Of Dietary Assessment For Individuals

There are many techniques through which individual intake can be appraised. If the aim of the study is to measure current intake then the widely used method is the weighed record, by which an estimation of the weight of consumed food is given by the trained subjects themselves. An advantage of applying this technique is that, even considering the possibility of biased information obtained from the subject, great accuracy has been attributed to it (Bingham, 1991). On the other hand, to collect records of current diet has been recognized to be expensive and somehow limited in the sense that it does not provide past diet information. Another important point to consider when using weighed records is that, it has been recently argued that different numbers of days are required to estimate true average food energy and nutrients intake depending on the intra-individual variation in intake.

Basiotis et al. (1987) using intake data from one year dietary intake study, demonstrated that food energy could be estimated over a relatively smaller number of days than was the case for vitamin A. In their work, to estimate habitual food energy intake with accuracy, 27 days were required for the males and 35 for females. For iron estimates 68 days were required for males and 66 for females. For vitamin A, 390 days were necessary for males and 474 for females (more than one year).

If the aim of the study is to evaluate past intake, then retrospective methods can be used. Within this perspective, food recall methods have been widely used, because they have the great advantage of being cheap and easy to administer.

The dietary recall has been the most employed procedure among retrospective methods (Quandt, 1987). The general requirement is that the interviewed individual recall all food eaten in a specified time antecedent to the meeting. Usually one to three days are the most frequent periods adopted for the recall methods; the 24-hour recall technique is most often employed. On the other hand, the 24-hour recall has been widely criticised for some limitations. For instance, it has been argued that it is unable to express the usual intake of the individual, not only because it represents a single day's dietary intake, but also because it is vulnerable to bias from distortions provided by errors and exclusion of quantities ingested (Todd et al., 1983, Ulijaszek, 1992). In addition, a 24-hour recall does not express within-subject variation, because such estimates can only be assessed by replicated measurements (Beaton et al., 1983). Such disadvantages are pointed out and summarized by Michael Nelson (1991) as: "reliant on memory, conceptualization skills needed, observer bias possible, reported diet may be a distortion, no measure of day to day variation in diet, requires regular eating habits, dependent on food composition tables".

2.5.5.3 Justification For Using 24-Hour Recall

Restricted financial resources were the main justification for the decision to use a 24-hour recall technique. In the light of such limitations, of examining the dietary data, a very clear purpose for undertaking this study had to be established. First, the dietary intake data would be considered to describe the group's means and not that of the individual. By doing this, errors related to intraindividual variability would be decreased, since the diet would characterize the group and not the individual. Second, in an attempt to minimize errors in the limited information provided by the 24-hour recall, the method was repeated 4 times during the study year, on different weekdays. This strategy was adopted because previous studies have demonstrated that there is no significant difference in energy intakes between weekdays (Todd et al., 1983), and that dietary intake of subjects could be estimated by repeated 24-hour recall (Lechtig et al., 1976).

In order for the analysis of the data to proceed, a subgroup was randomly chosen within each social group. Thus, 44 girls (30 %) from the high income group had their four 24-hour recall analyzed, and 62 (30 %) were analyzed from the low income group.

2.5.5.4 Energy And Nutrient Requirements Of Adolescents

2.5.5.4.1 Energy Requirements

The girls' energy requirements were calculated according to FAO/WHO/UNU (1985) recommendations. These calculations are formulated as follows:

1 - To estimate the **basal metabolic rate** (BMR).

Thus, the BMR was predicted using the mathematical expression:

$$\text{BMR (kcal/day)} = 12.2\ W + 746$$

where: W = weight of the subject (kg)

2 - To estimate the **total daily energy expenditure.**

Thus, the **physical activity level** (PAL) was predicted using the values provided by James and Schofield (1990) which can be used in a developing country:

Age (yr)	PAL
10	1.65
11	1.62
12	1.60
13	1.58

Energy expenditure = BMR x PAL

2.5.5.4.2 Protein Requirements

The protein requirements were considered in accordance with the safe level of protein intake of FAO/WHO/UNU (1985).

2.5.5.5 The Correction Of The Diet

The diet was corrected in two ways according to the recommendation of FAO/WHO/UNU (1985):

1 - For the available energy: first estimating the apparent energy by multiplying the obtained value for protein, carbohydrates and fat by the respective Atwater values of 4, 4 and 9. Second, correcting for the fibre amount. In this thesis, the value for diets containing moderate amounts is assured:

available energy x 0.975

2 - For the protein digestibility:

(total protein content of the diet x 82*) / 100

* The factor 82 is based on data provided for the Brazilian mixed diet (FAO/WHO/UNU, 1985 page 119).

2.5.5.6 The Application Of The 24-Hour Recall Method

The dietary intake recall was applied by the main investigator.

2.5.5.7 The Format Of The Dietary Intake Form

The dietary intake form was constructed with the aim of identifying the following questions:

1 - The name of foods and beverages consumed during the day APPENDIX C.1;
2 - The form of food eaten. i.e. if baked, broiled, fried, or stewed;

3 - The quantity eaten, i.e. number of units, weight and dimensions, usually expressed in household measures (spoon, glass) APPENDIX C.2;

4 - Eating occasions,i.e. the time of the day (if morning, afternoon and night) as well as what it is generally called (breakfast, snack, lunch, dinner etc.).

For practical reasons, a model adapted from Obert (1978) was used. APPENDIX C.1 shows the dietary intake design.

2.5.5.8 The Interpretation Of Dietary Intake

The analysis of the dietary intake was made for the following nutrients: protein, fat, carbohydrate, vitamin A value, thiamin, riboflavin, niacin, vit C, calcium, and iron. The energy content was also considered. The dietary intake value was calculated in accordance to the Panama and Central American Nutrition Institute (INCAP) and a regional table validated by the Universidade Federal de Pernambuco, because they are adapted to Latin American studies and the latter covers the specificities of the regional foods.

2.5.6 Sign Of Puberty - The Occurrence Of Menarche

As previously explained there is a large variation in timing of pubertal spurt. This is mainly because individuals differ in the rate of maturation from birth (Tanner, 1989) and, consequently, each one has her/his own time scale. This great diversity confounds and makes the interpretation of the growth data during puberty difficult to access. Tanner (1952, page 30) recognizes such difficulty by saying "Consequently our standards, though perfectly valid still, become far less potent for detecting abnormality. We need to combine them with some index of whether adolescence has started or not." This thesis considers **menarche** not only as a sign of puberty but also as an alternative way of scaling the girls.

For the study of such a particular phase of growth it is fundamental to find a more suitable form of scaling the subjects than scaling them by chronological age only. Consequently, "developmental age or physiological maturity" has been the most widely used form of scaling individuals when studying their respective growth performance (Tanner, 1962).

The "physiological maturity" status can be assessed in many ways, such as by skeletal age or dental age. In the present study it was not possible to use a classical maturity scale, so an ordinary characteristic was used instead which could be considered as a reasonable indicator of maturity, namely **occurrence of menarche**. Derived from the Greek words **meno** (month) and **arkhe** (beginning), **menarche** can be defined as being the first menstrual period. The occurrence of **menarche** indicates that the girl has probably achieved a critical level in her sexual maturation and that her reproductive phase is supposed to be arriving.

Although the choice for considering **menarche** was arbitrary, it was based on the fact that for an adolescent girl, **menarche** is an exact moment in the pubescence process. Therefore, it can be used to indicate the relation of a girl to her adolescent spurt (Tanner, 1952).

One limitation to use such a method is that it is more suitable to be used retrospectively, i.e., "a given girl being scored so many months before or after the menarche .." (Tanner, 1952 page 30). However, this is only possible in long prospective studies which cover the whole adolescent period (see Table 2.9).

Table 2.9 Summary of some longitudinal studies related to girls

Author, Year	Sample size/ Social Group	Age Range	No.Years
Bogin et al., 1989	100, 132, 90 HSL, LSL, LSM*	6.0-13.99	9
Bogin et al., 1992	85, 12 HSL, LSM	5.0-17.99	9
Billewicz & McGregor, 1982	62 Gambian girls	5-23/25	24
Brown & Townsend,1982	23 Aboriginal girls	7.0-19.0	10
Gasser et al., 1991	112 Swiss girls	9.0-18.0	9
Martorell et al., 1990	168 LS Spanish-Indian ancestry**	5.0-18.0	8
Tanner et al., 1966	41 London girls	birth-11/12	11
Tanner et al., 1976	35 London girls	birth-20	20
Shohoji & Sasaki, 1987	971 Japanese girls	6.0-22.0	16
Satyanarayana et al., 1981	197 LS Indian girls	birth-18.0	18

* High Socio-Economic Status Ladino girls, Low Socio-Economic Ladino girls, Low Socio-Economic Mayan girls
** Low Socio-Economic Status Spanish-Indian ancestry

The table presents only the results for the female groups. As can be seen, a long prospective study has sometimes smaller sample sizes than a cross-sectional one but, it lasts on an average of 9 years. As this study covered only one year of each individual's adolescent period, not all girls menstruated, and as a consequence it is not possible to use **menarche** in the same condition as suggested by Tanner. Consequently, **menarche** was used for all girls as an **indicator** of their respective growth phase.

Another reason for such a choice was that "menarche is much more closely related to skeletal maturity than it is to chronological age" (Tanner, 1962 page 78) and also it is closely related to the height growth spurt (Tanner, 1989).

Thus, after the body measurement, all girls were asked their respective menarcheal age. If the girls had not achieved menarche, the inquiry was repeated every month during the study year. If the girls had already achieved menarche by the enrolment to the study in October 1990, a more detailed questionnaire was applied with the aim to facilitate recall of the date (see APPENDIX D).

In order to stratify the girls according to the menarcheal condition, the whole period of the research, from October 1990 to September 1991, was considered as well as whether they had or had not achieved menarche during this time. The girls who had experienced menarche before the beginning of the study were considered together with those who had started to menstruate during the year.

It is important to note that this grouping procedure (dividing the girls according to the menarcheal stage), caused a reduction of the sample size in some age groups. One implication is that this reduction generated distorted results. One way of checking the importance of this distortion is to observe whether the results obtained by not considering **menarche** is different enough to change the interpretation of the growth curve. Thus, in Chapter 7, an additional curve is inserted into the graphs, which data are based on the chronological-age-based whole-year increments for standing height. In these curves, namely Group A and Group B, the **occurrence of menarche** is not considered. Since the result of this approach did not show a distinct trend in terms of the difference between the social groups, more detailed attention is paid to the chosen procedure, in which **menarche** is considered.

Another aspect to be highlighted is the decision to the grouping of the **menarche group**. When the results of those who were recorded as having attained menarche at the beginning of the research were considered separately, their reported menarcheal ages were similar in each group, being 11.7 years for the high income class girls, and 11.9 years for their counterparts indicating that on an average the mean ages of actual and recalled menarche were similar.

According to Mascie-Taylor (1990) the most reliable methods for collecting the age at menarche are : first, the "prospective", second, the "status quo", and third the less reliable "retrospective" or "recall method".

In the present study, both "prospective" and "retrospective" methods were considered jointly because the mean values of both methods were similar, and because the method adopted in the menarcheal questionnaire for "retrospective" data allowed differences in time of about 3 month period only. Therefore, this oscillation was assumed to be at an acceptable level which could be mixed with the "prospective" method. However, even considering these assumptions, it is important to note that the data for "attained menarche" are derived from different methods, so the results should be treated cautiously.

Figure 2.3 illustrates the strategy adopted in order to scale the girls according to their respective maturation levels.

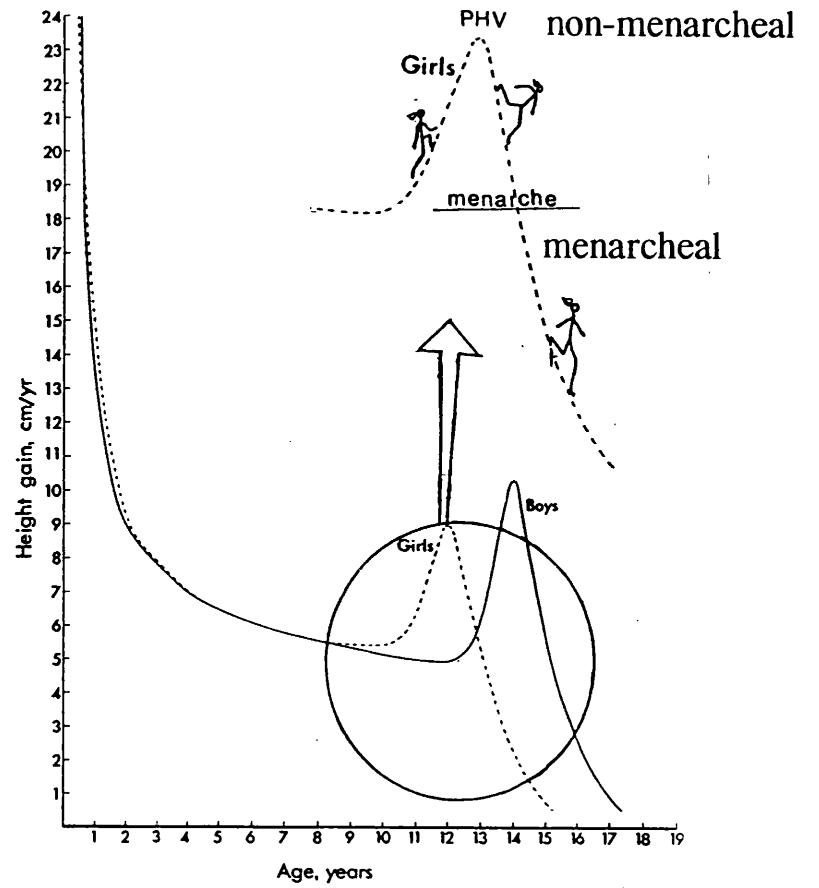

Figure 2.3 Base for scaling the girls by sexual maturity
(Adapted from Tanner, 1989)

By this approach, it was understood that the large variation among individuals in timing of pubertal spurt would be partially compensated, once the subjects had been aggregated by similarities in a growth-phase.

Nevertheless, it is important to note that although the present study had a longitudinal element, it lasted only for one year. This time limitation indirectly influenced the goals of the analysis, and consequently it was not possible to examine the complete pubertal spurt process, but only a part of the growth performance in terms of a yearly gain of the observed variables.

It is important to note that some studies carried out in India, Mexico, and Italy are unanimous in stating that the sexual maturation (identified in these cases as being the time of menarche) is strongly influenced by the socio-economic condition of the girls and their family. The poorer the girl, the later the timing of menarche (Roberts et al., 1977; Malina et al., 1977; Gallo, 1977).

2.6 Social Conditions

The social and living conditions were assessed through information provided by the social questionnaire applied during one interview.

2.6.1 The Social Questionnaire

The basic aim of the social questionnaire was to confirm the socio-economic status and to identify the living standards of the adolescents studied and their families. The questionnaire was divided into four sections. The first identified the adolescent, the parental status of the respondent, and details about the family size. The second section inquired about the place of birth and, whenever necessary, about migration. Another point was that, for the investigation about the place of birth, an "urban area" was a city (big or small town) or village with shops, and a "rural area" was a place where there was a predominance of fields and plantations. The third section explored housing conditions, and the last one investigated the family's income (see APPENDIX A). During the administration of the questionnaire, a colloquial language was used. in order to facilitate the interview.

As a native of the region, the investigator faced no communication problem. In the section on "housing conditions", household environmental conditions were interpreted according to three criteria as follows:

1 - Good environmental condition = score 8
2 - Moderate environmental condition = score 3 - 7
3 - Bad environmental condition = score 0 - 2

As can be seen from APPENDIX A for each item investigated concerning housing conditions there were three or two options. Each option had a score fluctuating from 0 to 3 points. The above criteria listed were based on the total sum of the points obtained for each household.

2.6.2 The Applicant

The social questionnaire was applied by the main investigator.

2.6.3 The Respondent

The social questionnaire was basically answered by the mothers. The majority of the fathers refused to participate in the interview, justifying this by claiming that the woman was better prepared to answer the questions related to the household. This behaviour was observed in both social groups. The high refusal of the men to take part perhaps occurred because of the traditional division of labour between men and women in Brazil. The household work is usually attributed to the female (Taube, 1986 volume I). However, it is not clear if this fact has influenced the findings.

2.7 The Investigation Of Morbidity

The investigation of the morbidity pattern was based on information provided by **reported morbidity**. Thus, every month after the anthropometric examination and the menarche investigation, information was sought about the occurrence of any complaint. For the subject to be considered to show reported disease, she had to have the symptom on the day of the examination and for at least more than one day before. (see APPENDIX E)

Complaints relating to the respiratory system were coded as cold/cough, and those of the digestive and intestinal system as diarrhoea. Other complaints such as fever, dengue, etc. were coded as others. The symptoms which identified different kinds of morbidity were:

1 - respiratory infection - cold/cough, nasal discharge and/or cough, sometimes with fever.

2 - diarrhoea - changes in consistency and number of stools, i.e., describing liquid stools more frequently than usual. A minimum number of stools was not specified. If a girl had vomiting and had diarrhoea, this was coded as diarrhoea.

3 - any other symptom than these above, were coded as "others", for instance fever without symptoms of respiratory infection, symptoms of dengue, or tiredness related to the nervous system.

2.8 The Pilot Study

According to Woodward & Francis (1988), a pilot study is an essential step to be developed before the survey proper begins. The authors justify the statement by the following reasons:

1 - it is a time of testing the questionnaires;

2 - identifying bias;

3 - estimating cost and survey duration;

4 - testing manpower and equipment.

Hence, a brief pilot study was made before the major survey began. The pilot survey ran for one week.(see APPENDIX F) and included 50 girls from the high income family group and 50 girls from the low income group.

Based on the result of the pilot study some plans had to be modified. First, an anthropometric examination on both parents was planned, but it was not possible to do so due to: the high refusal of the fathers to participate during the pilot study and during the study year. Further, some parents did not live together, especially in the low income group families. Second, a 2-day dietary intake record had been planned to be applied in addition to the 24-hour recall. However, during the pilot study there was a high refusal in answering the 2-day dietary record, in both social groups. For this reason, only the 24-hour recall was applied during the main investigation. In trying to overcome the limitation of the 24-hour recall, the method was repeated 4 times during the study year.

2.9 The Statistical Analysis Of The Data

This section presents a brief comment about the statistical methods through which the data were analyzed.

2.9.1 Variables Analyzed

2.9.1.1 Variables Analyzed For Building The Social And The Anthropometrical Profile (Cross-Sectional Analysis)

The socio-economic background was constructed from attributes such as:

- origin
- income level
- housing conditions
- number of siblings resident in the same household

In order to build the anthropometric profile of the studied girls, the following variables were considered:

- Height And Weight
  - i) attained height and weight
  - ii) in relation to NCHS reference (height-for-age and weight-for-age)

The analysis of height involved decomposing stature into standing height and sitting height. The standing height represents the whole stature and sitting height represents the trunk length. In order to observe the body proportion pattern, the sitting height was divided by the standing height, thus the sitting-standing height ratio was obtained and consequently leg proportion could be examined as well.

- Body composition (estimation of fatness)
  i) skinfolds (triceps, biceps, subscapular, suprailiac, sum 04 skinfolds)
  ii) arm circumference (TUA, UMA, FAA)
  iii) body mass index (BMI)

2.9.1.2 Variables Analyzed Longitudinally

In order to evaluate the growth performance, the following variables were considered: occurrence of menarche, morbidity, gain in height, gain in weight, gain in Σ 04 skinfolds, triceps, biceps, subscapular, suprailiac, fat arm area, and gain in upper arm muscle area.

Menarche was studied observing variables such as: girls menarche age, mother's menarche age, and height-for-age Z-score for the girls.

As stated previously, health was studied considering the reported morbidity.

To build the food intake profile of the studied girls, an analysis was made of the specific food groups: milk and milk products, eggs, meats, legumes, vegetables. fruits. cereals, fat and oils, sweets and sugar and beverages. The average daily intakes of various nutrients were calculated and their respective percentage of the nutrient requirements.

2.9.2 Descriptive Information Of Variables

In order to examine the collected data statistical procedures were developed. In general, to describe continuous variables (attained and annual gain) such as height, weight, skinfolds (triceps, biceps, subscapular, suprailiac and sum of 04 skinfolds), upper muscle area and fat arm area, mean and standard deviation (SD) were calculated.

Categorical variables were described by frequency distribution tables, in which the number and respective percentage of observations were displayed.

Height-for-age and weight-for-age were expressed as a standard deviation score (Z-score) in relation to the NCHS reference using Frisancho (1990) formula:

Z-score = (Standard's mean value - value of subject) / standard deviation of reference

2.9.3 Significance Tests

Significance tests were performed to estimate real differences between social groups on the studied variables. T-test was used to compare the variances of two samples (continuous variables). The Mann-Whitney test (two-tailed test) for two independent samples was performed to measure differences between groups in distribution of categorical variables (Altman, 1992).

To measure the degree of association between sets of continuous variables, the Pearson Correlation Analysis technique was used.

Anova (analysis of variance) was used when it was necessary to control the effect of age on the variables studied.

The **multiple linear regression** technique was used to observe the way the biological parameters were influenced by the socio-economic variables. In this regression model, the outcome observed (dependent variable) was expressed as a combination of the explanatory variables (covariates). or in other words, it was possible to observe the effects of each socio-economic variable, controlling for the effects of others.

Since this statistical method requires the data to be normally distributed, continuous variables which did not have a normal distribution, were log10 transformed before entering in the analysis. The variables that have been analyzed as dependent variables were: height, weight, sum of four skinfolds (triceps, biceps, subscapular, suprailiac) fat arm area, upper arm muscle area, body mass index, menarche age, morbidity. The socio-economic variables have been entered into the equation as the explanatory variables. Because the variables were categorical, they were coded as "dummy variables" being:

D1 = Domestic Waste Disposal
D2 = Waste Drainage System from the area
D3 = Waste Drainage System from the house
D4 = Water Source
D5 = Girl's Birthplace
D6 = Shower-Bathroom Availability
D7 = Parents Birthplace
D8 = Number Of Siblings
D9 = Growth Status
D10 = Menarche Condition
D11 = Morbidity

For coding of the "dummy variables" the following assumptions were established:

1 - Variables related to environmental conditions identified as being "the best condition" were coded as = 1. By this it is meant that it was expected to be found the best socio-economic conditions for the best values for the dependent variables.

2 - Variables related to birthplace setting with positive values for urban area were coded = **1,** meaning that it was expected that girls who were born in urban areas should present better values for the dependent variables.

3 - The growth status was coded "normal individuals" = 1.

4 - The absence of reported morbidity was coded = 1.

5 - The absence of menarche was coded = 1.

For this study, the strategy adopted was the **FORWARD STEPWISE REGRESSION,** in which each potential explanatory variable was examined separately in relation to the dependent variable. This method used the cut-off of **p = 0.05**.

Manova (repeated measures analysis) was used to assess the within subject differences (seasonal effects). The advantage of using this method is because it does not require a big sample to be studied, to provide a reasonable control on their differences (Norusis, 1988).

2.9.4 Graphical Presentation

Figures were shown in order to illustrate the data contained in the tables.

2.9.5 Confidence Interval And Significance Level

The 95 % confidence interval was used for the analysis of the data. The usual cut-off point of 0.5 was established meaning that any result presenting a p value greater than this level was considered "not significant". However, in certain cases, even when this "not significant" result was obtained, some comment was made if the data suggested a real effect (Altman et al., 1983).

2.9.6 Age Ranges

In order to present the results on the annual increment, the longitudinal standard was used for two occasions, where the result "is plotted at the age midway between the two ages on which the calculation is based" (Goldstein, 1979 page 177). So, the age-ranges of 9.0 to 10.0, 10.1 to 11.0, 11.1 to 12.0, 12.1 to 13.0 and 13.1 on were represented by **9.5, 10.5, 11.5, 12.5 and 13.5** respectively.

PART II Social And Anthropometric Profile Of Alagoan School Girls On Enrolment To The Study - A Cross-Sectional Analysis

Care is required when analyzing longitudinal data in order to avoid the use of wrong methods of analysis and consequent significant loss of information. This kind of error can be introduced when longitudinal data are treated by cross-sectional statistical methods.

In this study, although the data will be analyzed further using a longitudinal approach, this section presents a brief cross-sectional view of the sample population at the beginning of the study period. This view provides a baseline of the main characteristics of the study population before proceeding to the longitudinal analysis.

The main goal of **PART II** is to pinpoint the anthropometric and social characteristics of the girls and to point out their main differences on enrolment to the study.

Chapter 3

Social Background

This section presents the social profile of the Alagoan girls, noting the following characteristics: origin, income, housing conditions and number of siblings. The aim was to demonstrate the main social differences between groups. It is important to note that given the limitation of the sample size it was not possible to study the interaction among origin, migration and "growth status".

3.1 Origin Results

The origin was assessed by birthplace, i.e. if in an urban or rural setting. Table 3.1 presents the frequency distribution of the parents' and girls' origins.

Table 3.1 Origin distribution of girls and parents by social class

		Group A		Group B	
Origin	Subjects	Freq.	%	Freq.	%
Urban	Girl	141	97.2	167	80.7
	Mother	103	71.0	125	60.4
	Father	100	69.0	132	63.8
Rural	Girl	4	2.8	40	19.3
	Mother	42	29.0	82	39.6
	Father	45	31.0	75	36.2

Figures 3.1, 3.2, and 3.3 illustrate such data. The frequency distribution of girls' origin by social status is shown in Figure 3.1 In both social groups the majority of girls were of urban origin. However, the percentage of girls of rural origin was larger in the low income group than in the high income group. The Mann-Whitney test indicated that the difference in percentages between the social groups was significant ($p < 0.001$).

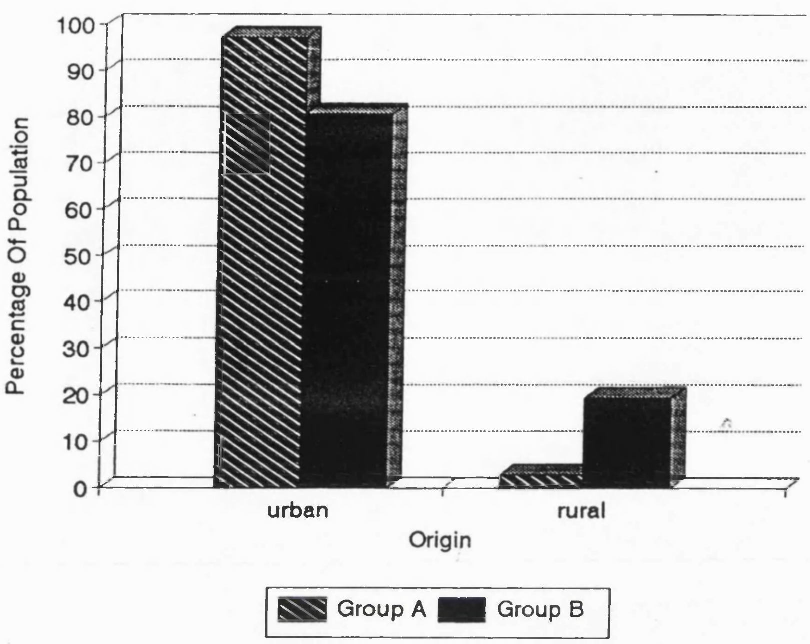

Figure 3.1 Origin of Alagoan girls according to social class

Figure 3.2 presents the mothers'origin according to social class. As can be seen, the majority of mothers from both social groups were from urban origin. Nevertheless, in comparison to the high income group, there were proportionally more mothers from the low income group with a rural origin (p=0.04).

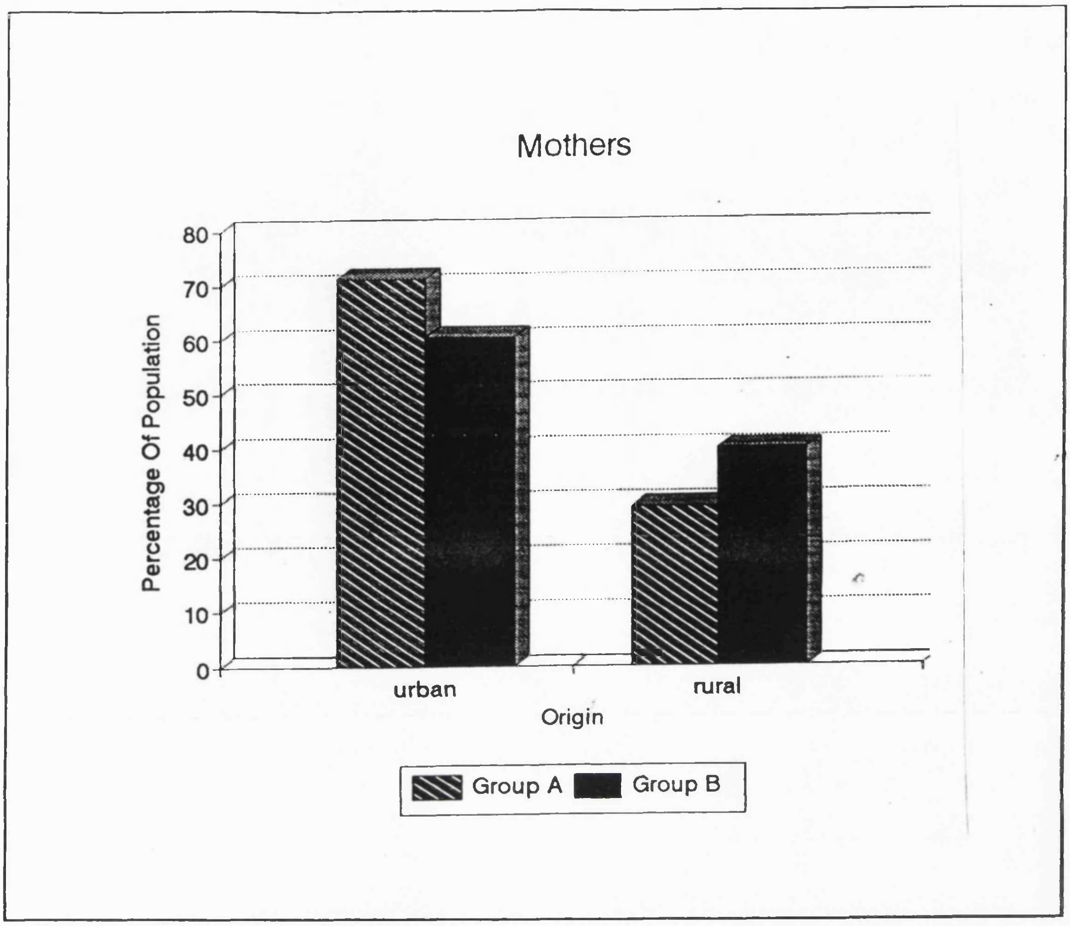

Figure 3.2 Mothers'origin by social class

In the case of the fathers, represented by figure 3.3, the difference in origin between social conditions, was not so large as it was in the case of the mothers (p=0.3), although it is clear that the urban origin was found to occur in a larger proportion in both social groups.

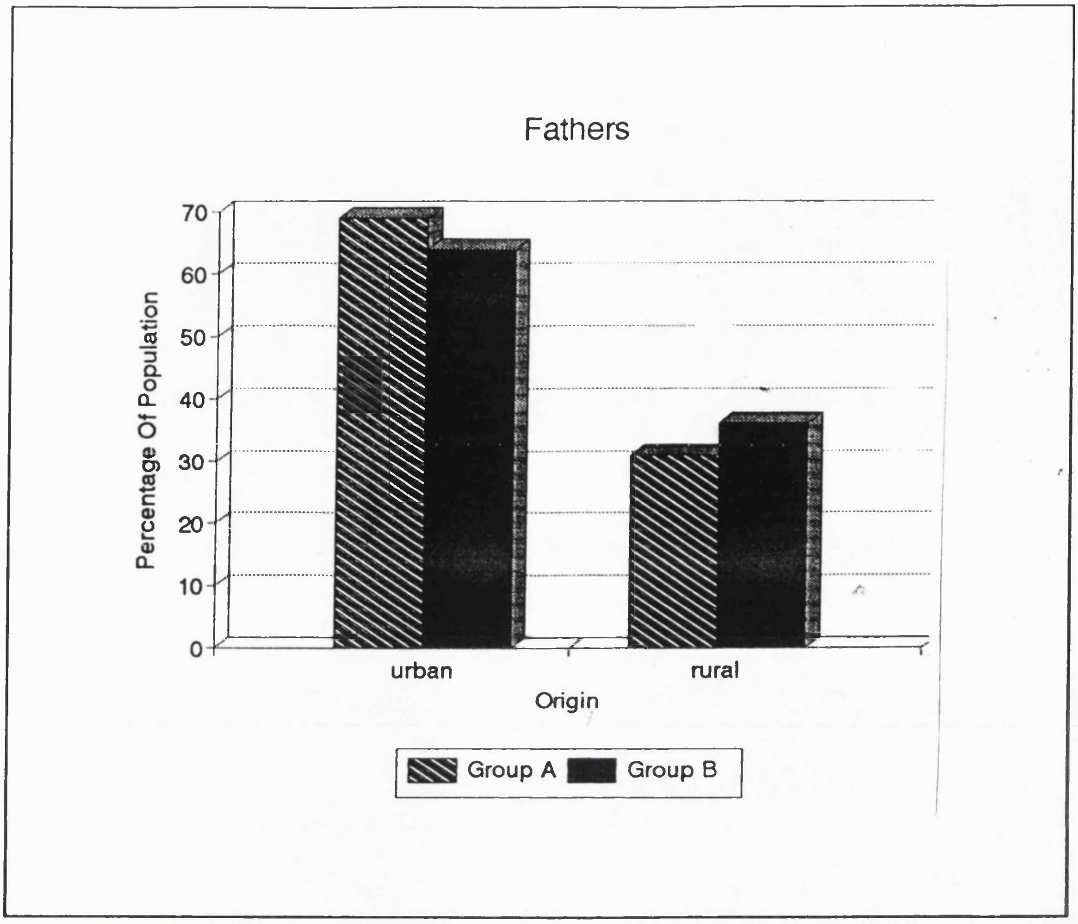

Figure 3.3 Fathers' origin by social class

3.1.1 Migration Causes

The results of the enquiry applied to parents born in a rural area and who afterwards had migrated to Maceio (urban setting) are presented in Tables 3.2, 3.3 and illustrated in Figures 3.4 and 3.5. The reasons for migrating are shown in Table 3.2. All the mothers of rural origin answered the enquiry, while the majority of fathers refused to be interviewed. The reasons for this refusal were sometimes related to causes such as "desculpe mas nao tenho tempo ha perder" (does not have time to waste), "estou cansado demais pra responder perguntas" (too tired to answer questions), "a mae dela e quem sabe dizer essas coisas de familia" (the mother is the right person to answer about the family) etc..

Table 3.2 Primary causes of migration by parents' social-class

	Group A		Group B	
Primary Causes	Freq.	%	Freq.	%
Job / Impr.life	10	18.9	83	95.4
Education	40	75.5	-	-
Health / Others	3	5.6	4	4.6
TOTAL	53	100.0	87	100.0

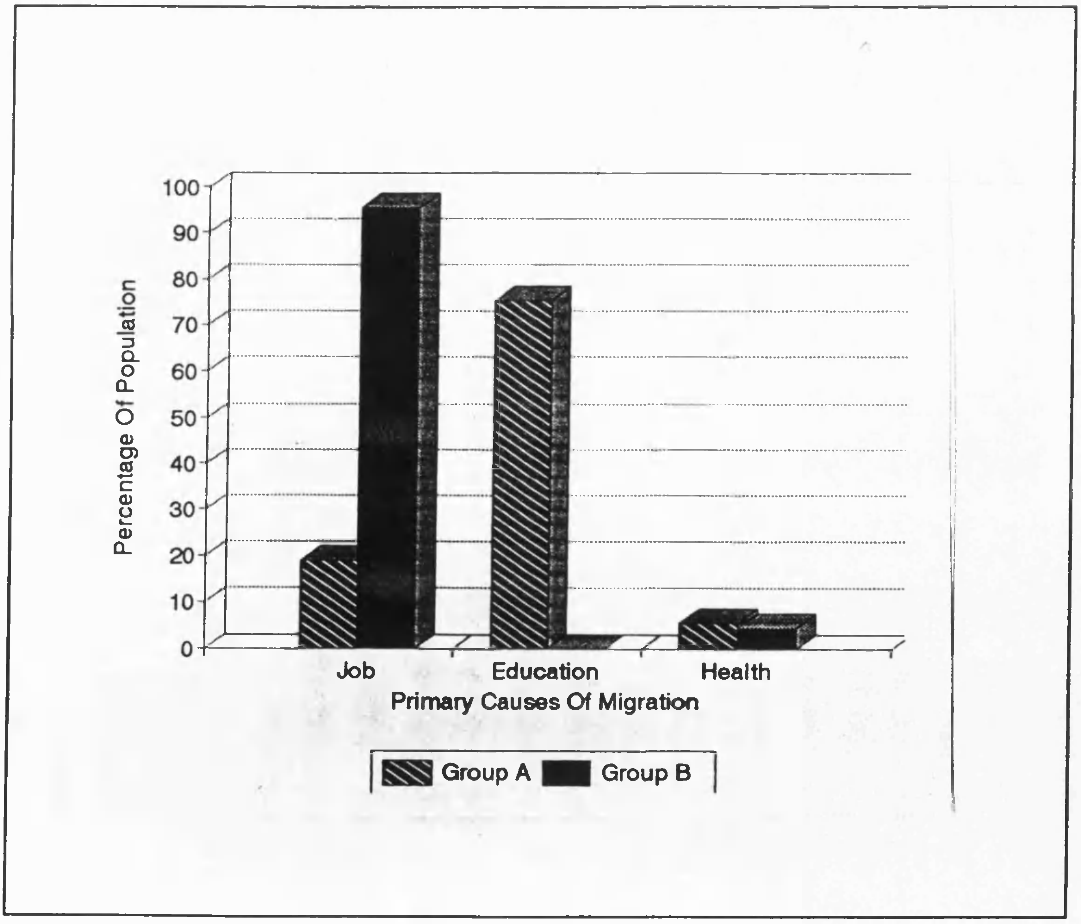

Figure 3.4 Primary causes of parents' migration

So, in order to obtain as much information as possible, all the primary answers collected, given by mothers and/or fathers, were analyzed.

Parents from different social status had different reasons for migrating (p=0.02). As can be seen in Figure 3.4, the majority of parents from group A (high income group) had migrated to Maceio looking for the best condition for education (75.5 %) and work opportunities (18.9 %).

In contrast, the reasons from the low income group were mainly related to improved work opportunities and a necessity for improving life (95.4 %) rather than any other motivation. The factors of health and other conditions were poorly cited in both social groups, being 5.6 % in group A and 4.6 % in group B.

Figure 3.5 illustrates the data, by showing the distribution of this primary evaluation. It is clear that the great majority in both Groups A (88.7 %) and B (82.7 %) agreed that the decision to leave the place where they were born was correct, since they consider that there has been an improvement in the quality of their lives. The Mann-Whitney test for two independent sample confirmed the similarity (p=0.4).

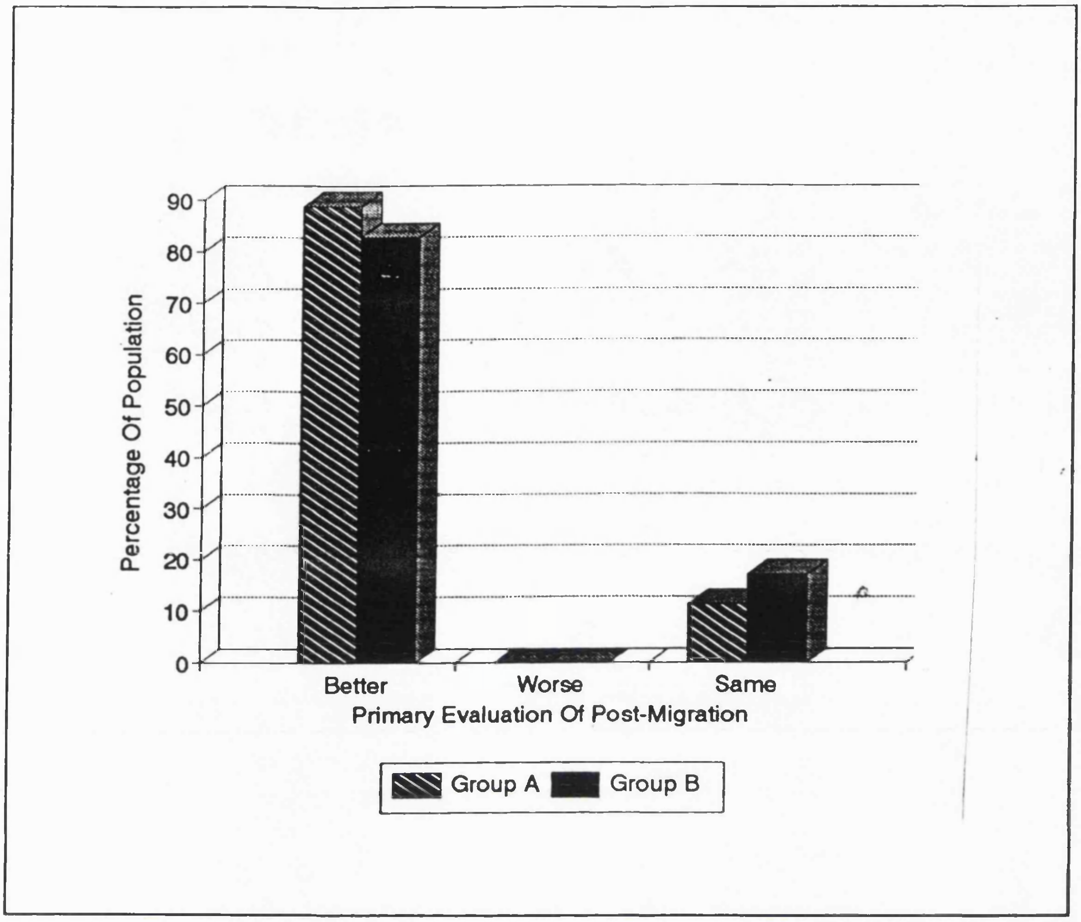

Figure 3.5 Primary evaluation of parents migration

Table 3.3 gives the numeric details of how these parents were supposed to feel about the success of their migration.

Table 3.3 Distribution of primary evaluation of post-migration situation by social-class

Situation	Group A		Group B	
	Freq.	%	Freq.	%
Better	47	88.7	72	82.7
Worse	-	-	-	-
Same	6	11.3	15	17.3

Nobody mentioned that the new condition was worse than the initial one, although some people in both Groups A (11.3 %) and B (17.3 %) agreed that they had not improved the standard of life as expected when moving.

3.1.2 Girls' Migration Age

The age of migration of those girls who were born in a rural area is displayed in Table 3.4.

Table 3.4 Age at migration of girls by social-class

Age of migration	Group A		Group B	
	Freq.	%	Freq.	%
Before 5 y	1	25.0	10	25.0
After 5 y	3	75.0	30	75.0

In both social groups, A (75.0 %) and B (75.0 %) the majority of girls arrived in Maceio aged more than 05 years, while 25.0 % in both groups arrived before 05 years old.

Although age of migration is an important subject, further analysis on these data is impossible because there were not enough girls in this category to warrant detailed investigation.

3.2 Income

The variable income was explored in terms of equivalence to the Official Minimal Wage (OFMW), which has been converted into American dollar values to make it easier to understand. The per capita monthly income was not considered in the case of this work, because it has been assumed that the most important anthropometric characteristics would be defined by the gap between 1 and 15 OFMW. The results are shown in Table 3.5.

Table 3.5 Distribution of income per household by OFMW by social-class

Wage (OFMW)	Group A		Group B	
	Freq.	%	Freq.	%
Up to 1.0	-	-	18	8.7
1.1- 2.0	-	-	109	52.7
2.1- 3.0	-	-	80	38.6
15.0- 20.0	121	83.4	-	-
20.1- 25.0	20	13.8	-	-
+ 25.0	4	2.8	-	-

Although social class was considered in two main groups, A and B, there was a variation in level of income between each subject in their respective group. As shown in Table 3.5, 83,4 % of girls from Group A lived in a household financial standard of 15 to 20 OFMW ($ 901.20 to 1201.60). 13.8 % of 20.1 to 25 ($ 1207.60 to 1502.00) and 2.8 % with more than 25 OFMW ($ 1502.10 +). In group B, 8.7 % of parents earned up to 01 OFMW ($ 60.1), 52.7 % earned up 1.1 to 2.0 OFMW (around $ 120), and 38.6 % up to 2.1 to 3.0 OFMW ($ 180). However, such income fluctuation within each social class has not been considered because this is assumed not to be strong enough to invert the social status. Therefore the economic homogeneity within social groups, reflected by the respective kind of school attended, was understood as being sufficient to be considered as a proxy for social status.

3.3 Housing Conditions

3.3.1 Toilet Facilities

The housing conditions were explored according to several characteristics. The first one to be studied was that of toilet facilities. Table 3.6 and Figure 3.6 give the details of these data.

Table 3.6 Toilets distribution by social-class

Number of toilets	Group A		Group B	
	Freq.	%	Freq..	%
1	-	-	198	95.7
2	21	14.5	9	4.3
3	107	73.8	-	-
4 +	17	11.7	-	-

Toilet facilities were not a problem in either social group. As expected, 100 % of girls from group A had access to private facilities in both conditions: inside the house (30.3 %) and in a combined form, i.e. inside and outside the house (69.7 %). In relation to the number of toilets in each household, 14.5 % of the girls had up to two, 73.8 % had three and 11.7 % had up to five toilets.

In group B conditions were quite distinct, although the whole group reported that they had at least one toilet available. Nevertheless, 89.9 % of the toilets were supposed to be located inside the house, 8.7 % outside and 1.4 % in a combined form. Only 4.3 % of the girls reported to have two toilets at home.

Mann-Whitney test conformed the inequality in terms of toilet availability, ($p < 0.001$).

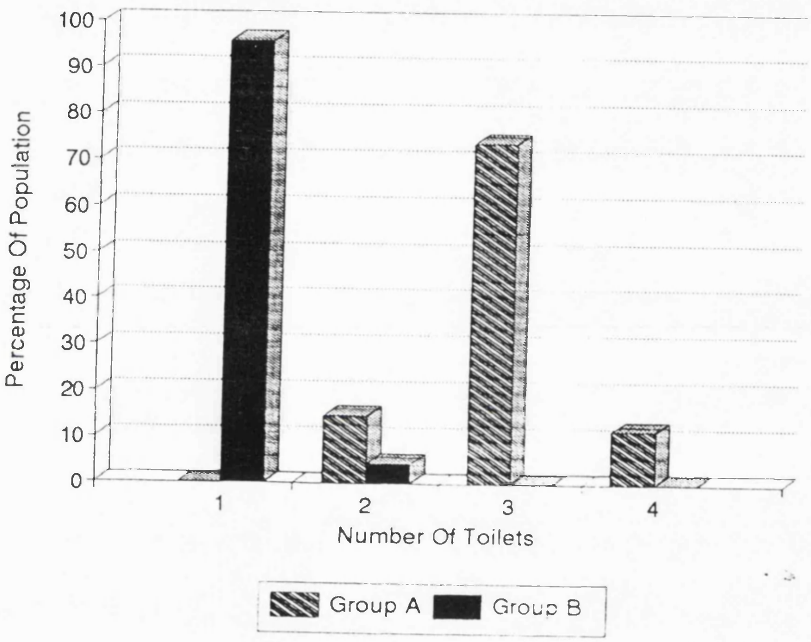

Figure 3.6 Distribution of toilets by social class

3.3.2 Availability Of Rooms By Household

Information about the house size is given in Table 3.7. Low income girls lived in smaller houses in comparison to their counterparts ($p < 0.001$). By this table, the majority of girls from Group A (66.2 %) lived in houses with 7 to 9 rooms. However, the rest 33.8 %, lived in houses with 10 or more rooms.

Table 3.7 Household size distribution by social-class according to rooms available

Number of rooms	High income		Low income	
	Freq.	%	Freq.	%
1 - 3	-	-	8	3.9
4 - 6	-	-	176	85.0
7 - 9	96	66.2	23	11.2
10 +	49	33.8	-	-

In contrast, the majority of the low income group (85.0 %) lived in houses with 4 to 6 rooms. Nevertheless, houses with up to 3 rooms (including kitchen and bathroom) were found to occur in 3.9 % of the cases in this group. The rest 11.2 % lived in houses sized from 7 to 9 rooms.

3.3.3 Water Source

The two social groups differed in terms of domestic water supply ($p<0.001$). As presented in Table 3.8 and Figure 3.7, all households from the high income group obtained their water from the official network (state water board) or from a spring water source.

In Group B, while 82.6 % received water from one of the sources above cited, 17.4 % had access to it from community taps and/or lorries.

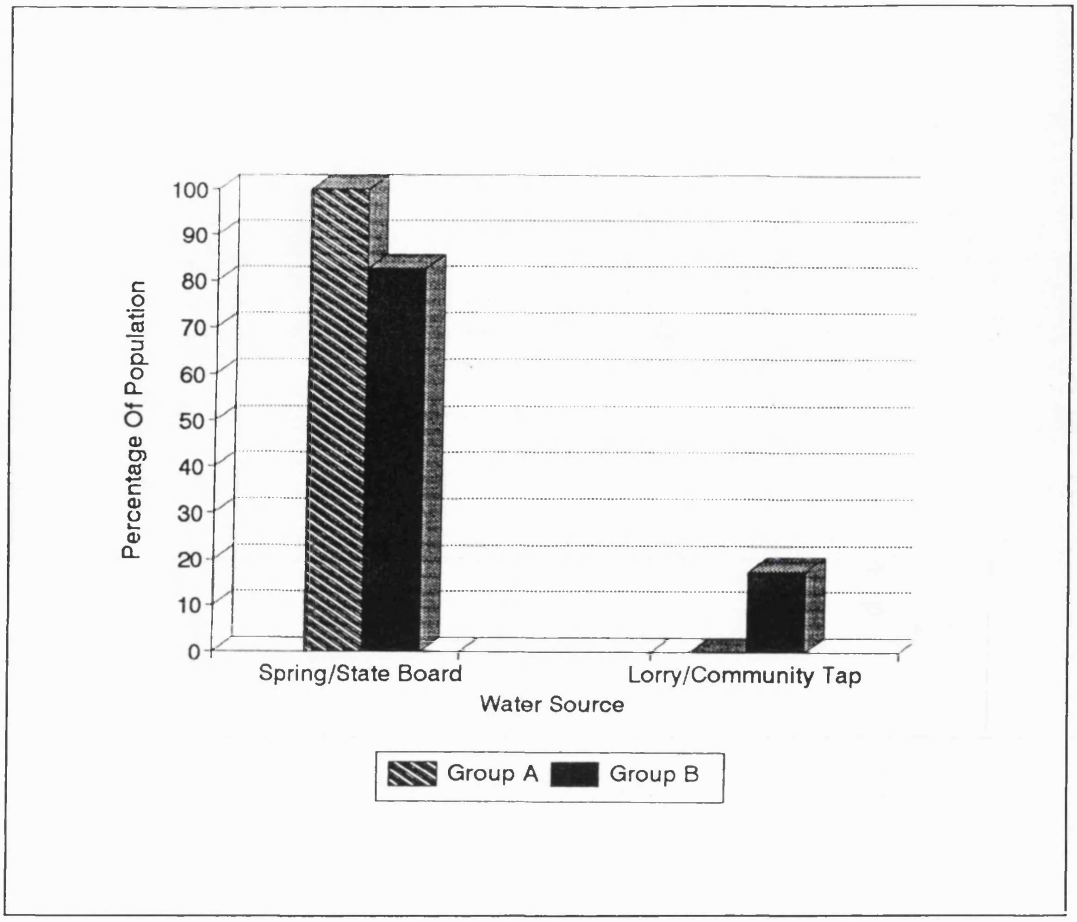

Figure 3.7 Source of domestic water by social class

Table 3.8 Water source distribution by social-class

Water source	High income		Low income	
	Freq.	%	Freq.	%
Spring water / State board	145	100.0	171	82.6
Lorry / Comm.tap	-	-	36	17.4

3.3.4 Electricity Facilities

In relation to domestic electricity, there was no contrast since all households from both Groups A and B had such facility. See table 3.9.

Table 3.9 Availability of domestic electricity by social class

	Group A		Group B	
Facility	Freq.	%	Freq.	%
Electricity	145	100	207	100

3.3.5 Excreta And Waste Disposal

3.3.5.1 Drainage System From The Area

In terms of sanitary conditions of the house, a marked difference was detected between the social groups. The first point to be explored was the one regarding excreta disposal related to type of drainage system from the area. Table 3.10 and Figure 3.8 reveal that both social groups had different conditions ($p < 0.001$).

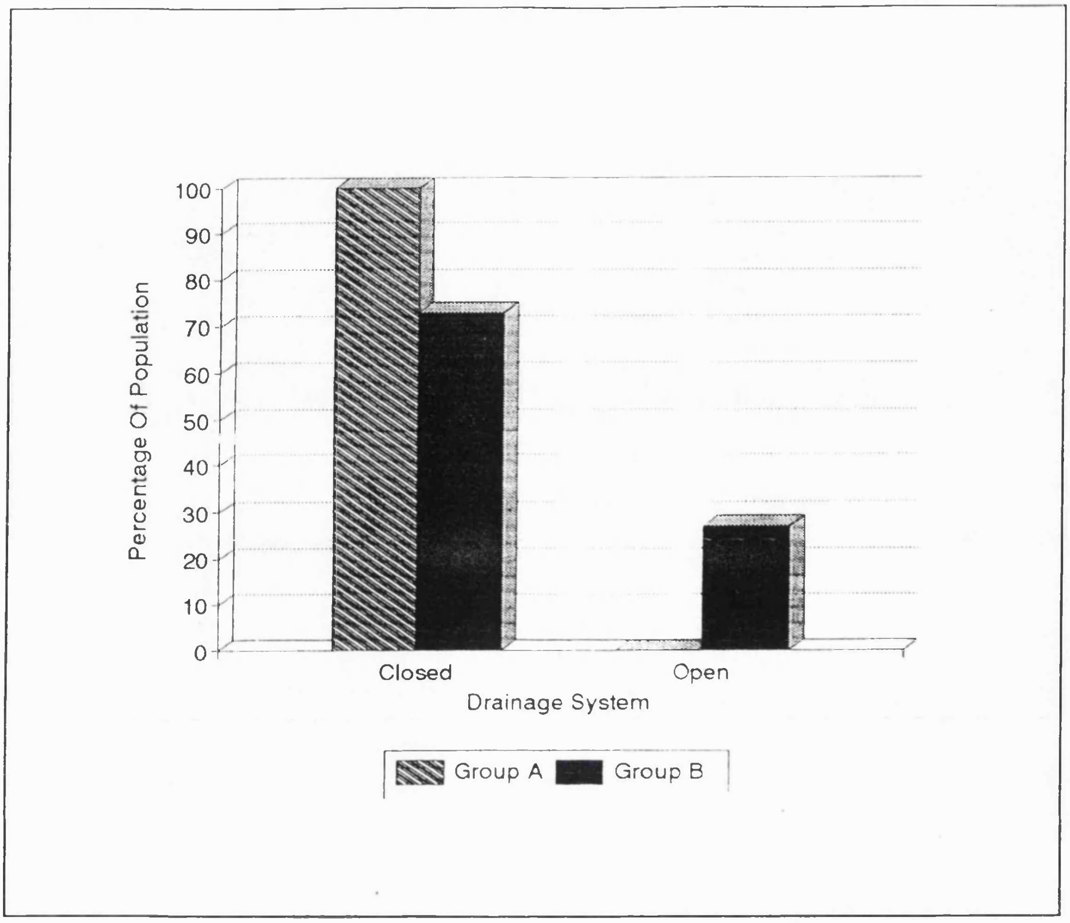

Figure 3.8 Type of drainage system by social class

All households in the high income group were connected to a closed sewage system. In contrast, 72.9 % of households from the low income group used a closed system, while the rest 27.1 % had none or used all other systems.

Table 3.10 Waste drainage system distribution by social class

Drainage system	Group A		Group B	
	Freq.	%	Freq.	%
Closed	145	100.0	151	72.9
Others	-	-	56	27.1

Figure 3.9 Open drainage system in one of the poorest households

Figure 3.9 illustrates a very usual situation found in many of the poorest areas of Maceio. It shows an open system in which all kind of waste runs outdoors.

3.3.5.2 Type Of Latrine

Details about the type of latrine used at the households are given in Table 3.11, from which it can be seen that the social groups did differ significantly ($p < 0.001$).

All households from the high income group used the flush toilet system. In contrast, 6.3 % of households from the low income group presented flush toilet system. Around 66.6 % had pit latrines and the rest 28.5 %, all others kinds of services less standardized.

Table 3.11 Distribution of waste drainage system from households by social-class

Latrine system	Group A		Group B	
	Freq.	%	Freq.	%
Flush toilet	145	100.0	13	6.3
Pit latrine	-	-	138	66.6
Others	-	-	56	27.1

3.3.5.3 Type Of Domestic Waste Disposal

Another contrasting sanitary condition was domestic waste disposal. As can be noted from Table 3.12, 100 % of the houses in the high income group had the "door collection" system.

In contrast, only 23.2 % of the low income households had access to a "door collection" system. Around 39.6 % had the "skips" system and 37.2 % put their wastes in open places in nearby fields. Such distribution was compared through Mann-Whitney test and the result confirmed the difference to be significant ($p < 0.001$). Details of these data are contained in Table 3.12.

Table 3.12 Distribution of domestic waste disposal by social class

Disposal system	High Income		Low Income	
	Freq.	%	Freq.	%
Door collection	145	100.0	48	23.2
Skips	-	-	82	39.6
Open place	-	-	77	37.2

3.4 Overall Pattern Of Living Standard

To facilitate interpretation of the results, an overall pattern of living standard was established, by giving different scores according to attained environmental conditions (refer to the Chapter 2). The results from this procedure are shown in Table 3.13 and Figure 3.10.

The data reveal a marked correlation between the socio-economic condition and pattern of living standard. The high income group has a completely different environmental condition ($p < 0.001$). In the high income group all girls lived in homes in which basic and sanitary conditions were completely fulfilled, while in the low income group the pattern of living standard oscillated between bad (37.7 %), regular (61.4 %) and good (0.9 %).

Table 3.13 Score distribution of housing condition by social-class

	Group A		Group B	
Pattern / Score	Freq.	%	Freq.	%
Bad / 0-2	-	-	78	37.7
Regular / 3-7	-	-	127	61.4
Good / 8	145	100.0	2	0.9

3.5 Number Of Siblings

Table 3.14 presents the details regarding the distribution of sibling residing in the same house. It shows that, 11.0 % of the girls from Group A had no siblings, 83.5 % had up to two, and 5.5 % had three or more.

In Group B, 23,2 % did not have any sibling, 51.7 % up to two and 25.2 % three or more. The overall distribution between the social classes regarding the total number of siblings was tested by Mann-Whitney test. A significant difference was found to be present (p=0.02).

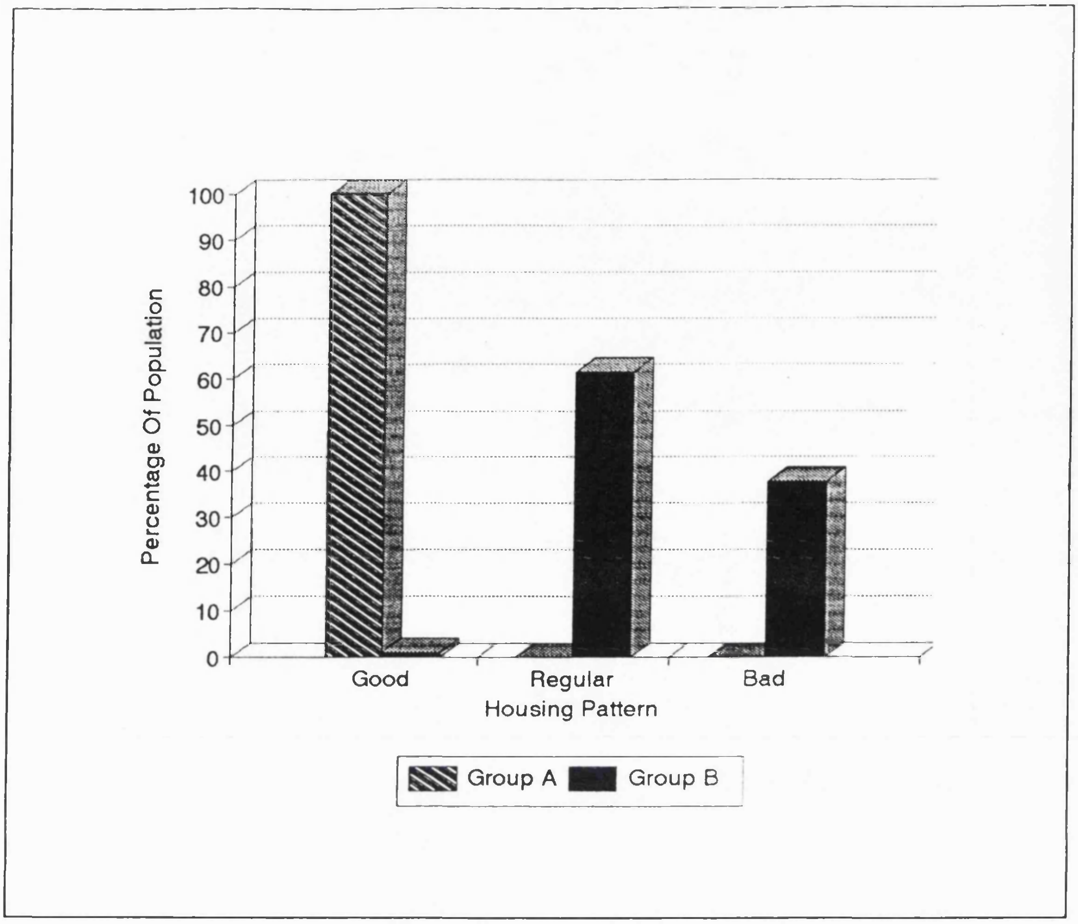

Figure 3.10 Overall pattern of living standard by social class

Table 3.14 Comparison of frequency distribution in total number of resident siblings per household by social group

No. resident siblings	Group A		Group B	
	Freq.	%	Freq.	%
0	16	11.0	48	23.2
Up to 2	121	83.5	107	51.7
3 +	8	5.5	52	25.2

3.6 Discussion Of The Socio-economic Profile On Enrolment To The Study

3.6.1 Origin And Migration Causes

The overall pattern of the birthplace distribution showed in Table 3.1, corroborate the data shown previously by IBGE (Table 2.2). In relation to this point, two characteristics could be observed in the data collected: first. it was found that there were more people of rural origin in Group B (low income) than in Group A (high income) whether parents and girls separately or together.

Second, it was found that most, parents from group B justified migration by the necessity of job opportunities and to improve their lives. This result does not differ from previous studies in developing countries. where the migratory flux is mainly determined by economic questions. For instance. Little and Baker (1988) suggest that human migration usually occurs by the desire of improving life, although the economic deprivation is supposed to be the real cause.

Janvry et al. (1986), analyzed the question of land and labour in Latin American agriculture during the period of 1950 and 1980. In this paper they discuss the question of peasant mobility, in the light of aspects such as land access and availability, and employment opportunities in agriculture and rural areas. According to them, all the information collected from this period of 30 years suggested that economic growth, access to land and employment creation were not sufficiently strong to reduce rural poverty. As a result of this, an intense migratory flow was established to the informal urban economy.

In the case of Alagoas, the question of landownership is a quite serious problem, which has pushed the poor rural people to urban settings such as Maceio when they decide to continue in the state. and to Sao Paulo and Rio de Janeiro when the decision is to move out from Alagoas.

For the low income group, migration then is motivated by the desire of achieving better life conditions through the possibility of entering a new and different work market, which is supposed to exist in urban areas ("porcauso que num dava mais pra ser escravo da cana, vendo os menino crescer no meio da paia" (it was not possible any more to be a sugar-cane slave and to see the children growing up within the sugar-cane straw)). Because at this moment, the fulfilment of basic necessities seems to be the main goal when moving, the education factor was not cited by parents in the low income group.

In contrast, parents of Group A argued that education was the main cause for them to migrate. In this case, it makes sense to affirm that, for two reasons: first, the best secondary schools are located in Maceio; and second, there are universities only at Maceio. Therefore, if it is considered that the basic necessities are the same in rural and urban areas in higher income levels, then the search for better educational activities seems to be a reasonable argument for moving from a rural area.

Because the opportunities in an urban setting are supposed to be greater than in rural areas, the evaluation of those who had migrated was positive. The majority of parents in both groups (A and B) indicated that their current condition was better than the previous one, although there was a minority which did not recognize any improvement in their living standard.

3.6.2 Income And Housing

All the variables explored in the study of housing conditions showed different patterns in different social-groups (A and B). There were clear differences in the living pattern of the girls. The higher the income level, the better the living standard. There was no difference in the quality of environmental conditions between the girls from Group A. All of them had good housing condition (score=8).

Some difference was detected related specifically to size of building (see Table 3.7).

but in this case it is not supposed to compromise environmental quality.

In contrast, girls from the low income group differed in both in comparison to the high income group, and among themselves. In comparison to Group A, the girls from Group B differed dramatically in housing conditions. For instance, only 0.9 % of these girls lived in environmental equality with girls from group A, although this does not mean that the quality of the building standard was the same. The other 99.1 % lived in regular or bad conditions. This means that the great majority of low income girls lived under the basic standard of living. Regarding the differences within social Group B, there were considerable differences related to points such as water source, drainage system from the house, drainage system from the area and methods of disposing domestic waste. In all cases, it was possible to observe that as the income level increased, the quality of services improved, i.e. more houses were linked to the official network (state water board) and more houses had better and safe conditions of sanitation.

3.7 Conclusion

As expected, the socioeconomic profile of the Alagoan girls in this study were very distinct. Being from low income group signified living in not very adequate environmental conditions, where the basic sanitary conditions were not ever achieved. High income status was identified as reflecting better living standards.

Chapter 4

Anthropometric Profile

This section covers the assessment of the anthropometric profile of the Alagoan school girls on enrolment to the study. The evaluation is based on a cross-sectional analysis of the data collected during the first month of the research (October 1990). The aim was to identify whether there was any particular difference in terms of nutritional and growth status between Alagoan school girls of different social status during adolescence.

4.1 The Sample Age Distribution According To Social Status

Table 4.1 shows the age distribution of the sample according to social classes.

Table 4.1 Age distribution by social classes of girls

	Group A		Group B	
Age	No.	%	No.	%
9.5	18	12.4	21	10.1
10.5	36	24.8	58	28.1
11.5	49	33.8	48	23.2
12.5	26	17.9	45	21.7
13.5	16	11.1	35	16.9
TOTAL	145	100.0	207	100.0

4.2 Height Results

Means, standard deviations and p values (derived from T-test) for attained height-for-age are shown separately by social group in Table 4.2 and Figure 4.1 .

Table 4.2 Mean, standard deviation and T-test results for height of Alagoan girls by age and social class on enrolment to the study (Oct 1990)

	Height (cm)								
	High Income			Low Income					
Age	No.	Mean	SD	No.	Mean	SD	t value	df	P value
9.5	18	138.2	6.1	21	131.7	6.9	3.10	37	0.004
10.5	36	142.4	5.3	58	133.4	7.2	6.97	90	0.000
11.5	49	145.1	6.5	48	142.4	7.0	1.96	95	0.053
12.5	26	150.5	7.4	45	147.3	8.2	1.66	69	0.102
13.5	16	157.3	5.5	35	151.0	7.9	2.88	49	0.006

It is clear from Table 4.2 that girls from the low income group were shorter than their counterparts. Figure 4.1 shows this. The vertical axis displays the mean of attained height of Alagoan girls. The horizontal axis compares the two social classes at different age ranges.

As can be seen from the graph, girls from low income group are shorter than high income individuals at all age ranges. This difference is larger at the beginning of the adolescence period (ages 9 and 10). Then, between ages 11 and 12, the difference decreases and both social groups present a similar pattern of height. However, at age 13, the curve for girls from the low income group again diverges from the high income group. T-test confirmed the difference.

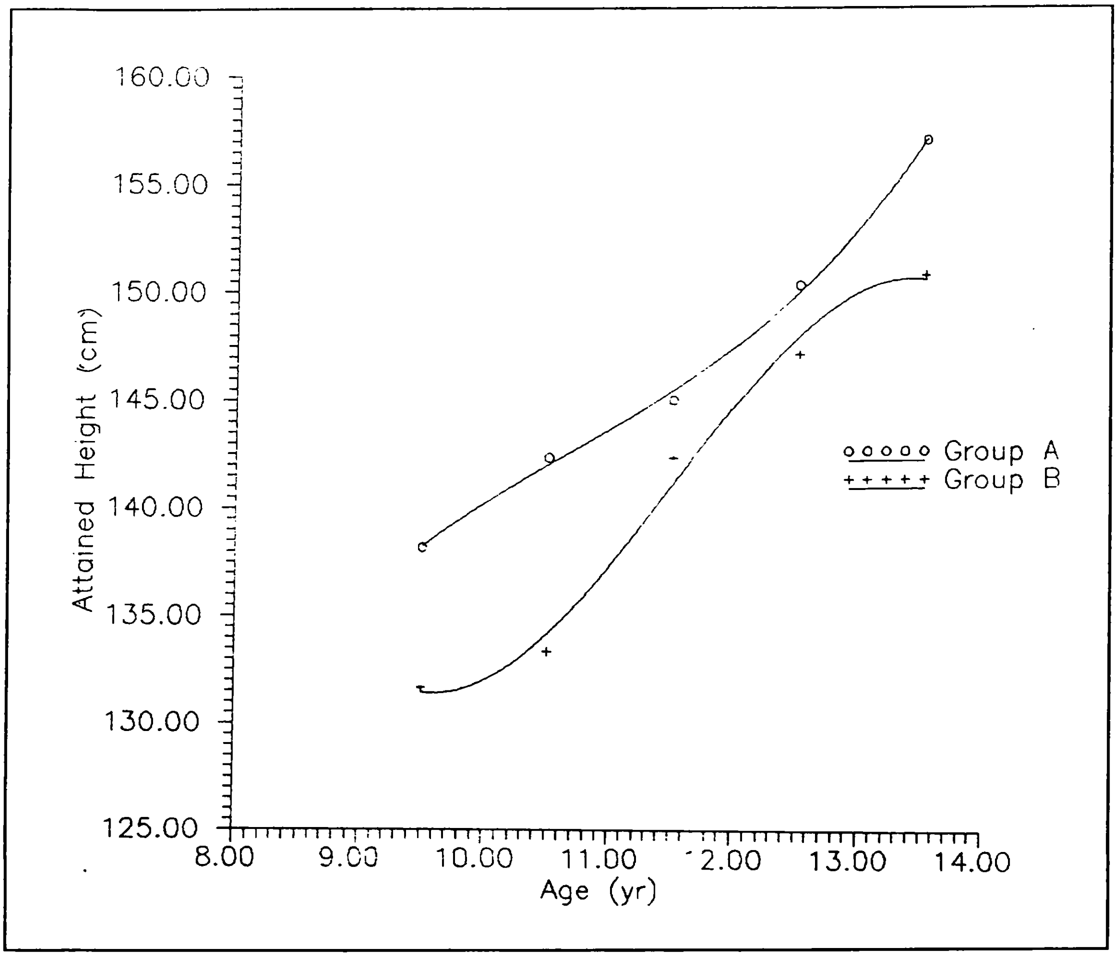

Figure 4.1 Mean attained height of adolescent Alagoan school girls by social group

Another investigated point was the proportion of the low income girls above the average height of the high income peers. The results indicate that there was a fluctuation in the proportion of low income girls who had the attained height above the average height of the opposite social group.

For instance, the proportion of low income girls above the average attained height of their counterparts had a distribution different according to the age ranges. At ages 9 and 10 only 17 and 11 % of low income girls were above the average height of the opposite group. Then, the situation seemed to improve. At ages 11 and 12 this proportion increased to 35 % in both age intervals. However, at age 13, again the proportion of the low income girls above the average of the high income group attained height fell to 21 %.

4.2.1 Alagoan Girls Attained Height In Comparison To NCHS

Additional information is provided by comparing both social groups in relation to NCHS and to a more recent Brazilian national research data (PNSN, 1989). Figure 4.2 gives some representative details that illustrate this attempt to assess the between group differences.
It is clear from Figure 4.2 how mean attained height for both groups performed in comparison to the American reference curve and Brazilian urban data. The high income group curve is similar to the American curve, while the low income group is closer to the Brazilian curve.

4.3 Weight Results

The means and standard deviations for attained weight values by age and by social group are displayed in Table 4.3 and Figure 4.3. On average, girls from the low income group presented lower values of weight compared to their counterparts. However, the differences were only significant at ages 10 and 13.

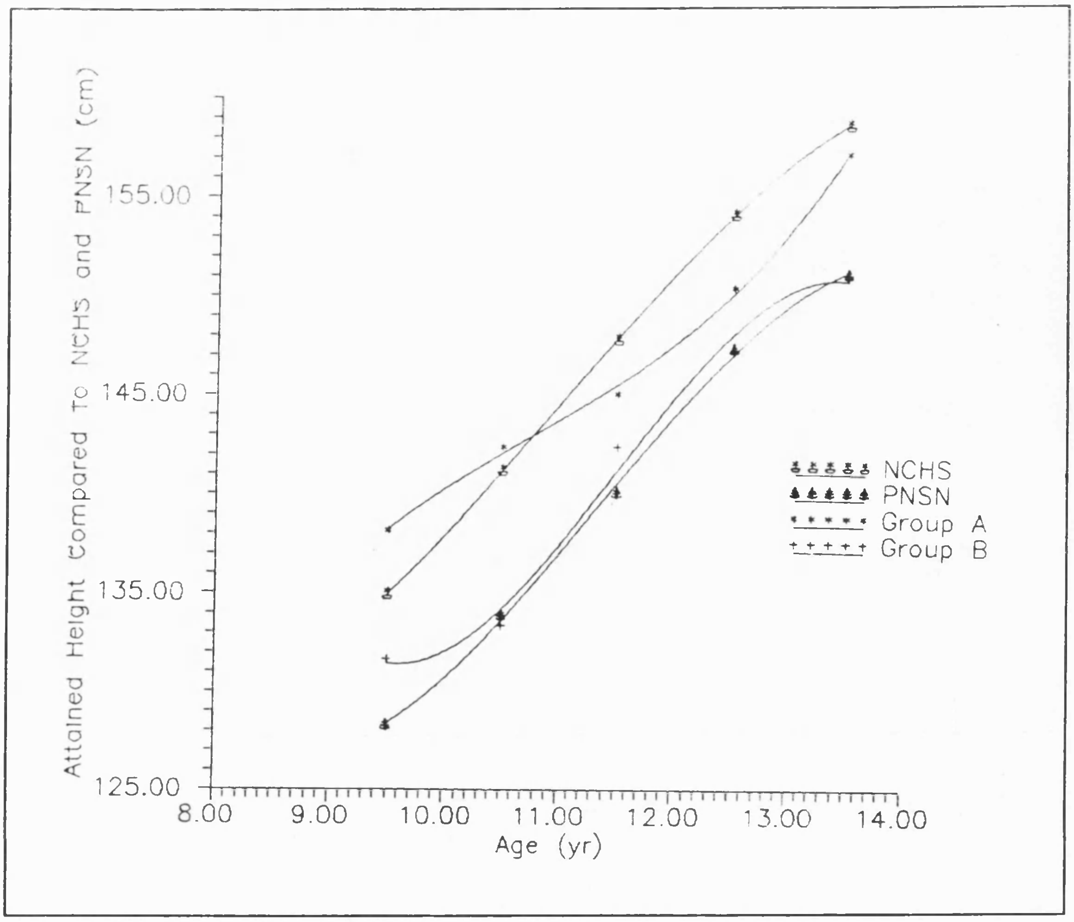

Figure 4.2 Attained height of adolescent Alagoan girls compared to NCHS reference curve and Brazilian urban data (PNSN, 1989)

Table 4.3 Mean, standard deviation and T-test results of weight of Alagoan girls by age and social group on enrolment to the study

	Weight (kg)								
	Group A			Group B			t		P
Age	No.	Mean	SD	No.	Mean	SD	value	df	value
9.5	18	34.2	10.0	21	29.2	5.3	1.91	25	0.068
10.5	36	36.7	7.6	58	29.8	6.0	4.85	92	0.000
11.5	49	39.4	10.1	48	36.1	8.3	1.75	95	0.083
12.5	26	42.6	9.3	45	39.1	7.5	1.73	69	0.089
13.5	16	50.8	8.1	35	42.9	7.4	3.45	49	0.001

Figure 4.3 shows details of mean attained weight. The vertical axis displays the mean weight for the Alagoan girls, while the horizontal axis shows the different age ranges. On average, girls from the low income group were lighter compared to their counterparts at all age ranges. At age 9, the low income girls had lower weights but the divergence was not significant. Then, at age 10 this gap was increased and some statistical significance was detected. At ages 11 and 12 the low income girls again became similar in weight pattern to the high income group. At age 13, the well-to-do group curve once again diverged from the low income group curve.

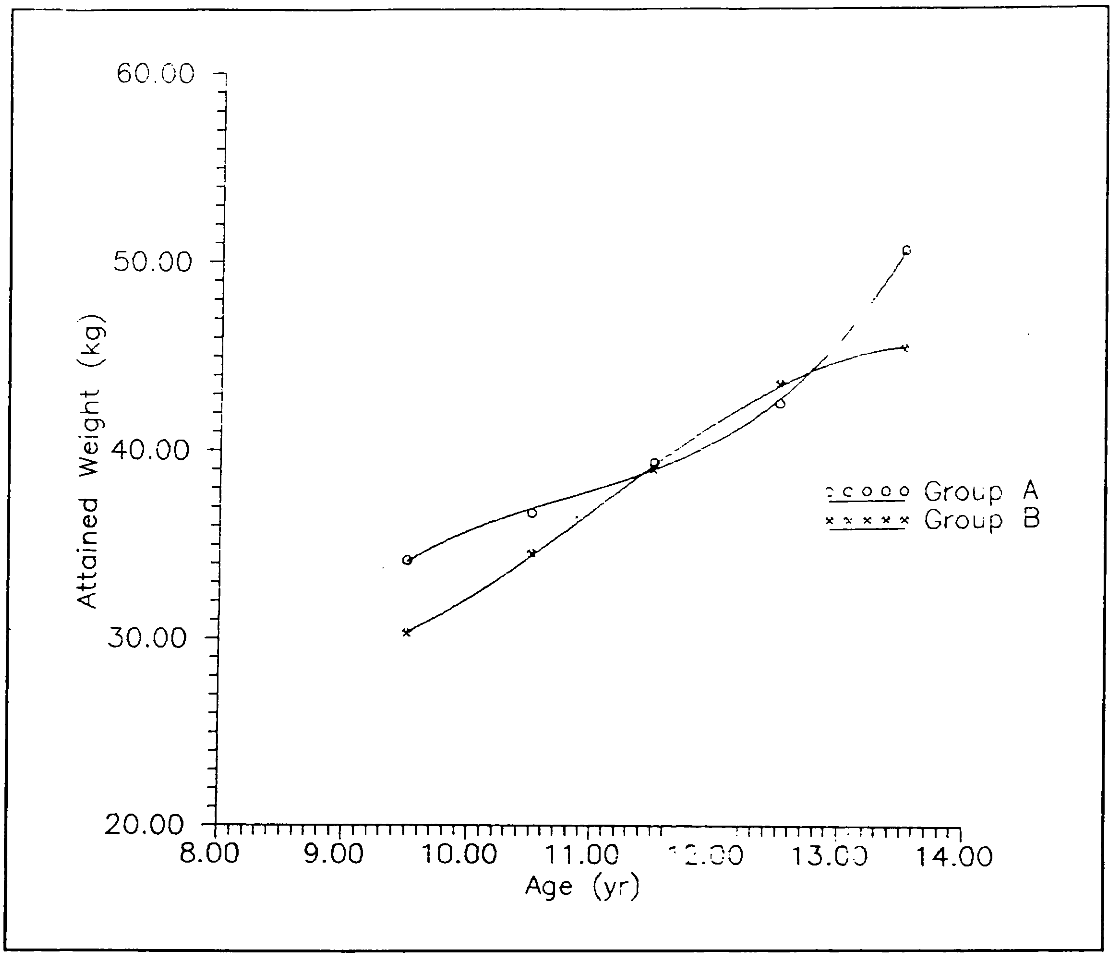

Figure 4.3 Mean attained weight of adolescent Alagoan girls by social group

4.3.1 Attained Weight Of Alagoan Girls Compared To NCHS

In comparison to NCHS reference curve, as can be seen in Figure 4.4 the attained weight of all Alagoan school girls had a similar upward trend. However, the high income group demonstrated a greater increase in weight after the age of 12 than the NCHS statistics and the girls of the low income group.

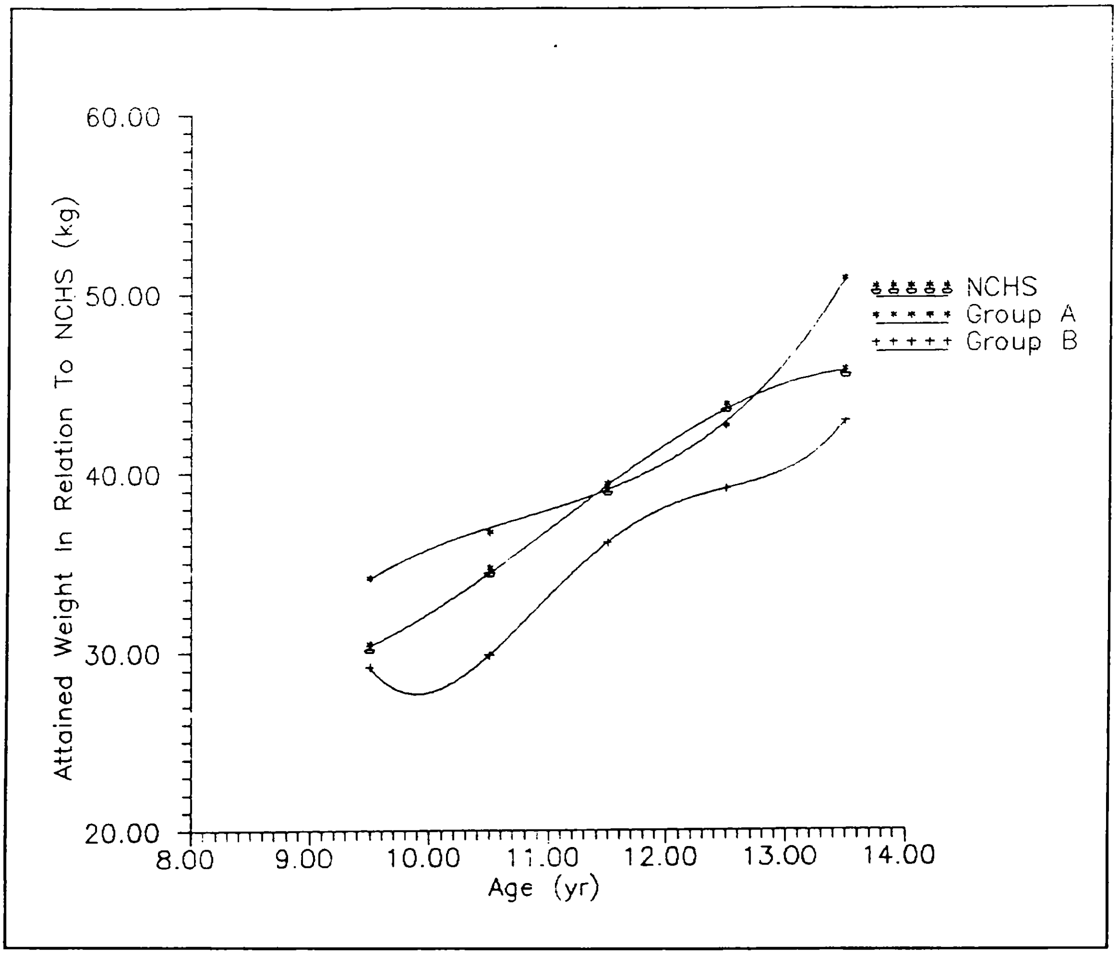

Figure 4.4 Attained weight of adolescent Alagoan girls compared to NCHS reference

Such results mean that the low income girl group did differ from the high income individuals in their anthropometric profile as expected. The low income girls were shorter and lighter than their counterparts.

4.4 Nutritional Status Indices

In order to understand the meaning of such anthropometric values, some measurements were combined and two indices were formed, namely weight-for-age, and height-for-age. It is important to note that, for building such indices the NCHS reference median values were used as recommended by the United Nations (1990). So, in proceeding with the analysis, Group A (high income) and B (low income) are compared by considering the specific age groups 9, 10 , 11, 12 and 13 and their respective characteristics.

4.4.1 Height-For-Age In Relation To NCHS

The general anthropometric status of girls was analyzed and the results are presented in Table 4.4 and Figure 4.5.

In Figure 4.5, the vertical axis illustrates the Z-score values for height-for-age, and the horizontal axis shows the different age ranges. From this figure it can be seen that, on average, low income family girls presented the lowest values for height Z-score at all age ranges. At age 10, high income family girls presented a gradual drop in the curve of their Z-score values, but such characteristics seemed to improve after the age of 12, when a steady increase could be observed.

Table 4.4 Mean, standard deviation and range values for height-for-age Z-score of Alagoan girls by age and social group

	Height-for-age							
	Group A				Group B			
Age	No.	Mean	SD	Range	No.	Mean	SD	Range
9.5	18	0.5	0.9	-0.8 - 2.6	21	-0.5	1.1	-2.2 - 1.4
10.5	36	0.2	0.8	-1.8 - 1.7	58	-1.1	1.1	-3.1 - 1.7
11.5	49	-0.4	0.9	-2.7 - 1.8	48	-0.8	1.0	-3.3 - 1.1
12.5	26	-0.6	1.1	-2.6 - 1.9	45	-1.0	1.2	-3.9 - 0.9
13.5	16	-0.2	0.8	-1.3 - 1.3	35	-1.2	1.2	-3.9 - 1.3

In contrast, there is a downward trend in the Z-score curve for girls from less favourable economical conditions. At age 9, there is a sharp drop in the curve as the age approaches 10. Then, a small rise occurs in direction towards 11 years, when a gradual decline is re-established until at least age 13. The standard deviations show that Z-score values for the low income group are somewhat more variable than those for the high income group.

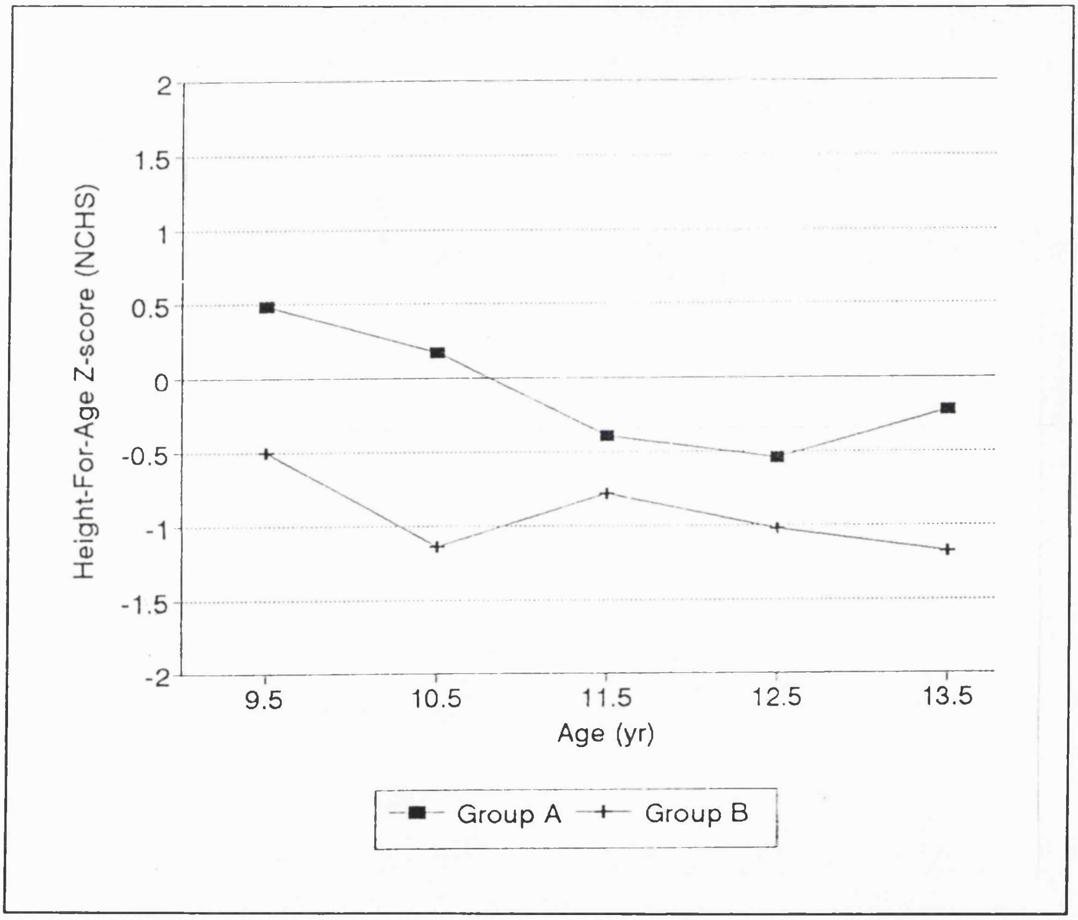

Figure 4.5 Height-for-age Z-score of girls in relation to NCHS by social group

4.4.2 Weight-For-Age In Relation To NCHS

In the case of weight, again the low income family girls showed the lowest values for Z-score at all age ranges. However, this time there was not a particular trend. In Figure 4.6, the vertical axis displays the Z-score values for weight-for-age and the horizontal axis presents the age-ranges: 9.5, 10.5, 11.5, 12.5, 13.5. At age 9, the curves were close to the American median curve (0 SD). Then, in the direction towards the age of 10 a small decrease was observed, after which another rise occured as they approximate the age of 11.

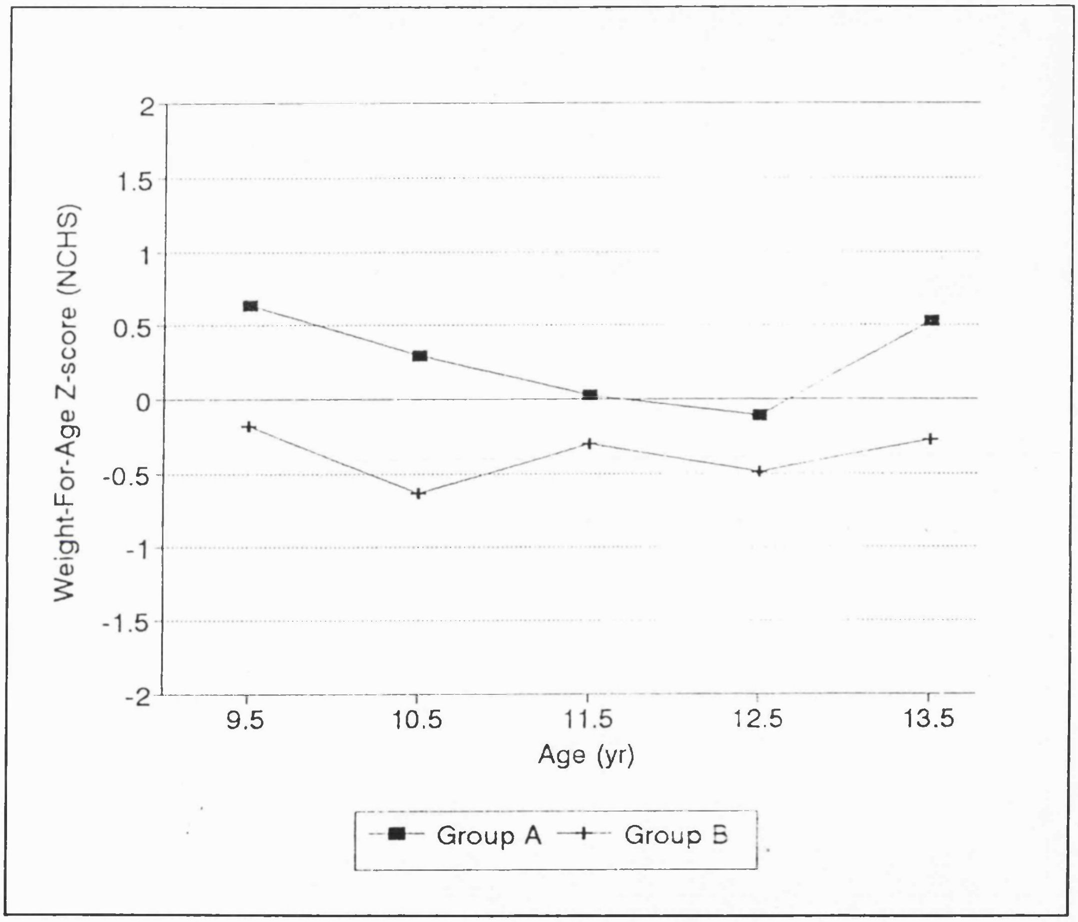

Figure 4.6 Weight-for-age Z-score values in relation to NCHS of girls by social group

From age 11 to 12 there was once more a slight decline in the curve. After age 12 another increase was observed, which continued at least to the age of 13. At all age ranges the low income family girls were under the American median of 0 SD.

In contrast, girls from the high income group were mostly above the American median curve (0 SD), at least at ages 9, 10, 11 and 13. Only at age 12 they were below such level.

Table 4.5 Mean, standard deviation and range values for weight-for-age Z-score of Alagoan girls by age and social group

	Weight-For-Age							
	Group A				Group B			
Age	No.	Mean	SD	Range	No.	Mean	SD	Range
9.5	18	0.6	1.6	-1.2 - 4.0	21	-0.2	0.9	-1.5 - 1.4
10.5	36	0.3	1.0	-0.9 - 3.0	58	-0.6	0.8	-1.8 - 2.0
11.5	49	0.0	1.0	-1.1 - 2.6	48	-0.3	0.8	-1.4 - 2.5
12.5	26	-0.1	1.0	-1.9 - 2.1	45	-0.5	0.8	-2.0 - 1.8
13.5	16	0.5	0.8	-0.7 - 2.2	35	-0.3	0.8	-1.7 - 1.7

In general, a downward trend could be observed in this group. For instance, from age 9 to 12 a gradual decline in Z-score values was observed. However, this trend seemed to invert after age 12, as a sharp increase was observed in the curve. The details from Figure 4.6 are contained in Table 4.5.

In contrast to what occurred with height, the variability of the weight Z-score values was smaller in Group B than in Group A.

4.4.3 Percentage Distribution Of Height-For-Age And Weight-For-Age Z-score In Relation To NCHS Median

Table 4.6 and Figures 4.7 and 4.8 give details about the percentage of the frequency distribution in relation to the American median Z-score values. Figure 4.7 displays the result related to weight-for-age. The vertical axis shows the percentage of

Alagoan girls at each respective weight-for-age Z-score. The horizontal axis presents the Z-score range.

From Figure 4.7, it can be observed that in comparison to the high income counterparts, the curve for the low income group girls is slightly shifted to the left. In contrast, the high income family curve is slightly shifted to the right. However, according to Mann-Whitney test, these percentages were not significant in both divergent situations (p = 0.4).

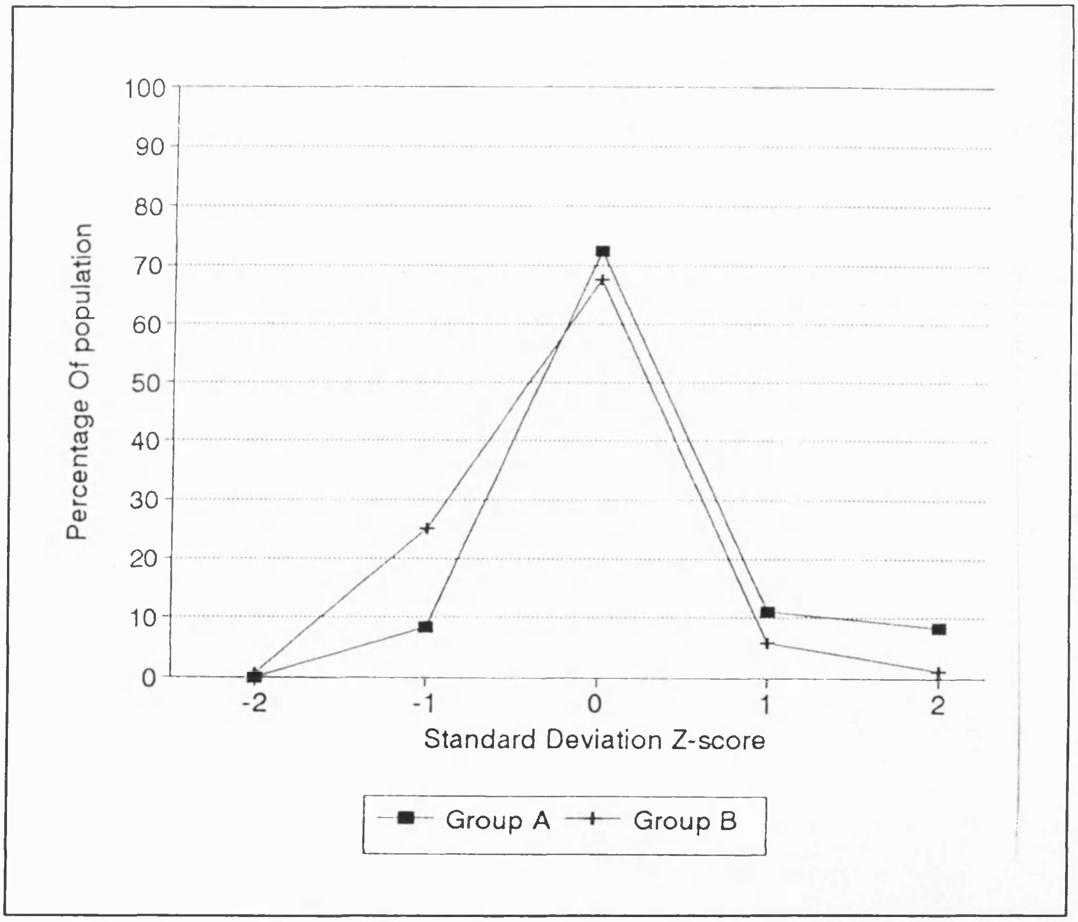

Figure 4.7 Weight-for-age distribution of girls according to median standard deviation by social group

Therefore, it can be said that in relation to weight-for-age aspect, the majority of girls from both social groups were well balanced, being 91.7 % of Group A and 98.5 % from Group B located above median -2.0 SD and under median +2.0 SD. In the high income group the remaining 8.3 % were above median +2.0 SD, perhaps suggesting a tendency to develop obesity. Only 0.5 % and 1.0 % in the low income group were under median -2.0 SD and above median +2.0 SD respectively.

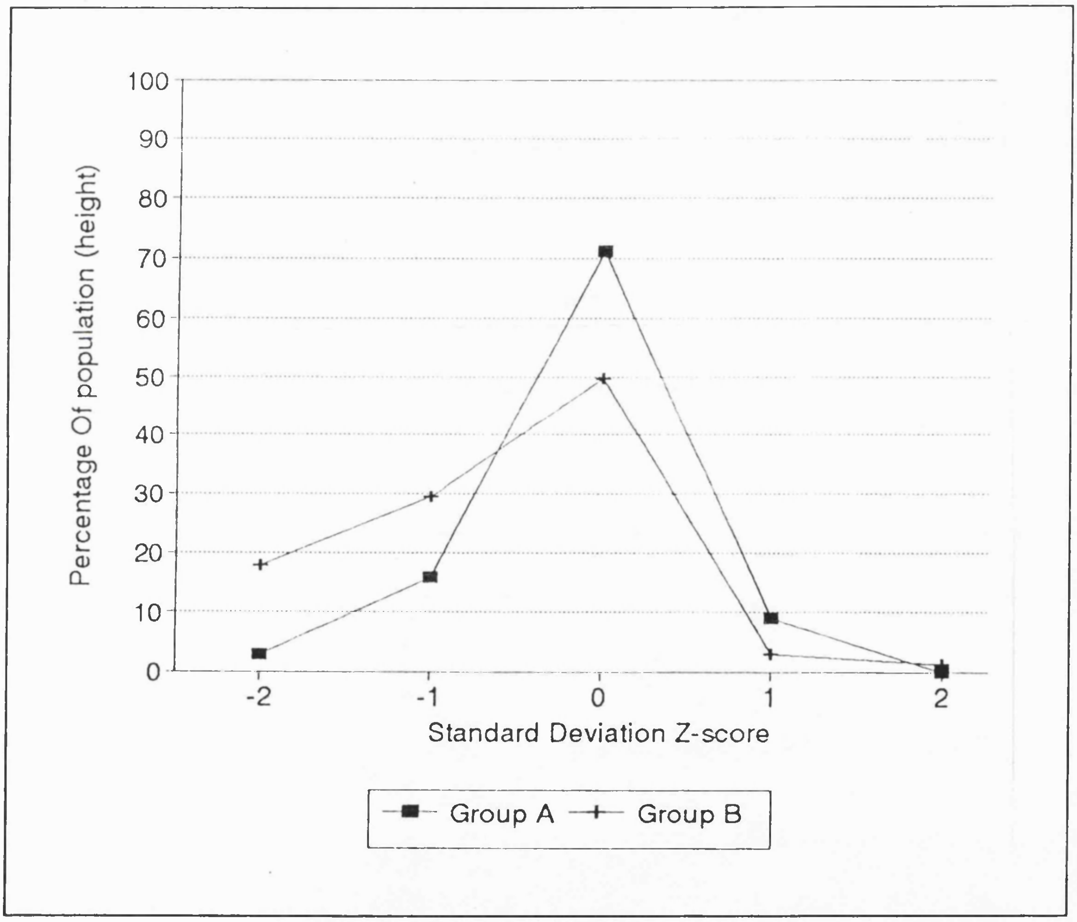

Figure 4.8 Height-for-age distribution of girls according to median standard deviation by social group

A different condition was found in relation to the indicator of height-for-age. The result can be observed in Figure 4.8. The vertical axis presents the percentage distribution of girls according to their respective height-for-age Z-score values. The horizontal axis displays the Z-score ranges: -2.0, -1.0, 0, +1.0 and +2.0 SD.

The curve of the low income group was markedly shifted to the left, represented by the value of 47.4 % (considering the contribution of median -1.0 and -2.0 SD jointly). Compared to the other girls who were located in this area of the curve, the stunted group represented 17.9 %.

In summary, at the beginning of the research, the profile of the low income group in relation to their stature was: 82.2 % had "normal" stature, while 17.9 % were stunted and 1.3 % presented "tall" sizes. This classification was made according to WHO (1990).

For the high income group, the curve was better balanced, with the majority of girls with values between -1.0 and +1.0 SD. From the whole sample of the high income group, it can be said that on enrolment to the study 96 % of these girls could be classified in relation to NCHS reference as having "normal" stature for their respective ages, 2.7 % as being "short" (stunted) and 1.3 % as being "tall". Mann-Whitney test indicated that the difference between social groups was significant ($p < 0.001$).

Table 4.6 Distribution of nutritional indicators by social class

Nutrition level	Weight-For-Age		Height-For-Age	
	Group A	Group B	Group A	Group B
No < median -2.0 SD	-	1	4	37
% < median -2.0 SD	-	0.5	2.7	17.9
No between median -2.0 and -1.0 SD	12	52	23	61
% between median -2.0 and -1.0 SD	8.3	25.1	15.9	29.5
No between median -1.0 and +1.0 SD	105	140	103	103
% between median -1.0 and +1.0 SD	72.4	67.6	71.1	49.8
No between median +1.0 and +2.0 SD	16	12	13	6
% between median +1.0 and +2.0 SD	11.0	5.8	9.0	2.9
No > median +2.0 SD	12	2	-	2
% > median +2.0 SD	8.3	1.0	-	1.3

The combination of the indicators weight-for-age and height-for-age indicated that the overall pattern of the nutritional status of girls from group A could be considered as being "normal", once they expressed "normal" weight-for-age and "normal" height-for-age values.

The combination in low income group shows that weight-for-age is "normal" irrespective of the classification of height-for-age,i.e. "normal" or "short". Hence, when girls were "normal" in their height-for-age they were usually "normal" in their weight-for-age as well. Even those who were "short" in stature were usually balanced in their weight-for-age.

But, being considered "normal" for their respective weight-for-age, does not necessarily mean that the weight is directly connected to fatness, since gain in weight may be evidence of muscle tissue, fat reserves or bone constitution (Tanner and Whitehouse, 1962). So, in trying to obtain a more accurate picture of this weight data, some fatness and muscle analysis was performed by the evaluation of body composition. Unfortunately the limitation on financial resources did not allow investigation of bone structure.

4.5 Body Composition

4.5.1 Body Mass Index (BMI)

Estimation of fatness was done primarily through the analysis of body mass index (BMI).

Table 4.7 Mean, standard deviation and T-test results for BMI of adolescent Alagoan girls by age and social class.

	High Income			Low Income					
Age	No.	Mean	SD	No.	Mean	SD	t value	df	P value
9.5	18	17.7	3.8	21	16.8	2.4	0.88	37	0.3
10.5	36	18.0	3.1	58	16.7	2.4	2.42	92	0.02
11.5	49	18.5	3.7	48	17.7	3.0	1.30	95	0.2
12.5	26	18.7	3.4	45	17.9	2.4	1.05	40	0.3
13.5	16	20.4	2.6	35	18.8	2.6	2.15	49	0.04

Table 4.7 gives details about the BMI values of the Alagoan school girls according to social group and age ranges. In general, the low income girls exhibited lower values for BMI than their peers, but the differences were significant only at ages 10 and 13. It can not be said that there was a significant impact in terms of nutritional impairment related to fatness.

Figure 4.9 compares Alagoan data with American data from National Health Examination Surveys of U.S.A. (NHANES I and II), by showing how both social groups performed in relation to this index of fatness.

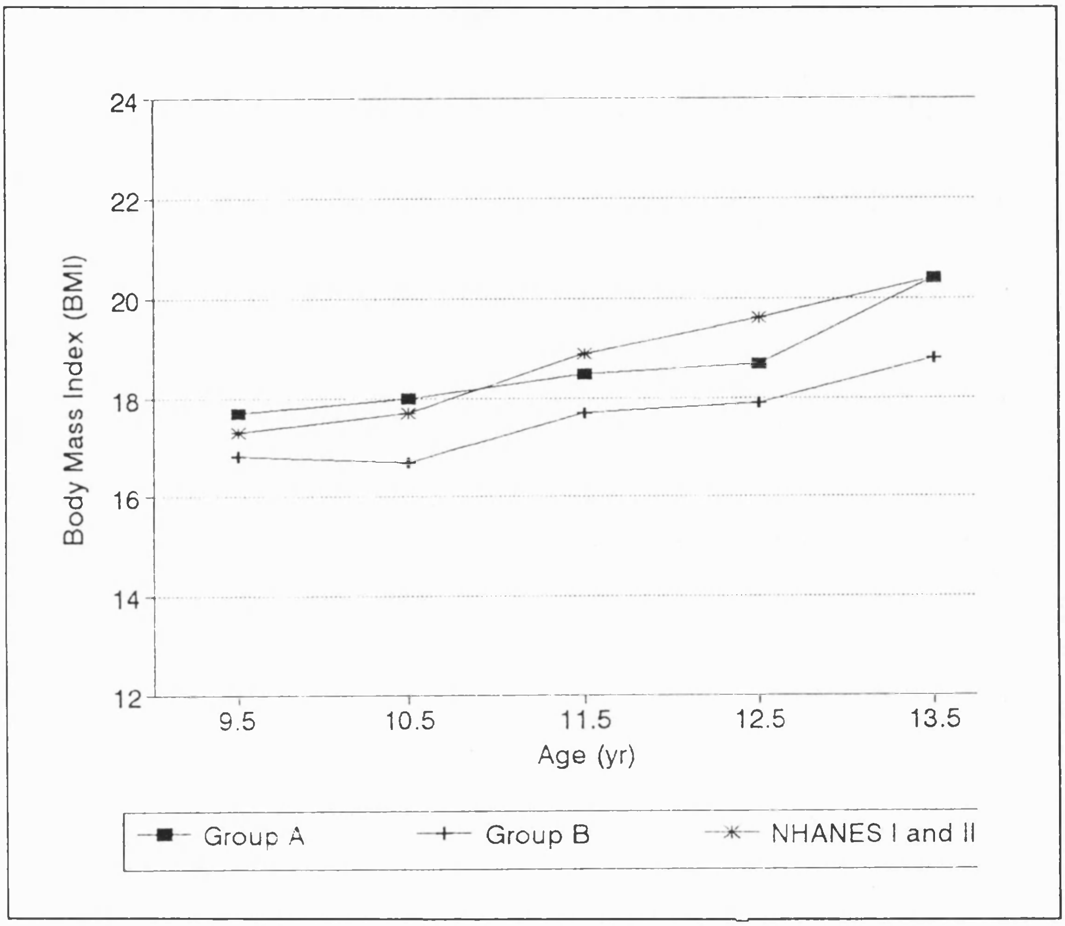

Figure 4.9 BMI of Alagoan girls compared to NHANES data

Clearly, the high income girls' curve was more similar to the NHANES curve while the low income curve was well below the average of the American sample. Before reaching the age of 10, girls from the high income group were slightly above the American curve, but after 10 years there is an inversion in the position of both curves. This occurred because the American BMI had a very marked increase at least until age 13. However, although the rise of BMI in the high income group presented a gradual trend up to age 12, it was after then that they increased sharply. This positioned both curves at the same point at age 13.

The low income group curve was definitely below the American curve at all age ranges. Although at age 9 the difference was not so dramatic, this trend changed largely after 10 years old.

4.5.2 Fat Reserves - Sum Of 4 Skinfolds

Table 4.8 presents mean, standard deviation and P values (derived from T-test) for sum of four skinfolds for girls at different age classes and by social group.

Girls from the low income class had thinner skinfolds than did girls from the high income group ($p < 0.001$) although, they were more homogeneous within their group.

Table 4.8 Mean, standard deviation and T-test results for sum of 4 skinfolds thickness by age by social group

	Sum Of 4 Skinfolds (mm)								
	Group A			Group B					
Age class	No.	Mean	SD	No.	Mean	SD	t* value	df	P value
9	18	49.7	24.0	21	39.0	14.4	1.64	27	0.112
10	36	52.8	22.3	58	36.1	16.1	3.91	58	0.000
11	49	51.9	23.0	48	41.3	17.4	2.58	89	0.012
12	26	51.5	23.3	45	42.2	17.7	1.91	69	0.061
13	16	56.2	18.2	35	43.7	17.5	2.34	49	0.024

* T-test after log transformation

Nevertheless, according to age-specific classes different degrees of fatness were found to occur. These differences were found to be significant at the ages of 10, 11 and 13, and not significant at 9 and 12 years. This result can be seen in Figure 4.10. The vertical axis shows the value in millimetres for the sum of 4 skinfolds (triceps, biceps, subscapular and suprailiac) of Alagoan girls on the enrolment to the study. The horizontal axis presents the different age ranges (9.0, 10.0, 11.0, 12.0 and 13.0).

The results indicate that in both social groups there was a tendency for accumulating fat during this period of adolescence. However, the fat accumulation of the high income group dropped slightly between the ages 10 and 12. These successive drops in high income curve, added up to the gradual rise of the low income group curve, helped the approximation of the curves at age 12. At age 13 this tendency changed again, and once more the social groups displayed divergence in skinfolds thicknesses.

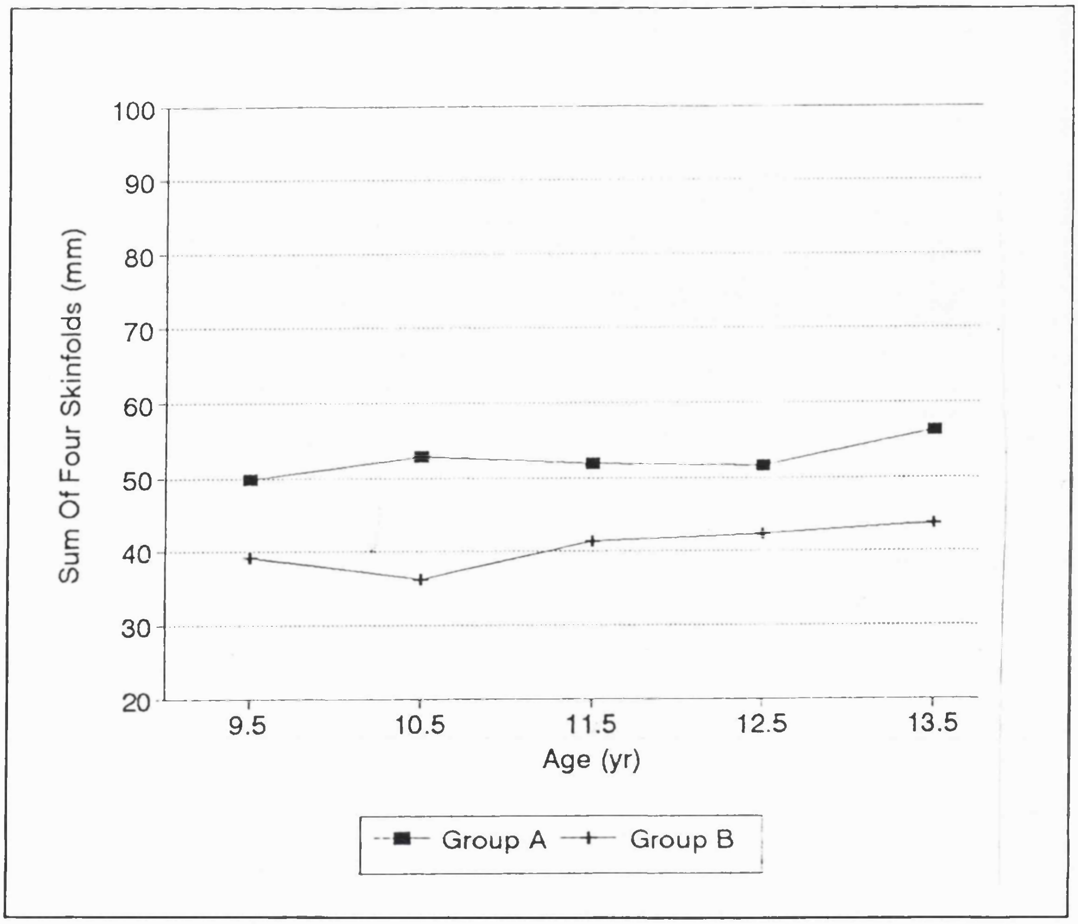

Figure 4.10 Sum of 4 skinfolds in girls by social group

4.5.3 Fat Arm Area

Like the overall degree of fatness, the fat arm area presented the same tendency, i.e., low income girls had smaller values than their counterparts. Once more such differences were greater at 10, 11, 12 and 13 years, but not significant at 9 years of age as indicated in Table 4.9 and Figure 4.11.

Table 4.9 Mean, standard deviation and T-test results for fat arm area of girls by age and social class

	Fat Arm Area (cm^2)								
	Group A			Group B					
Age class	No.	Mean	SD	No.	Mean	SD	t value	df	P value
9	18	11.9	7.1	21	9.2	3.7	1.45	25	0.2
10	36	12.9	5.6	58	8.3	3.4	4.37	51	0.000
11	49	12.7	6.6	48	10.3	4.9	2.05	89	0.044
12	26	14.3	7.5	45	10.4	5.4	2.56	69	0.013
13	16	16.9	6.2	35	11.8	5.5	2.93	49	0.005

In Figure 4.11, the vertical axis shows the values for the fat arm area for different social classes together with the American data. The horizontal axis presents the different age-ranges. There was an upward trend on either social groups curves, which indicates that the Alagoan girls presented the tendency to accumulate fat at the arm area with the increase of age. However, the curve of the low income group was significantly different from their counterparts at all age groups.

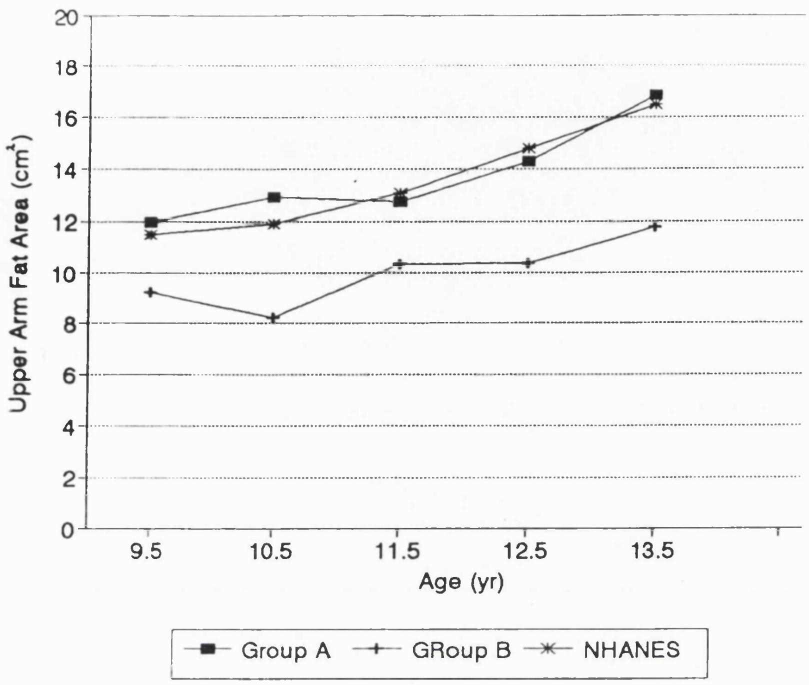

Figure 4.11 Upper arm fat area of Alagoan school girls compared to NHANES data

The high income group curve was marginally closer to the American curve at all ages. In contrast, the low income group curve was below the American curve at all ages. This means that the increase in fat reserves at arm area during adolescence (at least up age 13) in the low income group was not strong enough to push the curve to a pattern similar to the other groups.

Additional information is provided by Z-score analysis. Figure 4.12 shows the distribution of the Alagoan upper arm fat area values around the median of the American reference.

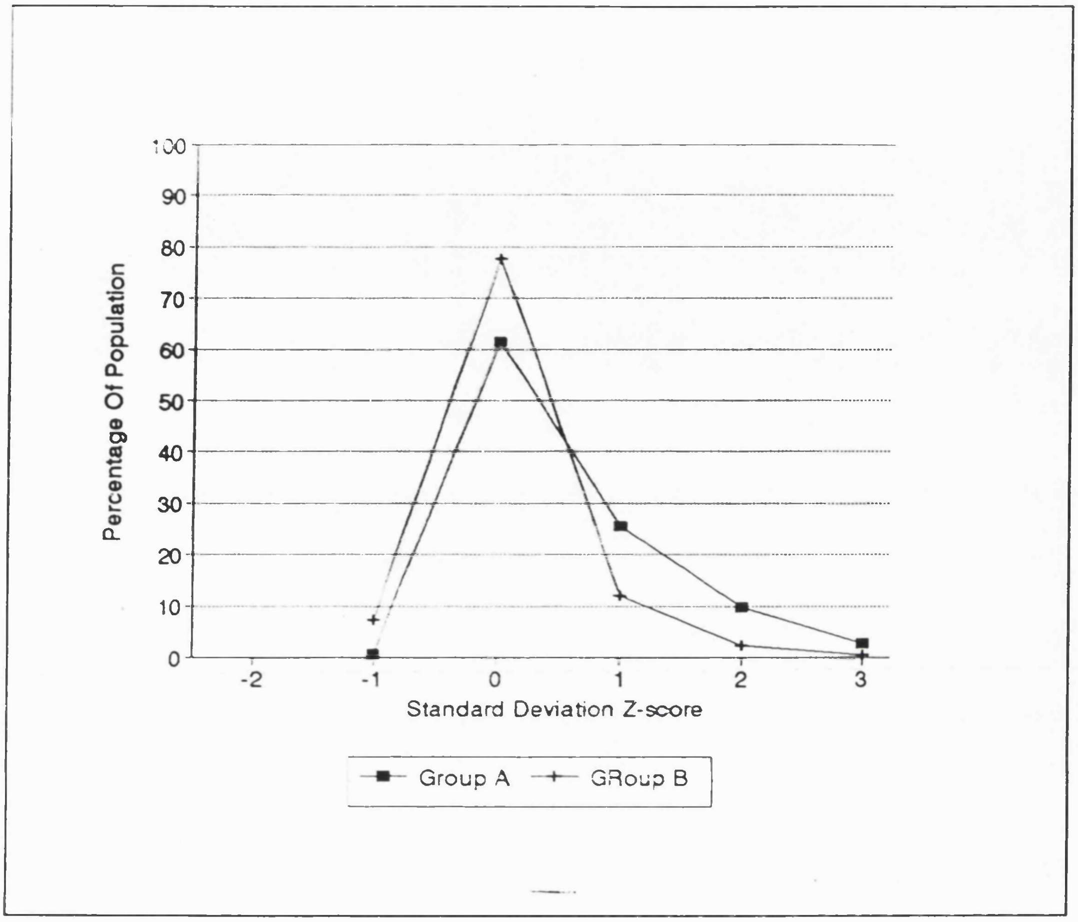

Figure 4.12 Fat arm area distribution of Alagoan girls in relation to the American median reference by social group

As can be seen, both social groups tended to accumulate fat between minus 1 SD and 1 SD of the median reference. However, the high income group curve was slightly skewed to the right.

4.5.4 Upper Arm Muscle Area

There was no evidence of contrasting results in terms of lean tissue between social groups. This can be observed from the results displayed in Table 4.10 and Figure 4.13.

Table 4.10 Mean, standard deviation and T-test results for upper arm muscle area of girls by age and social class

	Upper Arm Muscle Area (cm²)								
	Group A			Group B					
Age class	No.	Mean	SD	No.	Mean	SD	t value	df	P value
9	18	18.0	5.0	21	16.9	4.3	0.73	37	0.5
10	36	18.1	3.4	58	17.0	2.7	1.71	92	0.09
11	49	19.6	4.1	48	19.0	4.2	0.75	95	0.5
12	26	21.1	3.2	45	19.5	3.2	1.80	69	0.07
13	16	24.0	3.5	35	21.6	4.1	2.03	49	0.05

In Figure 4.13, the vertical axis presents the values for upper arm muscle area in both social classes and for American data. The horizontal axis shows the different age ranges.

It is clear from the graph that although the low income group presented the lowest values for upper arm muscle area at all age ranges, these differences were not significant by T-test. Both curves presented a gradual upward trend, meaning that the muscle arm area seemed to increase with the increase of age.

In addition, when Alagoan data for both social groups were compared to the American data a very distinct performance was observed. Alagoan girls of both social status had different pattern of protein reserves in comparison to the NHANES curve. The difference was observed from the start of adolescence and lasted at least up to 13 years.

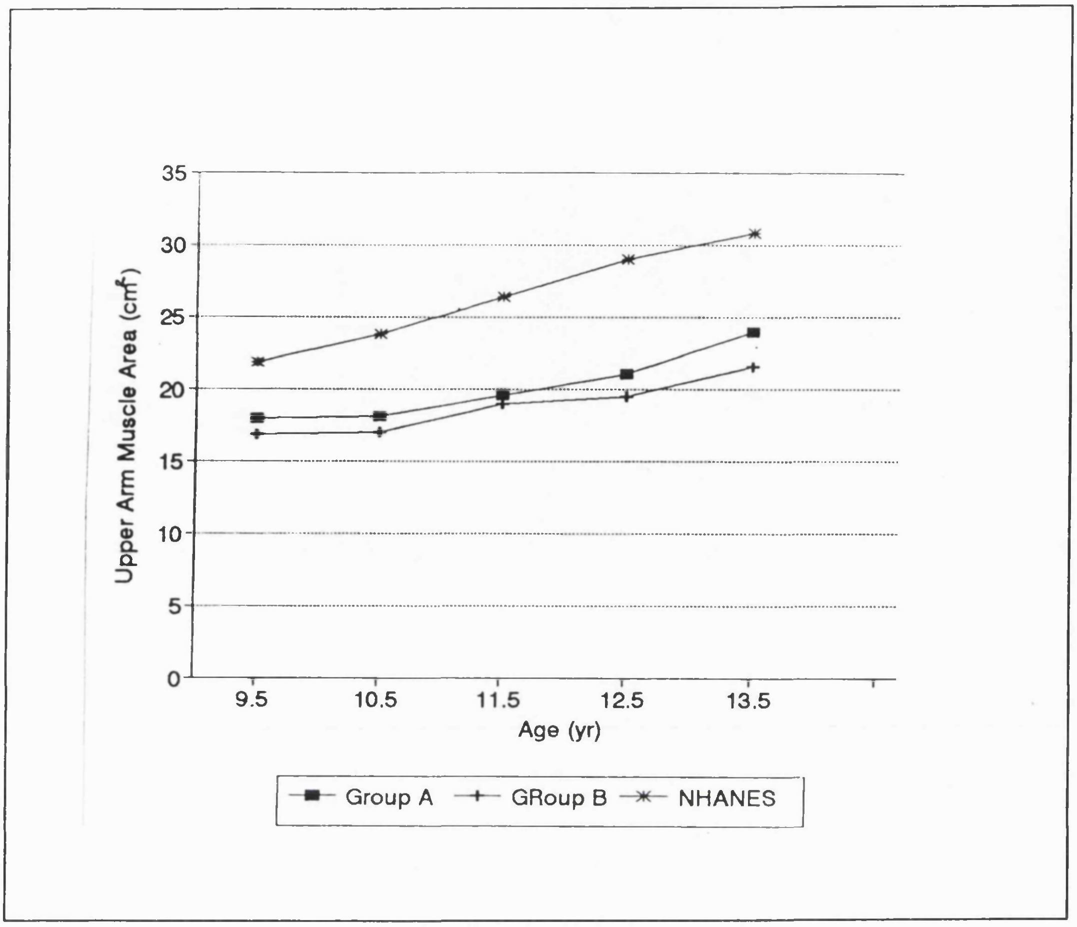

Figure 4.13 Upper arm muscle area of Alagoan girls by age and social class on enrolment to the study

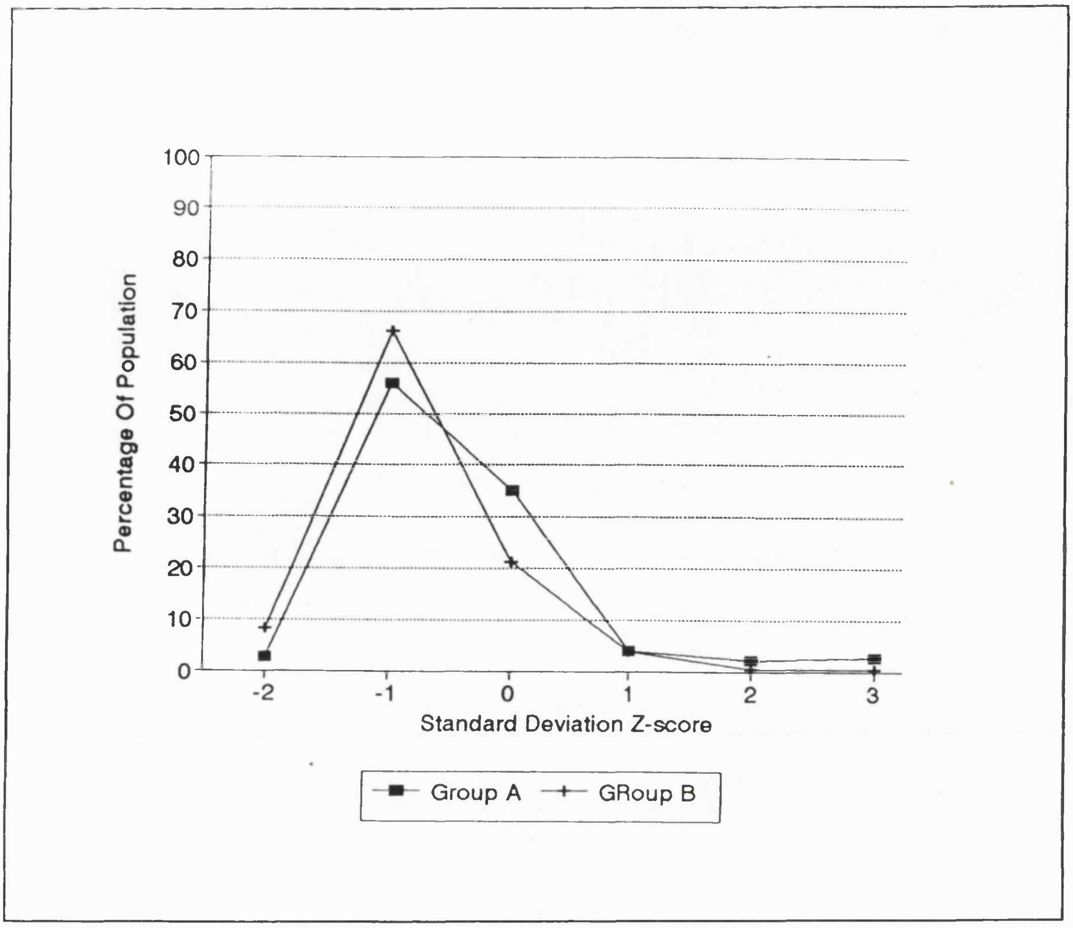

Figure 4.14 Upper arm muscle area Z-score of Alagoan girls in relation to NHANES data

The analysis of Z-score confirms this trend by showing that both curves from Alagoan girls were slightly skewed to the left when compared to American data. This result is contained in Figure 4.14.

4.5.5 Social Factors Influencing Biological Variables

A multiple linear regression was carried out to determine associations between socioeconomic and biological variables. The results can be observed in Table 4.11. All the socioeconomic variables which contributed to the variation in any of the biological variables correlated positively with them. As the comparisons were made by considering the best conditions equal 1 (see Chapter 2), it was expected to find best socioeconomic conditions related to increasing values in anthropometric indices. Age was an important covariate for the majority of the studied biological variables. Thus, the multiple regression analysis was performed while controlling for age.

Age, urban origin and housing sanitary conditions were the variables which contributed most to variation in girls attained height.

Table 4.11 Forward stepwise regression analysis of Alagoan girls anthropometric variables by socioeconomic characteristics

Dependent variable	Explanatory variable	Regression coefficient	SE B	R square	P value
Height	age	1.40	1.40	0.49	0.000
	origin	0.02	4.40	0.08	0.000
	waste	0.01	4.20	0.04	0.006
	water source	0.01	5.40	0.03	0.01
Weight	age	4.10	4.80	0.44	0.000
	morbidity	0.07	0.01	0.10	0.000
	origin	0.04	0.02	0.03	0.01
	water source	0.04	0.02	0.02	0.02
BMI	morbidity	2.40	0.40	0.31	0.000
	age	0.05	0.01	0.08	0.000
Sum of Four Skinfolds	morbidity	107.70	12.00	0.46	0.000
FAA*	morbidity	4.80	1.00	0.25	0.000
	age	0.10	0.03	0.11	0.000
	water source	2.80	1.30	0.03	0.04
UAMA**	morbidity	2.50	0.40	0.36	0.000
	age	0.03	0.01	0.04	0.01

* Fat Arm Area

** Upper Arm Muscle Area

The association between housing sanitary conditions (domestic waste disposal and water source) and attained height was independent of age. This conclusion was based on the fact that when age was included into the equation, the magnitude of regression coefficients for both explanatory variables did not change significantly. However, the inclusion of age added the contribution of girls birthplace to the height variation. Age contributed 49 % to the height variation, while girl's urban origin, domestic waste disposal and water source contributed 8 %, 4 % and 3 % respectively.

Age, reported morbidity in the October sample, girl's origin and water source correlated positively with attained weight and were the variables which contributed most to its variation.

Age contributed 44 % to the variation of attained weight, while morbidity, urban origin and water source contributed 10 %, 3 % and 2 % respectively.

While the influence of morbidity and water source occurred independently of age, urban origin contributed only when age was included in the equation. All this means that the highest values for attained weight were observed with the increase of age, in girls of urban origin who lived in houses where the water quality was assured by the official network.

Reported morbidity of October (absence equal 1) correlated positively with BMI, meaning that better values for BMI were found in girls who did not present any complaint. Independently of age, reported morbidity contributed 31 % for the girls BMI variation.

Absence of reported morbidity also correlated positively with sum of 4 skinfolds, upper arm muscle area and upper arm fat area independent of age. By this it is meant that higher values for fat and lean tissues were found in healthy girls regardless of the girl's age.

Reported morbidity of October contributed 46 % to the variation of sum of 4 skinfolds. The contribution of reported morbidity and age to upper arm muscle area variation was of 36 % and 4 % respectively.

Variation in upper arm fat area was influenced by reported morbidity, age and water source. The respective values were 25 %, 11 % and 3 %.

4.6 Discussion

4.6.1 Social Status And Height

All the anthropometric variables have shown significant differences between social Groups A and B. In relation to attained height, there was a significant difference between the means of the two distinct social groups, the low income girls being shorter than their counterparts at all age ranges.

When looking at the age specific groups it is noted that during the initial period of puberty there was a tendency for the groups to have similar height values, but this characteristic did not seem to continue for a long period. After 12 years of age, the height pattern of the groups began to differ significantly.

4.6.2 Comparison Of Attained Height In Relation To NCHS References And Brazilian Urban Data (PNSN)

Comparison with other data (American reference and Brazilian more recent urban data), confirmed that the social groups performed in different ways, the high income group being more similar to NCHS and the low income curve more similar to Brazilian data.

In relation to the high income group this finding is consistent with what was already been demonstrated by Marcondes et al. (1970, 1982). In their work, which was an attempt to build a national reference, the authors found that children from the high income class (Marcondes IV class) from Sao Paulo (Santo Andre and great Sao Paulo cities) were comparable in height and weight to NCHS reference data. This finding reinforced the validity of using NCHS as a reference for Brazilian data INAN (1990).

In relation to the low income results, some points have to be considered. First, the Brazilian data (PNSN) included different income groups, but this income level did not go beyond the limit of 10 OFMW (official minimal wage). Second, it is important to note that in Brazil around 25 % of the high income children belong to an economic sector with an income 23 times greater than that achieved by 25 % of the low income children (Monteiro et al., 1991). This indicates that a large percentage of the population lives as the poorest sector of the Brazilian society. Therefore, the similarity of the low income group curve to the Brazilian curve only corroborates such characteristic.

4.6.3 Nutritional Status And BMI Of Alagoan Girls In Relation To NCHS Reference

The high income girls seemed to be more homogeneous within themselves. When looking particularly at the meaning of the height values, it was found that, in relation to the NCHS reference, the prevalence of stunting was higher within the low income group than the opposite social condition. The percentages of 17.9 % from Group B against 2.8 % from Group A suggest growth retardation in the low income group.

So, first, a difference in height means was detected between social groups, second the data distribution around the reference median was contrastive amongst social groups. and third stunting was more prevalent in the low income group. All these findings are consistent with what was previously detected in Brazil and other parts of the world.

In Brazil, differences in stature between different socioeconomic conditions have been described by INAN (1990), Monteiro et al.(1989), Monteiro (1988), Neto et al.(1987), and Marcondes et al. (1970, 1982). In all these works, poverty conditions were associated with statural deficits.

Outside Brazil, other works such as those from Mascie-Taylor (1990) and Martorell (1985) have also identified substantial evidence of social-class differences related to stature. Nevertheless, it was not clear if these differences resulted of some environmental factors, genetic differences or the combination of both (Mascie-Taylor, 1990), although according to Martorell (1985) "the variation which can be attributed to the environment is several times greater than that which can be said to be due to genetics".

Also, Rona and Chinn (1991) studied attained height in relation to social condition, where father's employment status was used as a proxy for social condition. Their findings indicated that unemployment was associated with lower values for height mainly among younger children.

Cameron et al. (1992) reported that South African black children aged from 5 to 19 years were smaller than a well-off urban sample in two situations: being from rural area in first place, and secondly being from an urban area but not from a high income class. The authors concluded that the urban setting can not be advantageous when there is not adequate socioeconomic support.

Similar findings were also detected in urban school children of Bangladesh. There, Ahmed et al. (1991) investigated children aged between 5 and 12 years from high and low income levels, and discovered that the former were taller, heavier and had higher values for mid-upper arm circumference and skinfolds thickness when compared to the latter.

Boldsen and Mascie-Taylor (1985) demonstrated that in a British sample height was associated with social class, with upper class individuals being taller. This social class contrast was established before the age of 7 years (Lasker and Mascie-Taylor, 1989), although some have argued that it is already established at the age of two years (Rona, 1981).

In line with the previous researches it can be said that, in spite of the genetic characteristics, socioeconomic circumstances may have made a distinct contribution to the attained height of the Alagoan girls in this study. It may be that the increasing access to health care during the last years in Alagoas has contributed to the better nutritional profile of the low income girls under 10 years.

The second aspect to be discussed is related to the prevalence of stunting. Since stunting is common in Latin American populations (Victora, 1992, WHO, 1986), the present findings were expected to occur. Other studies in Brazil point to the same direction. For instance, Victora et al. (1986) studying the "nutritional status" of children aged from 12 to 35.9 months in Rio Grande do Sul (South region - one of the richest areas of the country), reported a prevalence of stunting around 12.3 %.

Molina et al. (1986) studying the health and "nutritional status" of 254 children of urban low-income communities, aged up to 6 years from Belo Horizonte (Minas Gerais - west-centre region) found that 20.1 % of the children were stunted in relation to NCHS reference.

INAN - Instituto Nacional de alimentacao e nutricao - (1990) published the results of a national survey conducted in Brazil, in which the growth profile of the Brazilian population was explored. According to this research, the prevalence of stunting in young female adults aged between 20 and 25 years in Brazil was around 17.19 % for the urban area.

4.6.4 Social status and weight

In comparison to the high income group, the low income girls not only were shorter, but had lower values for weight and fat reserves as well. Nevertheless, the difference in weight between social groups was not significant, since only 2.7 % of low income group demonstrated to be "underweight" at the time of the study. This result is consistent with the fact that stunting and wasting are different biological processes. Therefore marked weight deficits are not expected to occur. The findings for BMI and weight-for-age corroborate this statement.

In addition, underweight and wasting conditions are not expected to have high incidence in Latin America countries (Victora, 1992, Monteiro et al. 1991, United Nations, 1990, Keller, 1988). According to Victora (1992), the median prevalence of malnutrition for children aged under five years in Latin America are:2.7 % for wasting, 33.8 % for stunting, 22.8 % for underweight.

Another aspect must be considered: the susceptibility of adolescent group in increasing fat deposits during this life period. Thus, perhaps the adequacy in weight independently of social class of the girls of this study could be explained. On the other hand, the dietary intake could play a role in the aspect related to weight gain and in body reserves of protein and fat.

The partial homogeneity of both social groups can be seen in relation to how they were distributed around the reference median Z-score. Both curves were partially well adjusted, i.e., the majority of girls were located between -1.0 SD and +1.0 SD in both social groups.

4.6.5 Social Status And Fat Reserves

The low income girls had smaller fat reserves than their peers. This was demonstrated when their skinfolds thicknesses were compared to those of the well-off girls, and the low income girls presented the lowest values for sum of 4 skinfolds.

This result is in agreement with other findings in Brazil. Some researches such as those from Guedes (1980) and Anjos et al. (1989) have pointed out differences in skinfold thicknesses which could be related more to social determinants than any other factor, such as genetic propensity for instance. In both studies the authors found that school children, aged from 7 to 16 years in the former and from 7 to 11 years in the latter, who lived in poor environmental conditions, had significantly lower sum of 7 skinfolds thickness (biceps, triceps, subscapular, suprailiac, mid-axillary, abdominal and calf) in comparison to those who lived in a better situation.

Other studies give another perspective on the subject by suggesting that the thickness of the subcutaneous tissue can be influenced by factors such race (Harsha et al., 1980; Cronk & Roche, 1982), sex (Cronk & Roche, 1982; Petroski, 1989), level of sexual maturation (Guedes, 1984; Ridder et al., 1991), physical activity (Faintuch et al., 1986) and socio-economic conditions (Guedes, 1980; Anjos et al., 1989).

4.6.6 Social Status And Protein Reserves

As was shown previously, both social groups presented similar reserves of protein, since by the analysis of upper arm muscle area no significant difference was detected between the social groups. However, in comparison to NHANES data, Alagoan girls presented less muscle tissue. In relation to this point, it is difficult to speculate whether such difference was due:

1 - to genetic difference leading to a different pattern of muscle tissue at least at arm area

2 - to a different pattern of dietary intake.

3 - to a different pattern of physical exertion

4.6.7 Factors Influencing Nutritional Status

It is well known that height, weight, fatness pattern and growth are subject to genetic and/or environmental factors (Tanner, 1976; Rona, 1981). Frisancho (1980) has already made a contribution in this particular respect, describing that in subjects aged from 6 to 17 years (males and females) higher values of protein reserves were associated with greater stature, whatever the situation, i.e., high-muscle and high-fat versus low-muscle and low-fat, high-muscle and low-fat versus low-muscle and high-fat. In addition, the author also detected an association between increased calorie reserves with greater values for stature in female individuals.

The multiple regression results demonstrated the contribution of the socio-economic and health conditions to the anthropometric data. The results suggest that health, environmental and origin factors, have contributed to the variation of the biological data. Of course, especially during adolescence age is a very important factor and that is why its contribution to variation of biological variables was so marked. However, this characteristic can act as a possible confounding effect in relation to the association of other explanatory variables. Even considering this aspect, better values for the studied anthropometric variables were found in Alagoan girls who were of urban origin, healthy and lived in safe sanitary conditions. On the other hand, it is important to note that in the present study, how far these anthropometric data are linked to both genetic and social conditions is still unclear.

For instance, in relation to the question of birthplace, girls from urban origin were taller and heavier than those born in rural areas. This finding reinforces the previous finding of the social background section, related to the migration causes reported by the parents. According to them, the situation in the rural area was worse than in the urban area. This strongly suggests a decisive environmental contribution, since the height of girls could be related to the effects of genes and/or associated with deleterious or beneficial effects of the environment shared by the family.

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In addition, it is possible that, in agreement with Monteiro et al. (1991), lower percentages of minus two Z-score (up to 2.3 %) do not imply in occurrence of stunting but a genetic characteristic. If the percentage of stunting is compared between social groups it can be noted that the 17.9 % of group B can be more associated to socio-economical condition than the 2.8 % from group A, and this had already been suggested by the multiple regression analysis.

4.7 Conclusion

As was expected, the heterogeneity of girls from group A (high income) and B (low income), was easily demonstrated by the analysis of the social and anthropometric data. Low income girls presented the lowest scores for all the studied biological variables. In general, they were shorter, lighter, had a greater prevalence of stunting, and had less caloric reserves. However, in terms of biological adequacy no great discrepancies in BMI, weight-for-age or muscle patterns were detected.

Therefore, the most significant and contrasting aspect between the studied Alagoan groups was linked to the heterogeneity of stature, reflecting disturbances related to growth delay. This result confirms the **Hypothesis 1** which predicted a difference in stature between social groups subjects, the poorest individual presenting the tendency to show a height deficit in comparison to their well-to-do counterparts.

This result is widely recognized to occur, since it is well known that some socio-economic factors such as income, education level, housing conditions to name but a few, can contribute in some occasions to build up the biological status of a population.

Monteiro et al. (1991), reviewed and analyzed the growth and "nutritional" status of Brazilian children, from vulnerable groups, from 1975 to 1989 and found that the growth pattern of these children still was not adequate and was worse in the lower income levels. They also suggested that the estimation of undernourished children in 1989 for the whole country was around two million distributed in a similar way in urban (51.7 %) and rural (48.3 %) areas. Such subjects were supposed to live in "extreme poverty" (83.4 %) mainly in Northeast region (66.8 %), therefore the adolescents from the low income group of this research possibly reflected this reality.

As was suggested before, the index height-for-age can reflect chronic nutritional imbalances, and because of this it can be used to detect growth disturbances (Monteiro, 1991, United Nations, 1989). So, once the main social and anthropometrical differences were identified between the social groups, the next step was to investigate whether such detected contrasts would be reflected in differential responses of growth performances during the adolescent period.

Considering the statement by Tanner (1989 page 66) that " The adolescent spurt is under somewhat different hormonal control from growth in the preceding period and probably as a consequence the amount of height added during the spurt is to a considerable degree independent of the amount attained before", it would be expected that the growth performance of Alagoan girls during adolescence period should present similar gain characteristics whatever the social status, even considering the differences in growth velocities (tempo of growth).

Of course, the low prevalence of underweight indicated that weight deficit was not a confounding factor for such a differential response. Therefore, only growth retardation would be expected to interfere in the growth performance.

PART III Menarche, Health And Growth Performance Of Alagoan Girls During The Study Year - A Longitudinal Analysis

In this **PART III** the data are considered in the light of a longitudinal approach. The main differences between social groups were pointed out in the previous **PART II**, and the next step is to investigate whether and to what extent such differences would interfere in the occurrence of menarche, health patterns and growth performance of the groups studied. For such analysis, the chosen groups were followed up during the period of one year.

It is important to note that, for the longitudinal analysis different grouping arrangements had to be made, considering all the peculiarities regarding the adolescence period; thus, a different method was used for grouping the girls .

III.1 Criteria For Grouping The Variables

As previously stated, the main concern of this study was to evaluate growth performance, health and nutrition of Alagoan girls at adolescence under different social conditions. Therefore, the goals were to identify their anthropometric status and to evaluate their growth performance. Such analysis should be conducted by observing the characteristics not only in terms of attained height but also considering the respective rates of growth.

For this aim, anthropometry was used as an index which could mark the specific risk of altering the rate of growth. The age at menarche and annual increments in height were used as response indexes. In addition, for the analysis, the girls were grouped according to their maturity stage, i.e. menarcheal condition.

Since attained height was assumed to be a measure of past influences, the evaluation of growth performance in terms of gain in height, weight and skinfolds under different socio-economic conditions and different patterns of physical growth status were recognized to be of fundamental importance. So, the research was developed basically according to the following approaches:

1 - By comparing socio-economic conditions and growth

The variability in growth performance during adolescence was investigated by determining any differences in the amount added to height between distinct socio-economic groups, which could be attributed to interactions between environment and genetics rather than only to normal genetic variation.

2 - By comparing physical growth status and growth performance

The second approach examined whether there were differences in terms of annual increments between different patterns of physical growth status.

Considering the results from the previous cross-sectional analysis, it is important to note that in the longitudinal analysis the results from the low income group reflect not only the characteristics of the "normal individuals" but also of the "stunted" ones. The difference in terms of gain in the anthropometric variables between "normal" and "stunted" girls was analyzed by the multiple regression analysis.

The state of being "stunted" was explored in relation to NCHS reference (see discussion about "The use of NCHS" in Chapter 2). These two approaches differ somewhat one from another, because in the first one it was not assumed that there was a developmental impairment already established in any of the studied groups, while in the second one past growth failure was recognized to exist. That is, differences that could be related to unbalanced height for age were considered at first. Nevertheless, these two approaches are complementary, and were explored jointly in this study.

Chapter 5

Menarche During The Study Year

This section provides information of the occurrence of menarche in the social groups studied. Details are given about the frequency distribution of menarche among the Alagoan girls and the age it occurred. The mother's menarche age is also explored.

5.1 Results

Based on previous criteria for grouping the girls (see Chapter 2), those who achieved menarche were studied separately in this section from those in the different condition.

5.2 Menarcheal Condition

Table 5.1 gives the number and percentage of the girls in different maturity stages and age range according to the social class.

Table 5.1 Frequency distribution of Alagoan girls according to maturity stage (without and with menarche),age (mid- point of the age-range), and social class (A, B)

	Without Menarche				With Menarche			
	Group A		Group B		Group A		Group B	
Age (yr)	No.	%	No.	%	No.	%	No.	%
9.5	15	15.8	20	14.4	3	6.0	1	1.5
10.5	33	34.7	56	40.3	3	6.0	2	2.9
11.5	33	34.7	33	23.7	16	32.0	15	22.1
12.5	12	12.6	20	14.4	14	28.0	25	36.8
13.5	2	2.1	10	7.2	14	28.0	25	36.8
Total	95	100.0	139	100.0	50	100.0	68	100.0

The details of this table are illustrated in Figure 5.1. In both groups the majority of subjects, high income = 65.52 %, and low income = 67.15 %, were at the stage before achieving menarche. The Mann-Whitney test for two independent samples showed that they were homogeneously distributed throughout the age ranges whatever was the maturity stage, i.e., without menarche (p=0.8), and with menarche (p=0.07).

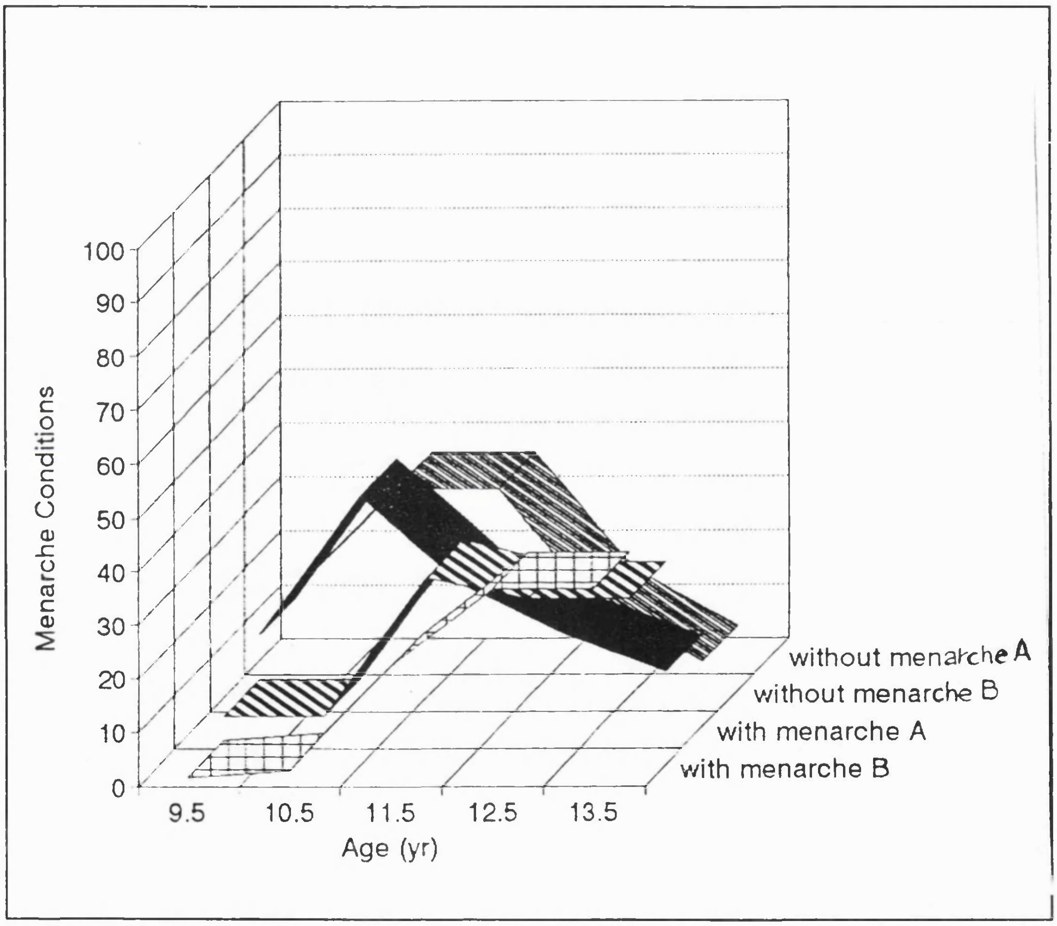


Figure 5.1 Menarche condition in the sample study

5.3 Menarche Age And Social Class

In the present study, girls from the low income group started menstruating 5 months later than girls from the high income group. The mean age at menarche was 12.1 years (145 months) for the former and 11.7 years (140 months) for the latter. The T test showed such difference as being marginally significant ($p=0.048$). The same tendency was observed in relation to their mother's menarche age, in which the high income mothers presented the mean average of 12.1 years (145 months) against 12.8 years (154 months) from the low income mothers. Therefore, in this group the difference in the onset of menarche was 9 months, and such result was found to be statistically significant as confirmed by the T-test ($p < 0.001$). (See table 5.2)

Table 5.2 Mean average and range of menarche age of Alagoan girls and mothers by social class*

	High income			Low income					
Subject	No.	Mean	SD	No.	Mean	SD	t value	df	P value
Girls	50	11.7	0.9	68	12.1	0.9	-1.94	116	0.048
Mothers	50	12.1	1.3	68	12.8	1.6	-2.52	116	0.01
Mothers	145	12.3	1.3	207	13.0	1.4	-5.30	350	0.001

* This result should not be interpreted as being representative of population values

This result suggests that the girls matured earlier than their mothers in both social classes. The mean difference to the onset of menarche between mothers and daughters was higher for the low income group, being 9 months (0.76 yr), compared to 5 months (0.40 yr) for the high income individuals. It is important to bear in mind that the data of mothers and daughters were collected using different methods, therefore the comparison must be considered with caution. Although the girls'menarcheal age correlated positively with the mother's menarcheal age, the Pearson coefficient method showed a very weak level of correlation, being for the high income group 0.14 and 0.08 for the low income group. To predict girl's menarcheal age from the mother's menarcheal age, a simple two-variable regression was performed separately for either social groups. Figure 5.2 shows these results.

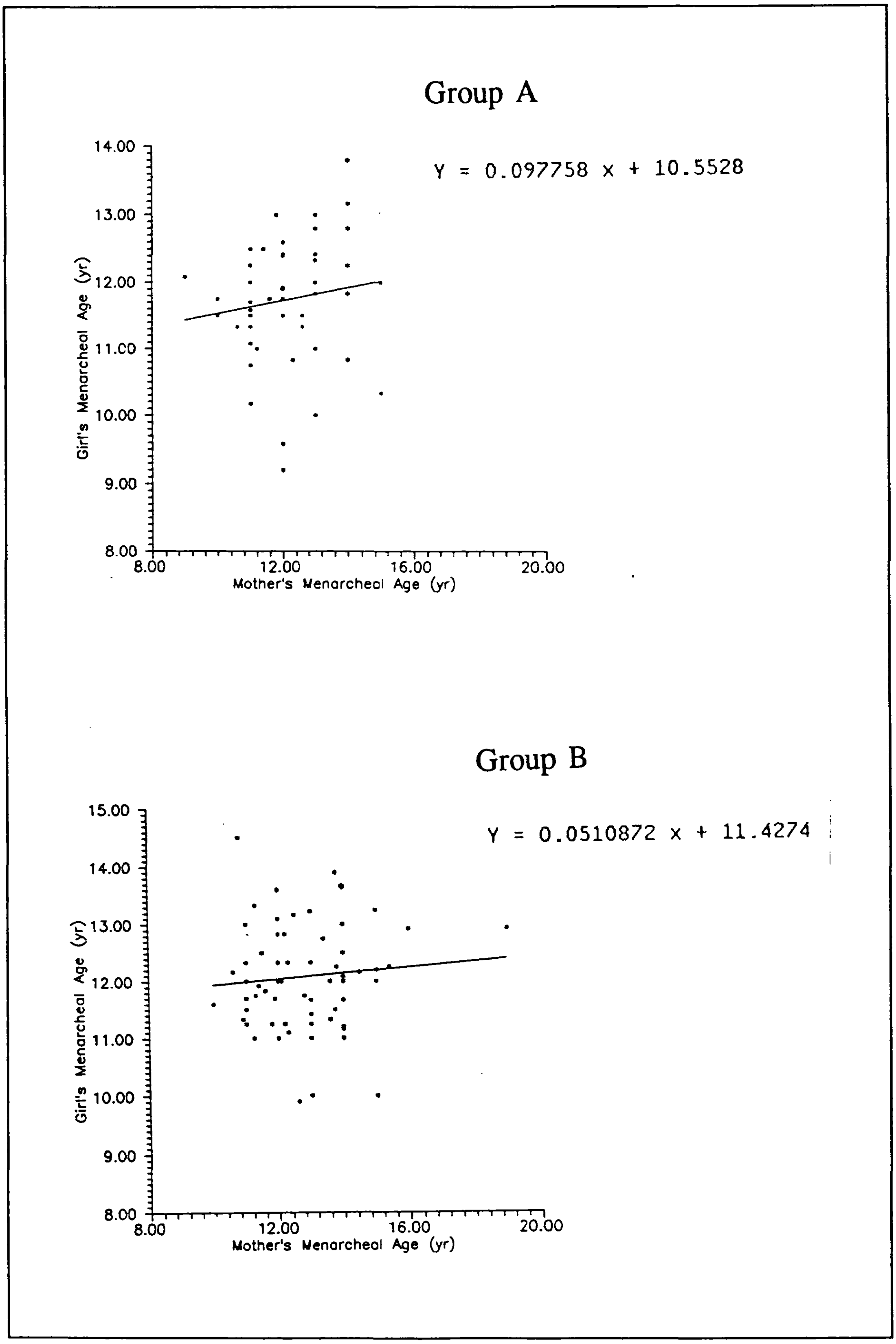


Figure 5.2 Linear regression of the girl's menarcheal age regressed against mother's menarcheal age: Group A and Group B

Table 5.3 allows comparison of the menarcheal age distributions of mothers and girls from different social classes.

Table 5.3 Frequency distribution of menarcheal age of Alagoan mothers and girls by socio-economic condition and age-ranges

Age Range	High income				Low income			
	Mothers		Girls		Mothers		Girls	
	No.	%	No.	%	No.	%	No.	%
9.0 - 9.9	2	1.4	2	4.0	-	-	1	1.5
10.0 - 10.9	11	7.6	6	12.0	5	2.4	2	2.9
11.0 - 11.9	30	20.7	21	42.0	32	15.5	27	39.7
12.0 - 12.9	47	32.4	17	34.0	57	27.5	24	35.3
13.0 - 13.9	32	22.1	4	8.0	44	21.3	13	19.1
14.0 - 14.9	15	10.3	-	-	44	21.3	1	1.5
15.0 - 15.9	8	5.5	-	-	19	9.2	-	-
16.0 - 16.9	-	-	-	-	5	2.4	-	-
19.0 - 19.9	-	-	-	-	1	0.5	-	-

In the case of mothers, a greater proportion (Mann-Whitney test $p < 0.001$) from the high income group achieved menarche mainly between 10.0 and 13.9 years (82.8 %) while in the low income group 66.7 % started menstruating between the ages of 10.0 and 13.9 years.

The majority of girls from the high income group (88.0 %), experienced menarche when they were aged between 10.0 and 12.9 years, and 8.0 % after 13.0 years.

In the low income group the percentage related to those with menarche in the age-range of 10.0 to 12.9 years decreased to 78.0 %, with an additional 20.6 % menstruating after 13.0 years of age. Therefore, there was a larger variation in age at menarche of the low income group in comparison to their counterparts. The

Mann-Whitney test confirmed such difference as being significant ($p < 0.001$).

Figures 5.3 and 5.4 present this information as graphs. Figure 5.3 shows the percentage of girls according to their respective age at the onset of menarche.

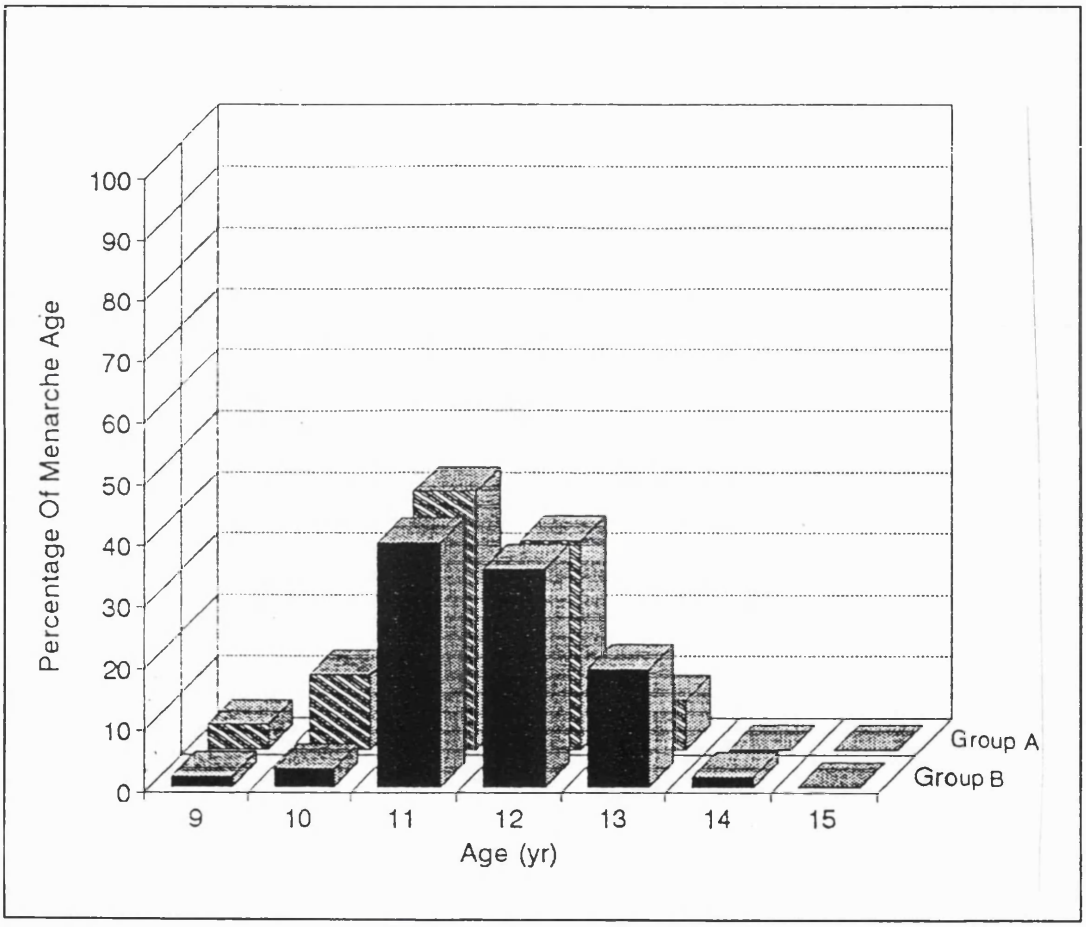


Figure 5.3 Percentage of girls according to menarcheal age and social class

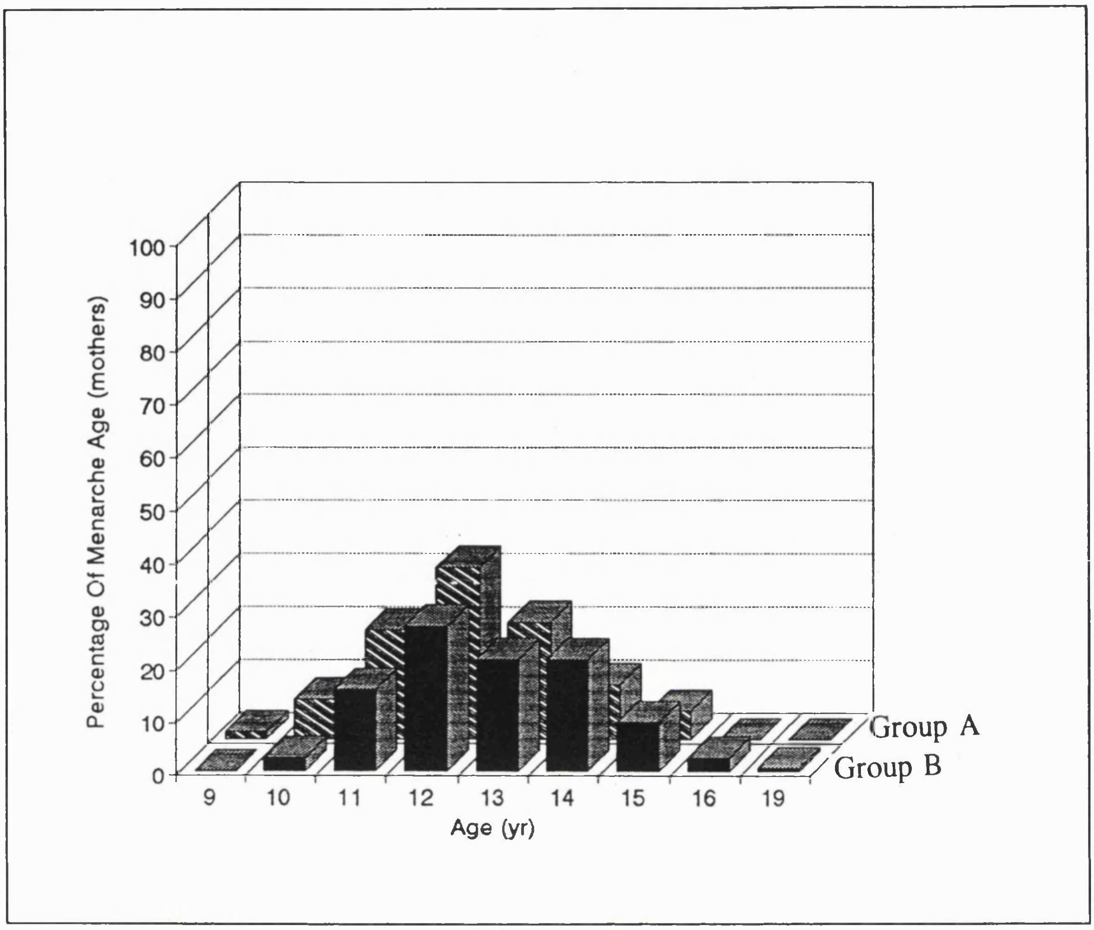


Figure 5.4 Percentage of mothers according to menarcheal age and social class

Figure 5.4 presents the percentage of mothers and their respective menarcheal ages. The vertical axis shows the percentage of mothers with different ages at menarche. The different age-ranges can be observed in the horizontal axis.

According to this graph, the high income mothers started their periods earlier compared to their counterparts. In contrast, mothers from the low income group were delayed in achieving menarche by on average of 8 months. In some cases the first period was manifested at a later age such as after 16 years.

5.4 Menarcheal Age And Growth Status

Menarcheal age was also observed in relation to the growth status of the Alagoan girls. Table 5.4 presents the mean and standard values for the distribution of growth status based on the Z-score values classification for height-for-age for girls according to the social class.

The difference in terms of Z-score values between the two social groups was considered significant by T-test ($p < 0.001$), meaning that over all age-ranges the low income girls, who had achieved menarche, showed the lowest Z-score values. Nevertheless, it has to be pointed out that in both social groups the delay in the onset of menarche was observed for those who presented the lowest Z-scores values with the exception of those aged between 10.0 and 10.99 years in the low income group. This result was probably due to the small number of girls in this age group.

Table 5.4 Mean, standard deviation and frequency distribution of growth status (height for age) based on Z-score values for Alagoan girls who reached menarche, by social class (A, B) and age (midpoint of the age-range)

Age (yr)	Group A*				Group B			
	No.	%	Mean	SD	No.	%	Mean	SD
9.5	3	6.0	1.7	1.3	1	1.5	0.5	-
10.5	3	6.0	1.1	0.5	2	2.9	-0.5	2.2
11.5	16	32.0	0.1	1.0	15	22.1	0.1	0.9
12.5	14	28.0	0.1	0.9	25	36.8	-0.6	1.0
13.5	14	28.0	-0.2	0.9	25	36.8	-0.8	1.0
TOTAL	50	100.0			68	100.0		

* T-Test $t = 3.63$ $df = 116$ $p < 0.001$

5.5 Factors Contributing To The Variation Of Menarcheal Age

Multiple regression analysis was used to investigate the influence of social variables, "growth status", anthropometrical gain in some parameters such as height, weight and skinfolds (triceps, biceps, subscapular, suprailiac, and sum of 4 skinfolds) on occurrence of menarche age. The results can be seen in Table 5.5.

Table 5.5 Variables which contributed to variation in age of menarche by social class

Dependent variable	Explanatory variable	Regression coefficient	SE B	R square	P value
menarche Group A	growth status height-for-age	-0.50	0.1	0.26	0.000
menarche Group B	annual gain suprailiac	0.01	0.3	0.12	0.01

The age of menarche in the high income girl group correlated negatively with the Z-score for height-for-age. Also, Z-score for height-for-age contributed 26.5 % of the variation of menarche in Group A. No other variable showed significant effect on the menarche age.

When analyzing this aspect in the low income group, a different condition was found. The menarcheal age of poor girls correlated positively with yearly gain at suprailiac site. The contribution of this variable to the variation in the age of menarche in this group was about 12.0 %. No other variable showed a significant effect on the menarche age in Group B.

5.6 Discussion

In the present study, the girls from the underprivileged social class experienced menarche later than well-off girls. This difference between the social classes is comparable to results from various parts of the developing world. For instance, although the obtained values of 11.7 (SD 0.9) years for the high income girls against 12.1 (SD 0.9) years of the low income group, were the lowest to date for Brazil, the difference was similar to that reported between poor and well-off subjects elsewhere.

Fuzii (1989) found that the mean menarcheal age for girls who were from private schools was 12.46 years against 12.65 years of those from public schools. When she analyzed the data in relation to housing conditions (neighbourhood where the girls lived) and type of school they attended (private or state), the results were 12.38 years for those living in more favourable conditions, and 12.87 years for those in less satisfactory socio-economic situation. Therefore, she concluded that the higher the socio-economic condition the lower the age of menarche. This trend is identical to that of the current findings.

Another study in India (Roberts et al., 1977) had already related differences in median age of menarche to different socio-economic status. The study was carried out in the two Indian cities of Warangal and Madras and 1267 girls were interviewed. The median ages were 12.86 for the well-off girls resident in Madras, while for two different groups in Warangal the values were 14.08 and 13.74 among the poorer girls.

Prado (1984) also reported differences in the onset of menarche between different social classes. The study was carried out in Madrid (Spain), and there a menarcheal age of 13.02 years was found for the high social class girls, and 13.16 years for working class family girls of the suburban area of the city.

In England, Ulijaszek et al. (1991) studied age at menarche of girls of different ethnic origin (European, Afro-Caribbean and Indo-Pakistani) residing in London. According to the authors, there were significant differences in the age of menarche amongst the distinct 5 social classes. Girls from families where the father was unemployed menstruated later than others.

Another finding of this study is that the low income group girls presented the larger percentage menstruating at a later age in comparison to their counterparts. This also agrees with previous findings of others. In Brazil, Fuzii (1989) observed that the lower the income condition the lower the 97 percentile, and the higher the third percentile. This means that, the poorer the community the larger percentage of girls menstruating at a later age, and the richer the group the bigger the percentage of girls achieving menarche at earlier ages.

Burrel et al. (1969) had already pointed this out. In their study, 47,420 Bantu schoolgirls from South Africa were classified as being "not poor" and "poor", and according to these characteristics not only a delay in the age of menarche was detected in the "poor" group but also a bigger variation in age at menarche as well.

One possible explanation for this fact had been explored by some authors such as Susanne et al.(1987) for instance, who state that "malnutrition, but also infection, bad socioeconomic influences, negative psychosocial influences, will result in a delay of skeletal maturation, in a delay of puberty and of age at menarche". In fact, they suggested that even a slender stage of malnutrition can retard the timing of pubescence.

It is possible that this was what had occurred with the girls of the present study. From the results of the cross-sectional analysis of the data, some points can be observed: firstly, that the low income group presented a curve for the z-score for height-for-age skewed for the left. Secondly, that the lower the Z-score related to height-for-age the bigger the susceptibility for the girls to have the menarche delayed. and thirdly that in social Group A the Z-score for height-for-age correlated negatively with age at menarche.

By this it is meant that,although in comparison to the high income girls the low income girls were shorter and had the tendency to menstruate later, the increase in adiposity at the suprailiac site was important enough to overcome the effect of the height-for-age. This is possible to occur because it has been suggested that the endocrine factors responsible for puberty may be dependent on body fat (Passmore and Eastwood, 1986).

However, it is important to note that the low Z-score for stature in girls from low income group can not be neglected because of its observed insignificant contribution to menarche in this group. Instead of this, some additional attention must be paid to the fact that around 47.4 % of girls from low income group had Z-score values for height-for-age less than -1 SD, while in group A, 18.6 % had a similar condition. It is possible that this characteristic, in terms of low stature, had contributed to this result, since bigger differences amongst the girls from this group would not be detected, in contrast with what could be found in the high income group.

Therefore, if this reduction of body size is considered as a response to environmental constraints and a signal of previous long-term episodes of undernutrition, then the delay of menarche in the low income group would be expected to occur.

In this sense, Satynarayana and Naidu (1979) reported a mean age at menarche of about 15.2 years for rural Indian girls who presented a statural deficit related to an undernourished condition at age 5, and 13.7 years for those without any diagnosed nutritional stress.

Eveleth (1966 A) studying human growth and maturation under changed environmental conditions, reported a menarcheal age of 12.65 years for American girls from a high income class and brought up in Rio de Janeiro (Southeast region of Brazil).

In China, Lin et al. (1992) analysed the menarcheal age of 162,902 Chinese girls from different origin, urban and rural by "status quo" method. They found that urban girls had the tendency to menstruate earlier than their rural counterparts. The median menarcheal ages were 13.46 years for those from urban areas and 13.87 for those from rural settings.

In a previous study Gurjao (1959) found a mean of 12.68 years for Brazilian whites, 12.9 years for Brazilian mulattoes, and 12.68 for Brazilian negroes, all of them resident in Rio de Janeiro (Southeast region of Brazil). Eveleth and Souza Freitas (1969) found that Brazilian-born Japanese girls resident in Sao Paulo (Southeast region of Brazil) had the first period at a median age of 12.85 years. Hegg and Levy (1974) reported a mean of 12.56 years for the onset of menarche of girls from Sao Paulo (Southeast region of Brazil). Also in Bauru - Sao Paulo, Scaf et al. (1983) studying age at menarche of Brazilian white girls found that the median age at menarche was 12.97 years.

Nevertheless, studies of menarcheal age in Brazil, in other regions of the country than the Southeast, are not extensive.

Although the present result is the lowest known for Brazilian population, it might be noted that all the previous results were related to populations living in the Southeast region of the country, where the climate and the ethnic background are quite distinct from what can be found in the Northeast region where this study was developed.

Other studies in Latin America such as that of Rona and Pereira (1974) in Chile, revealed a median age at menarche of 12.60 years. Jordan in Cuba (1984) indicated a mean age at menarche of 13.01 years, the urban girls having achieved menarche earlier than their rural counterparts.

In Mexico, Malina et all (1977) reported a median age at menarche for Oaxaca girls from state primary schools of urban and rural communities, of 14.27 years. According to the authors the sample did not included the better-off girls of the capital city Oaxaca de Juarez.

Some information about a decrease in the mean at menarche has been reported to occur in highly developed countries of the West (Burrel et al., 1969).

The menarcheal age has also been compared between mothers and daughters. As indicated in Table 5.3, the sexual maturation of Alagoan girls was found to be accelerated in relation to that of their mothers. A bigger difference was detected between mothers and girls from the low income group (9 months) than between the well-to-do group (5 months). This bigger acceleration in low income group could be related in part to changes in environmental conditions, which certainly can be linked to availability of food and health care in urban rather than rural areas in Brazil, especially in the Northeast region. This suggests that in the low income group, the migration can possibly be identified as an important factor that influences age at menarche. In fact, when considering the results of the social questionnaire (Table 3.3) it can be noted that in the low income group, most parents (95.4 %) related their migratory decision to the desire of improving life, and recognized an improvement on the socio-economic conditions (82.7 %) after the migration. Therefore, it is possible that the post-migration environment had an influence on the difference in menarcheal age between mothers and daughters. Nevertheless, more investigation is needed on this subject.

Also in this respect, the results of the present study are consistent with previous findings. For instance, it has been suggested (Damon et al., 1969) that differences in nutritional conditions could account for a weak correlation of age at menarche between mothers and daughters. They concluded that the more uniform and favourable the environment, the stronger the correlation between ages at menarche, and the smaller the difference in age at menarche, of mothers and daughters. This assumption was based on the fact that in their study the authors found a coefficient of correlation between mothers and daughters of 0.24 (SD 0.11), and an acceleration of 1.5 year. i.e., mothers menstruating at 14.38 years and daughters 12.88 years.

Hegg and Levy (1977) reported a similar but smaller acceleration in age at menarche between Brazilian mothers and daughters residents in Sao Paulo (Southeast region of Brazil). There, the authors found an advance of 0.2 year in favour of the daughters, who had a mean of 12.56 years for the onset of menarche.

5.7 Conclusion

Confirming the **Hypothesis 3**, in this study, low income girls presented the tendency to menstruate later, in comparison to their high income counterparts. Although the annual gain in fat at the suprailiac site was pointed out to be the most important contributor to menarcheal age in the low income group, it is possible that post-migration environment and growth status had influenced as well.

On the other hand, regardless the social class there was an acceleration in the age at menarche in the daughters in comparison to their mothers. The acceleration was higher in the low income group.

The growth status was the most important factor influencing age at menarche in the high income group.

Similar pattern was observed in relation to the mothers menarche age, low income group mothers menstruating at later ages than their counterparts.

Chapter 6

Reported Morbidity

This section describes the morbidity pattern of the Alagoan girls during the study year. The health condition was evaluated monthly, recording the reported morbidity of the sample studied.

6.1 Results

Alagoan girls from the low income group presented a higher level of morbidity compared to their peers, regardless of menarcheal condition. Details are presented in Table 6.1.

Table 6.1 Prevalence of health status for the whole period of the study, according to menarche condition and social class considering all girls

		Without Menarche*				With Menarche**			
		Healthy		Sick		Healthy		Sick	
Social Class	Total Cases	No.	%	No.	%	No.	%	No.	%
A	1450	768	80.8	182	19.2	438	87.6	62	12.4
B	2070	804	57.8	586	42.2	508	75.0	172	25.0

* Mann-Whitney test $p < 0.001$
** Mann-Whitney test $p < 0.001$

The frequency distribution of the observed illnesses are shown in Table 6.2 and 6.3, and Figure 6.1 and 6.2. During the whole year, the low income group showed the highest incidence of illness episodes regardless of menarcheal condition.

Table 6.2 Frequency of episodes of cold/cough, diarrhoea and other illnesses in Alagoan girls without menarche according to social class (A and B) and months of the year

	Cold/Cough				Diarrhoea				Others			
	A		B		A		B		A		B	
Mth	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Oct	15	15.8	44	31.7	1	1.1	8	5.8	-	-	10	7.2
Nov	27	28.4	45	32.4	3	3.2	14	10.1	-	-	5	3.6
Feb	10	10.5	51	36.7	1	1.1	12	8.6	-	-	14	10.1
Mar	20	21.1	45	32.4	1	1.1	15	10.8	-	-	6	4.3
Apr	27	28.4	38	27.3	1	1.1	6	4.3	1	1.1	13	9.4
May	10	10.5	32	23.0	1	1.1	10	7.2	1	1.1	9	6.5
Jun	9	9.5	23	16.5	1	1.1	7	5.0	2	2.1	7	5.0
Jul	7	7.4	44	31.7	-	-	1	0.7	-	-	8	5.8
Aug	13	13.7	40	28.8	1	1.1	11	7.9	-	-	6	4.3
Sep	28	29.5	52	37.4	1	1.1	4	2.9	1	1.1	6	4.3

* Mann-Whitney test for two independent samples $p < 0.001$

Table 6.3 Frequency of episodes of cough/cold, diarrhoea and other illnesses in Alagoan girls with menarche, according to social class (A and B) and months of the year

	Cough/cold				Diarrhoea				Others			
	A		B		A		B		A		B	
Mth	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Oct	7	14.0	8	11.8	1	2.0	2	2.9	-	-	1	1.5
Nov	10	20.0	21	30.9	1	2.0	1	1.5	-	-	4	5.9
Feb	2	4.0	14	20.6	-	-	3	4.4	-	-	2	2.9
Mar	5	10.0	10	14.7	2	4.0	5	7.4	-	-	-	-
Apr	9	18.0	11	16.2	1	2.0	2	2.9	1	2.0	2	2.9
May	4	8.0	7	10.3	-	-	4	5.9	-	-	4	5.9
Jun	2	4.0	8	11.8	-	-	5	7.4	1	2.0	1	1.5
Jul	1	2.0	7	10.3	-	-	1	1.5	-	-	2	2.9
Aug	6	12.0	16	23.5	-	-	5	7.4	-	-	1	1.5
Sep	7	14.0	23	33.8	1	2.0	1	1.5	1	2.	1	1.5

* Mann-Whitney test for two independent samples $p < 0.001$

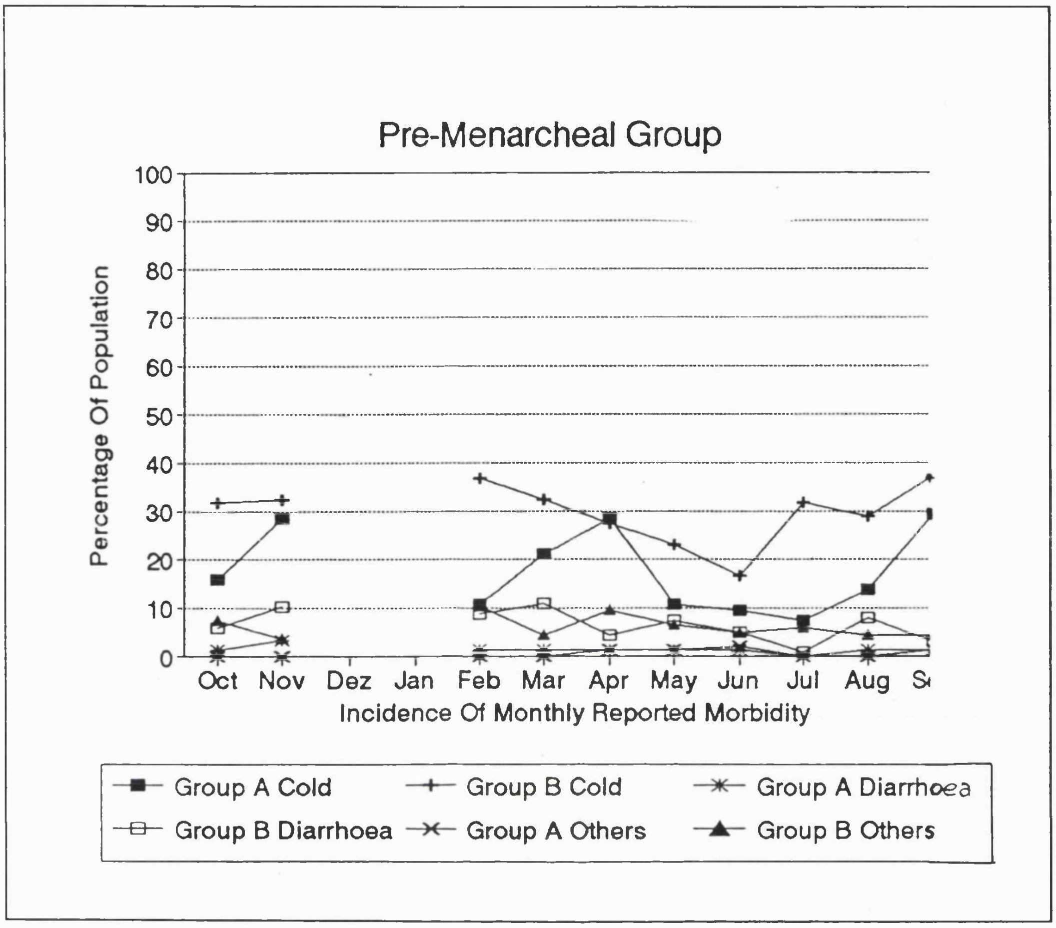


Figure 6.1 Frequency distribution of episodes of cold/cough, diarrhoea and other illnesses in Alagoan girls without menarche according to social class and months of the year

The Mann-Whitney test confirms these differences showing that illnesses episodes were higher among low income girls than in the opposite group, regardless of symptom and menarche condition, without menarche $p < 0.001$, and with menarche $p <= 0.001$).

Cold/cough was the most common complaint encountered in both social groups regardless of the growth phase. The group without menarche reported 166 cases for high income family girls (17.5 %) and 414 cases for the low income subjects

(29.8 %).

In the group of girls who had attained menarche, 53 cases (10.6 %) with cold/cough were reported in the high income family group while in the low income counterparts 125 cases (18.4 %) were recorded.

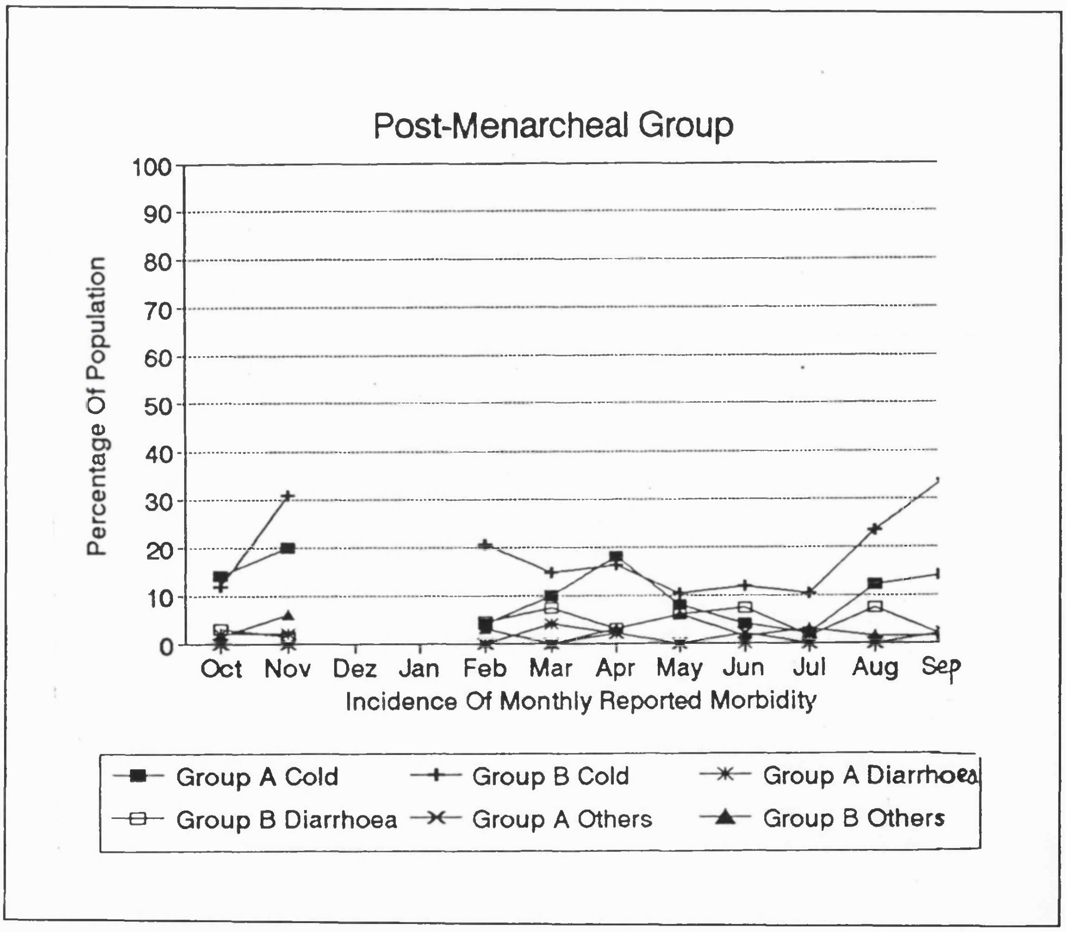


Figure 6.2 Frequency distribution of cold/cough, diarrhoea and other illnesses in Alagoan girls with menarche according to social class and months of the year

Diarrhoea also was present in both social groups and in both menarche conditions, but in smaller proportions than in cold/cough complaints. The high income group

reported 11 cases (1.2 %) for those girls without menarche and 6 cases (1.2 %) for those with menarche. The results of the low income family group were higher in comparison to their counterparts. There were 88 cases (6.3 %) in the group without menarche and 29 cases (4.3 %) in the group with menarche.
In relation to the "other diseases" group, 84 cases (6.0 %) were found in the group without menarche, and 18 cases (2.7 %) in the group with menarche from the low income family.
The percentage in the "other diseases" category in the high income group was smaller, 5 cases (0.5 %) being reported by the group without menstruation and 3 cases (0.6 %) by the group who had achieved menarche. The summary of these data can be seen in Table 6.4.

Table 6.4 The most reported diseases according to social class and menarcheal condition

	Without Menarche						With Menarche					
	Cold		Diarrh.		Others		Cold		Diarrh.		Others	
Social Class	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
A	166	17.5	11	1.2	5	0.5	53	10.6	6	0.6	3	0.6
B	414	29.8	88	6.3	84	6.0	125	18.4	29	4.3	18	2.7

To assess the influence of social and anthropometric variables on the incidence of morbidity a multiple regression analysis was carried out. Initially, morbidity was regressed separately against the independent variables in the groups according to the social status. In this situation, no marked effect of social proxies such as domestic waste disposal, type of toilet and water facility was found to contribute to morbidity variation. Not even growth status showed any influence.

Significant interactions were observed, however, when income was considered in the equation as an independent variable excluding the other social proxies. In this case, income correlated negatively with morbidity and contributed to 18.1 % of its variation. Age correlated negatively with morbidity and contributed to 5.2 % of its variation. The growth status also correlated negatively with morbidity and contributed to 2.0 % of its variation. The number of siblings correlated positively with morbidity and contributed to 1.6 % of its variation.

Therefore, those who came from families with lower income, were less aged, stunted and had many siblings had more episodes of illnesses during the study year. Table 6.5 provides the details of the multiple regression analysis.

Table 6.5 Variables influencing the variation of morbidity

Dependent variable	Explanatory variable	Regression coefficient	SE B	R square	P value
morbidity	income	-0.1	4.6	0.18	0.001
	age	-1.7	3.2	0.05	0.001
	growth status*	-0.1	0.1	0.02	0.005
	siblings	0.1	4.0	0.02	0.01

* Growth Status coded as "dummy variable", normal=1 and stunted=0

Repeated measures analysis of variance indicates that the growth status affected the incidence of reported morbidity, the growth retarded girls reporting more episodes of illnesses during the study year ($F = 4.16$ $p < 0.001$).

6.2 Discussion

Analysis of health conditions is a complex issue. This is because "health condition" can be assessed in different terms, depending on study aims. In general, the conventional approach for assessing population health is by monitoring growth performance through analysis of indices such as height-for-age, weight-for-age, and weight-for-height. An impairment in one or more of these conventional indices suggests an imbalance in general health. In developing countries, such health disturbance is supposed to be related predominantly to dietary imbalances and/or repeated episodes of infection (Monteiro et al., 1991, Chandra, 1991, United Nations, 1990, Grantham-Mcgregor, 1990, Black et al., 1984).

In general, when studies of morbidity have been made, they have mainly focused on children aged less than 10 years (Walker et al., 1992, Becker et al., 1991, Briend, 1990, Delgado et al., 1988, Rowland et al., 1988, Zumrawi et al., 1987, Hummert and Goodman, 1986, Black et al., 1984, Sommer et al., 1984).

This is possibly because it has traditionally been suggested that adolescents are less exposed to the risk of being sick due to environmental conditions. An implication of this assumption is reflected in the limited available information on the morbidity of adolescents.

This study provides evidence that environmental and social conditions still play an important role during adolescence. Adolescent girls from the low income group, who lived in less favourable conditions, presented a higher incidence of illnesses compared to their counterparts. In addition, it must be borne in mind when considering the results that, the growth retarded girls were not severely underweight nor thin.

6.2.1 Social Status And Morbidity Incidence

Income was the major contributor to the variation of reported morbidity. The low income family girls showed the highest incidence of morbidity, regardless of the growth phase. This occurs because poverty is often associated with inadequate houses. overcrowding and inadequate sanitary services.

The most reported illness in this study was cold/cough. In addition, the percentage of cases was greater in the group without menarche. One possible explanation for this pattern is that, in the phase of growth before menarche the girls must be experiencing an acceleration in linear growth, meaning that their nutritional requirements must be increased. If the girl is not able to meet her requirements, then perhaps a disturbance in her "nutritional status" is established, and consequently an increased susceptibility to get ill can be generated. Chandra (1988) supports this explanation by saying that specific or multiple nutrient deficiencies can impair the immune response, consequently a failure in this mechanism leads a decreased capacity of the subject to resist infection.

Although, girls from both social groups did report cold/cough, it was the low income group girls who showed the highest incidence. The same trend was observed in other illness episodes. An alternative explanation for this finding relates to the fact that the girls from the low income families are more exposed to overcrowded conditions in their habitat. The majority of low income group girls lived in slums with unsafe sanitary conditions, and in small houses where, large families often share the same space to sleep and live in. These conditions, have been recognized to promote spread of airborne infections (Victora et al., 1986, Passmore and Eastwood, 1986, Grantham-Mcgregor, 1990). Therefore, although related to adolescent subjects, the results of this study corroborate the findings of previous studies.

In developing countries, a higher prevalence of respiratory infections contributes significantly to the child population's morbidity profile. This incidence is mainly reported to be linked to underprivileged social conditions (Delgado et al., 1988, Grantham-Mcgregor, 1990), mild stages of vitamin A deficiency (Sommer et al., 1984), and infant mortality (Klinger, 1989). However, a more accurate investigation is still necessary in this area.

Some studies have tried to understand whether childhood background, in terms of occurrence of respiratory infections, could be associated with future increased susceptibility to such specific episodes. Some evidence of this can be found in the works of Pullan and Hey (1982) and Mok and Simpson (1984). These studies demonstrated an association between acute lower respiratory tract infections during childhood with persisting episodes during adolescence. However, more conclusive studies are required in this particular area.

6.2.2 Growth Status And Morbidity Incidence

By multiple regression analysis, income, age, growth status and number of siblings were the factors contributing more to the morbidity profile of the studied population. This suggests that income was associated with the environmental conditions experienced by both social groups and therefore linked to differences in exposure level between the groups. Results from the social profile showed that safer sanitary conditions were associated with higher income levels. However, it is a very complex task precisely to measure this exposure level. The influence of age over the susceptibility to illness, perhaps gives an indication that the maturation process pushes the individual to be more resistant to environmental stress.

The growth status contribution to variation in morbidity, considering all illnesses together (multiple regression), and considering monthly incidence (Manova repeated measures) suggests a link with the effectiveness of the immune response. According to Chandra (1988), immunocompetence is strongly determined by "nutritional status", the undernourished individual being more susceptible to impaired immune response. This is true at least for undernourished children aged less than 5 years. As previously stated, "At birth the lymphoreticular system is very immature and its functional capacity limited. Maturation is slow and is completed only after several years...Malnutrition and undernutrition delay the development of immunity responses and of the central nervous system and their adverse effects are much greater in childhood than in adult life."(Passmore and Eastwood, 1986 page 563) In addition, the adequate repair of injured tissues as well as a competent immune mechanism influences the duration of the infection (Tomkins, 1988). Thus, it seems reasonable to conclude that well-nourished individuals are more resistant to infections. In addition, if they are infected, they are more likely to respond effectively to the insult, and they will probably need less time to recover from it.

Although the findings support the hypothesis that nutrition affects the capacity to resist to infection, two questions about this issue remain unresolved. The first is whether it is possible to apply this hypothesis to the adolescent period. The second one is whether this hypothesis can be applied to moderate or mild malnutrition (particularly as low height-for-age).

In relation to the second question, Chandra (1991) states that "Nutritional regulation of immunity and risk of illnesses have several practical applications. First, changes in immune responses occur early in the course of nutritional deficiency. Thus, we can employ immunocompetence as a sensitive functional indicator of nutritional status".
Consequently, it is possible that the left-skewed characteristic of the Z-score related to height-for-age (discussed in Chapter 4) was reflected in the major susceptibility of the low income family girls in presenting symptoms of cold/cough for instance. Although it can be said that 17.9 % of the low income family girls were stunted, another 29.5 % were located between the minus two Z-score and minus one Z-score, meaning that they may be close to some growth retardation stage.

The limitation in considering only the minus two Z-scores as the critical level for chronic malnutrition has lead to the necessity of a more detailed discussion in developing countries. In this sense, Monteiro et al. (1991) in Brazil, have made a contribution, when they point out that this cut-off point could not identify specific nutritional deficiencies or mild forms of malnutrition that could interfere with growth performance. If this is considered then a connection can be made between the growth status of the low income group and their susceptibility to illness.

6.2.3 Social Class And Incidence Of Diarrhoea

Diarrhoea also occurred in a greater proportion in the low income group. However, this did not show the same intensity as cold/cough. As will be discussed in Chapter 7, the reported morbidity did not contributed to annual height gain. However, morbidity contributed to the annual weight gains.

In infant groups, aged less than 2 years, diarrhoea is known to produce a deficit in weight gain, which contributes to acute malnutrition (Zumrawi, Dimond and Waterlow, 1987). The repetition of diarrhoeal episodes during this early childhood would transform the status of "failing to grow" to the next one known as "having failed to grow". Some evidence of this was described by Rowland et al. (1988) in Gambia. There, the authors found that, in children aged more than 2 years, despite the persisting infections, a deceleration in the growth velocity was not detected. Therefore, if some height deficit had occurred previously, then at that time it was already established. But, it is important to note that some say that this height deficit is already established in children by two years' age, others extending this period to 5 years.

However, whether diarrhoea is a major cause of malnutrition or whether malnutrition predisposes to diarrhoea is still under debate. It has been suggested that this occurs mainly because it is a difficult task to determine the causal priority of these events (Briend, 1990). Based on other studies, Briend argues about the biological plausibility of the question saying that, "...malnourished children have a depressed immunity and therefore are more easily infected or, when infected, take a longer time to eliminate pathogens..." (Briend, 1990 page 213).
Nevertheless, what remains to be answered is whether this theory can be applied to growth retarded individuals who are not severely underweight nor thin during the adolescence period.

6.3 Conclusion

The results of the longitudinal analysis indicate that the low income group girls experienced a higher incidence of illness whatever their growth phase. Growth retardation and inadequate environmental conditions can be related to this responsiveness. This confirms the **Hypothesis 6** which predicted a higher incidence of illnesses in girls who lived in a poor environment. However, it is important to note that the impact of height (growth status) on the incidence of morbidity pattern was detected only by the longitudinal approach. This suggests that cross-sectional analysis may not be suitable to determine the relationship between height and subsequent morbidity, at least in adolescents.

Reported respiratory infections occurred in a higher proportion of the low income group girls. Diarrhoea did not play an important role in the morbidity profile of these adolescent groups, although more cases were found to occur in the low income group.

Chapter 7

Annual Growth Performance

This chapter examines the results concerning the longitudinal analyses of the anthropometrical variables. The central idea of this chapter is to show the evolution of these anthropometric variables during the study year. It is important to note that, although the approach used to analyze the annual increment considers the menarcheal condition, the curve of the whole group independent of occurrence of menarche is added to the graphics. Consequently, the whole social group is expressed as: **Group A** = high income group without considering menarcheal condition, **Group B** = low income group without considering menarcheal condition. When the menarcheal condition is considered the groups are expressed as: **A (non-menarcheal), B (non-menarcheal), A (menarcheal), B (menarcheal).**

7.1 Height Results

The analysis of height involved decomposing stature into standing height and sitting height. Therefore their results are presented separately.

7.1.1 Annual Gain In Standing Height

Table 7.1 and Figures 7.1.1 and 7.1.2 display the results for annual gain in standing height of Alagoan girls.

Table 7.1 Means and standard deviations for yearly standing height gain (cm/yr) of Alagoan girls by maturity stage (without and with menarche), age (midpoint of the age-range), and social class (A, B)

		Maturity Stage					
		Without Menarche*			With Menarche**		
Age (yr)	Social Class	No.	Mean	SD	No.	Mean	SD
9.5		15	5.9	1.7	3	5.6	1.3
10.5		33	6.7	1.4	3	6.9	1.3
11.5	A	33	6.7	1.2	16	5.8	1.9
12.5		12	7.0	1.6	14	4.1	1.9
13.5		2	6.0	3.3	14	2.9	1.5
9.5		20	5.8	2.1	1	7.9	-
10.5		56	5.3	1.4	2	4.8	2.1
11.5	B	32	5.5	1.4	15	3.6	1.4
12.5		20	4.8	1.3	25	2.8	1.5
13.5		10	3.8	2.3	25	1.7	1.4

* T-test without menarche $t = 5.30$ $df = 232$ $p < 0.001$
** T-test with menarche $t = 4.49$ $df = 113$ $p < 0.001$

In Figure 7.1.1, the vertical axis shows the annual gain in standing height of girls without menarche of different social classes and also of the social groups (A and B) without considering the menarcheal condition. The horizontal axis presents the age-ranges: 9.5, 10.5, 11.5, 12.5, 13.5.

As can be seen from the figure, on average, considering all the age intervals together, the low income family girls had lower gain in standing height in comparison to their counterparts.
The T-test (considering all age groups) confirms the significant difference between social groups in terms of intensity of linear growth acceleration, being for the non-menarcheal group $p < 0.001$.

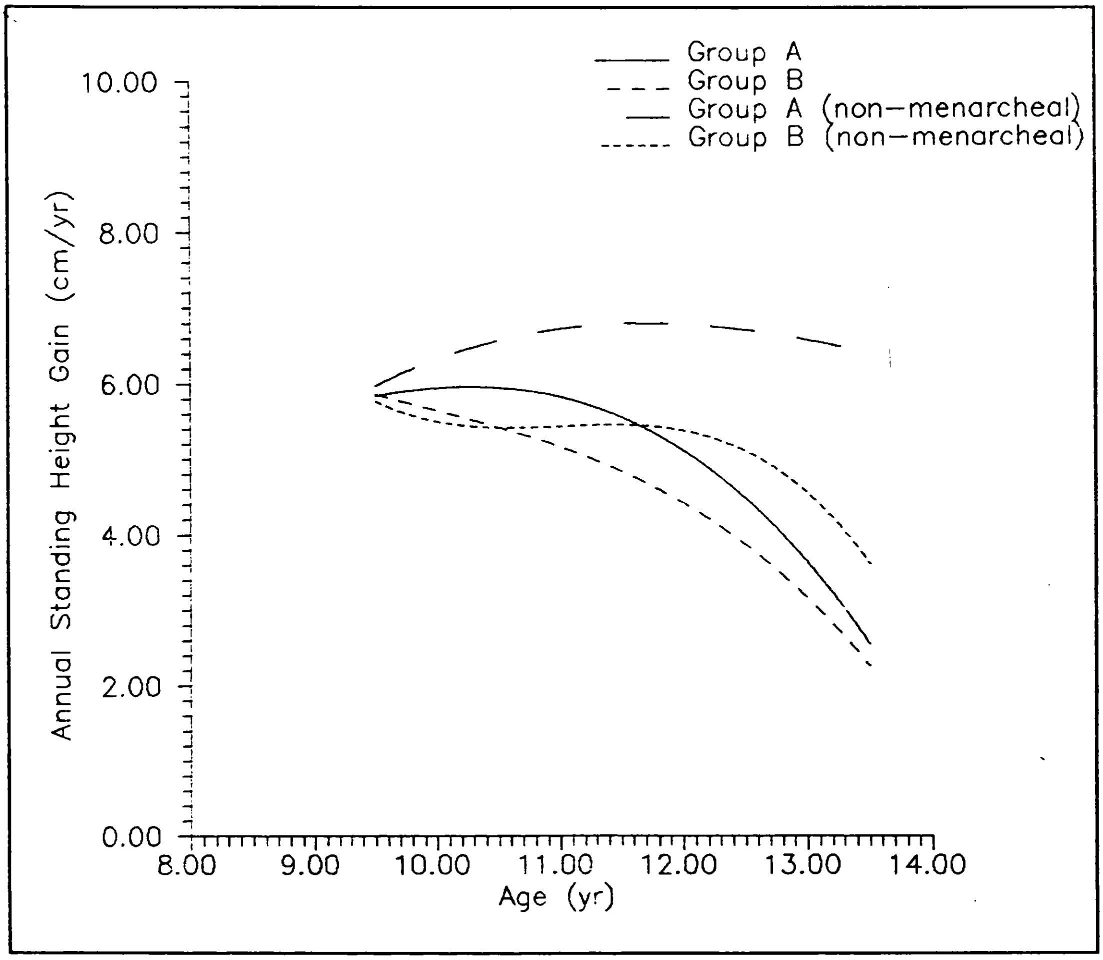


Figure 7.1.1 Yearly gain in standing height of Alagoan girls without menarche by social class and age range

Figure 7.1.2 illustrates similar findings for the group who had attained menarche. Confirmed by the T-test ($p < 0.001$), again the girls from the low income families displayed the lowest increments.

Some attention has to be paid, however, to the findings for age 13.5 from the high income group without menarche and for ages 9.5, and 10.5 from the high income group with menarche, as well as for ages 9.5 and 10.5 from the low income group with menarche. for which the results were based on a very small number of subjects. Before achieving menarche, girls from both social groups had bigger increments than those who had already initiated the periods.

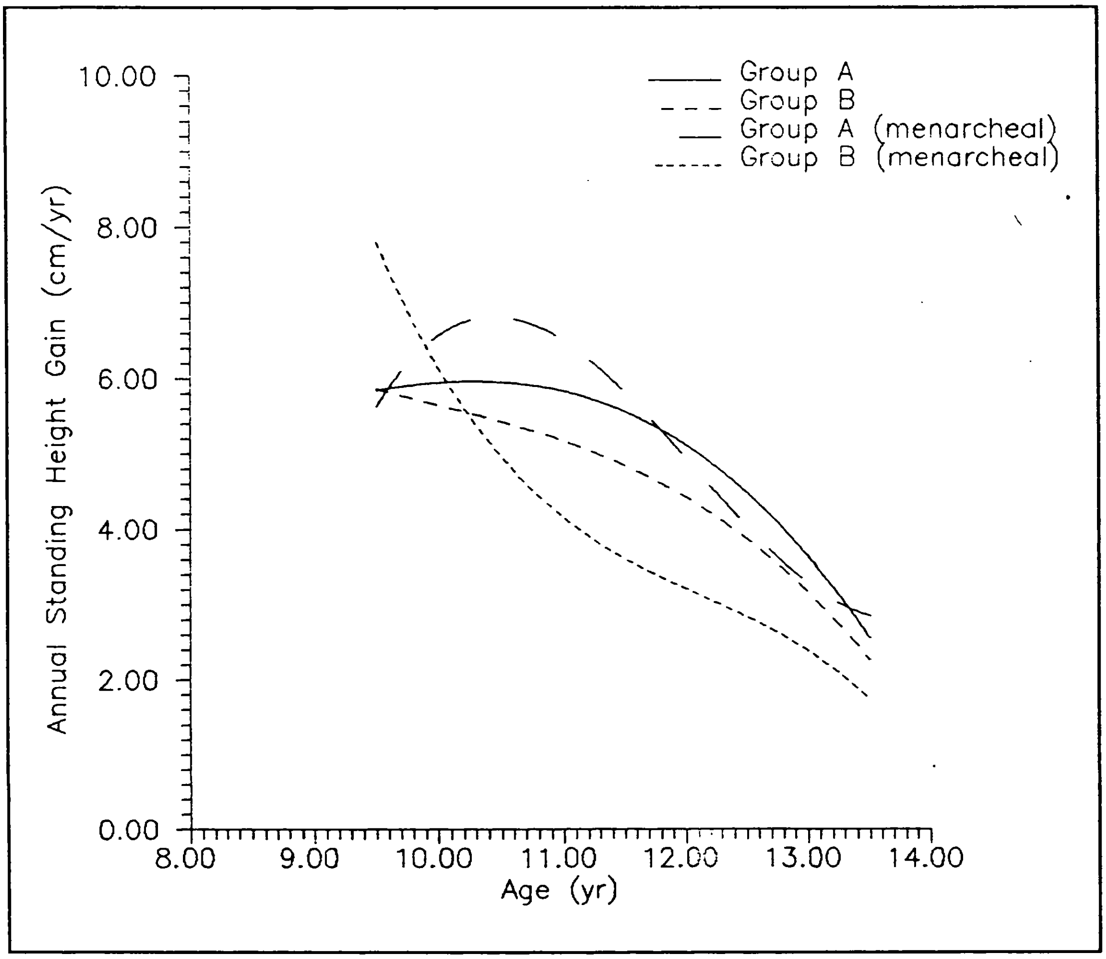


Figure 7.1.2 Yearly gain in standing height of Alagoan girls with menarche by social class (A,B) and age range

Multiple linear regression was performed to test the impact of socio-economic variables, growth status, weight gain and maturity stage on growth of standing height. As shown in Table 7.2, age and number of siblings correlated negatively with yearly increment in height. In contrast, sexual maturity stage (absence of menarche) and annual weight gain correlated positively with growth in standing height. This means that those who had not achieved menarche during the study year, were younger, had higher level of annual gain in weight and less siblings had a higher annual gain in standing height.

Table 7.2 Variables which contributed to variation in annual height gain of Alagoan school girls

Dependent variable	Explanatory variable	Regression coefficient	SE B	R Square	P value
height (gain)	sexual maturity	1.47	0.35	0.348	0.0001
	weight (gain)	0.26	0.04	0.172	0.0001
	age	-0.05	0.01	0.070	0.0001
	siblings	-0.28	0.11	0.030	0.008

In addition it is possible to examine the data for three different conditions: first, considering "growth retarded" as being those at the traditional cut-off point of less than or equal to minus 2.0 SD height-for-age (no. 1), and then comparing them with the "normal" children regardless of their social condition. Second, considering the "growth retarded" as being those below a cut-off point of less than minus 1.0 SD height-for-age (no.2), and then comparing them with the "normal" ones, regardless of social class. Finally, excluding the "growth retarded" at traditional cut-off point of less or equal minus 2.0 SD, and then comparing only the "normal" ones by social class (no. 3). These results can be seen in Table 7.2.1.

Table 7.2.1 Annual height gain (cm/yr) in different grouping criteria: 1 = stunted (less or equal -2 SD), 2 = Stunted (less than -1 SD) and 3 = normal (excluding those less or equal -2 SD)

Criteria	Comparison Condition	Without menarche No.	Mean	SD
1 - Stunted *	Growth retarded	34	5.0	1.6
	Normal	200	6.0	1.7
2 - Stunted **	Growth retarded	100	5.4	1.7
	Normal	134	6.1	1.7
3 - < -2.0 SD *** not included	High income	91	6.5	1.4
	Low income	109	5.5	1.8

* Anova controlling for age F = 0.12 p = 0.7
** Anova controlling for age F = 0.43 p = 0.5
*** Anova controlling for age F = 44.7 p < 0.001

The results of Table 7.2.1 indicates that "growth retarded" and "poor" girls had lower annual standing height gain and that age had a great impact on the annual height gain of this group. According to the first criteria, those who were "growth retarded" grew 1.0 cm/yr more slowly than those who had "normal" height-for-age. However, this different pattern of growth was significant only when age was included in the equation. When the effect of age was not considered, there was no significant difference between "growth retarded" and "normal" subjects.

According to the second criteria, those who were "growth retarded" grew 0.7 cm/yr more slowly than those in the contrasting situation. In this analysis, again the impact of age was very important, the pattern being the same as in the first comparison.

And finally, according to the third criteria, those who were "normal" and from the high income group grew 1.0 cm/yr more quickly than those "normal" but living in less favourable condition. In this group, the differences in the rate of growth remained significant even after controlling for the effects of age.

7.1.1.1 Seasonal Effect

Seasonal effects were studied through the analysis of repeated measures. The result reveals that there was a significant seasonal variation in height velocity in the group of girls who had attained menarche ($F = 5.59$ $p = 0.02$), and a marginally significant variation in the group of girls who had not achieved menarche ($F=4.03$ $p=0.05$).

7.1.2 Annual Gain In Sitting Height

The results for yearly sitting height gain can be seen in Table 7.3 and Figures 7.2.1 and 7.2.2.

Table 7.3 Means and standard deviations for yearly sitting height gain (cm/yr) of Alagoan girls by maturity stage (without and with menarche), age (midpoint of the age-range), and social class (A, B) in the period of Oct 1990 to Sep 1991

Age (yr)	Social Class	Without Menarche*			With menarche**		
		No.	Mean	SD	No.	Mean	SD
9.5	A	15	3.2	1.6	3	3.0	0.8
10.5	A	33	4.1	1.7	3	3.7	1.9
11.5	A	33	3.5	1.2	16	3.4	1.7
12.5	A	12	4.3	1.1	14	2.8	1.1
13.5	A	2	2.3	2.6	14	2.5	1.1
9.5	B	20	3.3	1.6	1	6.9	-
10.5	B	56	2.9	1.1	2	2.3	2.5
11.5	B	32	2.7	1.1	15	2.7	0.8
12.5	B	20	2.7	1.2	25	1.8	1.2
13.5	B	10	2.3	1.2	25	1.5	1.1

* T-test without menarche $t = 3.91$ $df = 232$ $p < 0.001$
** T-test with menarche $t = 3.64$ $df = 113$ $p < 0.001$

In the Figure 7.2.1, the vertical axis represents the values for annual sitting height gain, and the horizontal axis displays the age-ranges: 9.5, 10.5, 11.5, 12.5 and 13.5.

Girls from the low income group gained significantly less in trunk than did girls from the high income families. The T-test confirmed the significance of these differences ($p < 0.001$). The trend between social groups in this grouping condition is similar to when the menarcheal condition is not considered. However, the intensity of the between social groups differences is higher when the menarcheal condition is considered (in this case, absence of menarche)

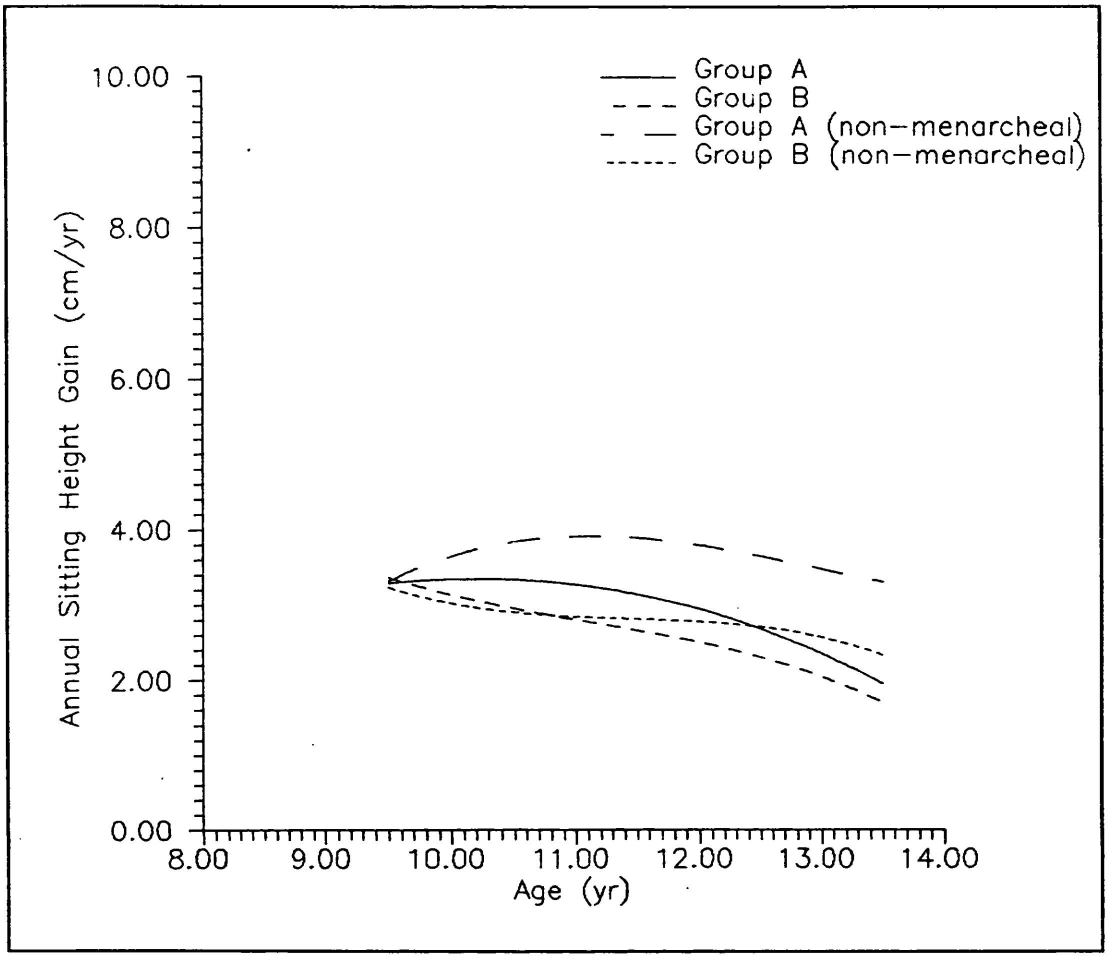


Figure 7.2.1 Annual sitting height gain of Alagoan girls without menarche by social class and age range

Figure 7.2.2 displays the results for the girls with menarche. The low income group girls in this maturity stage added significantly less trunk length than their counterparts ($p < 0.001$).

In addition, those who attained menarche had bigger trunks than those who had not started menstruating, and this can be observed in both social groups.

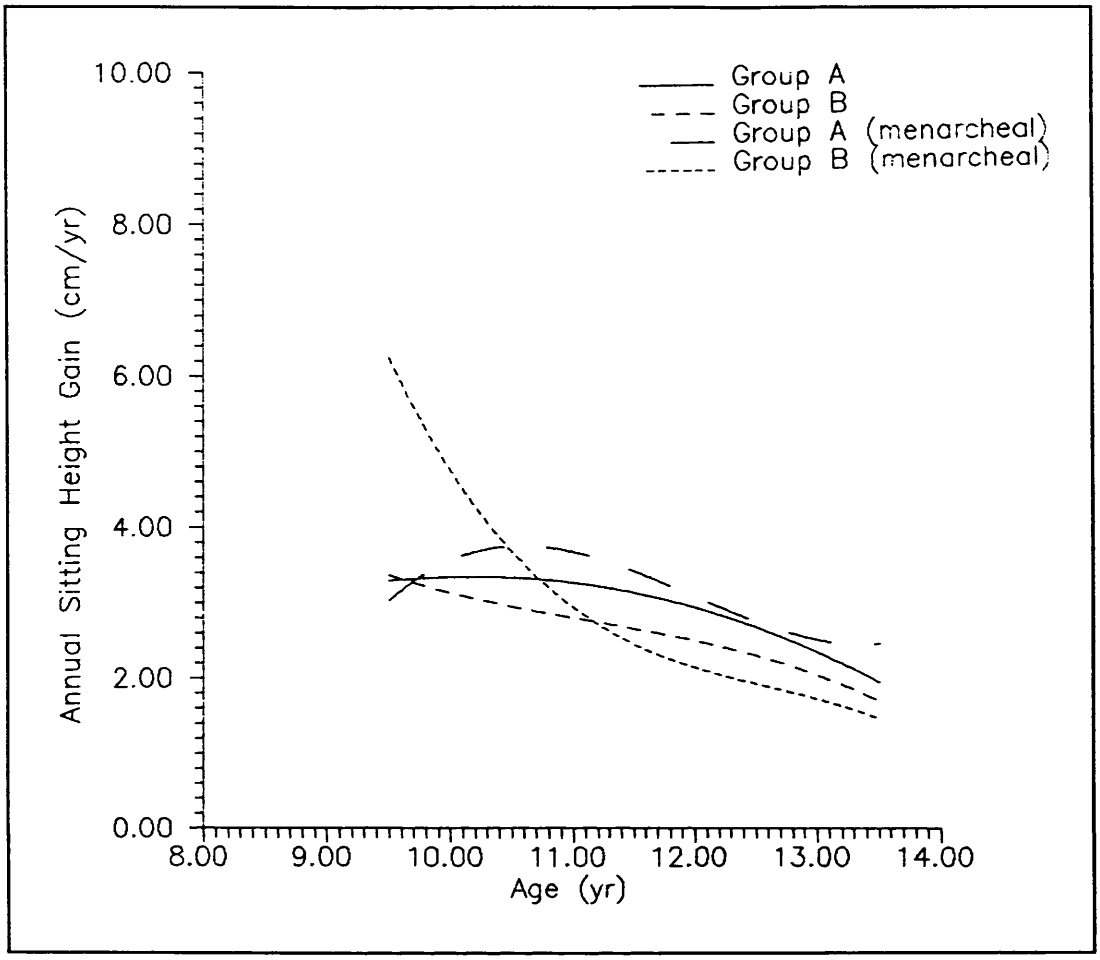


Figure 7.2.2 Annual sitting height gain of Alagoan girls with menarche according to social status and age range

7.1.3 The Sitting/Standing Height Ratio And Leg Length

Additional information about the annual gain in different parts of the body, trunk and legs, is provided by observation of the ratio between sitting and standing height.

Table 7.4 Mean and standard deviations for sitting/standing height ratio of Alagoan girls by maturity stage (without and with menarche), age (midpoint of the age-range), and social class (A, B) during the period of Oct 1990 and Sep 1991

			Maturity Stage					
			Without Menarche			With Menarche		
Age (yr)	Social Class	Mth	No.	Mean	SD	No.	Mean	SD
9.5		Oct	15	0.520	0.01	3	0.524	0.02
		Sep	15	0.520	0.01	3	0.525	0.02
10.5		Oct	33	0.524	0.01	3	0.533	0.02
		Sep	33	0.528	0.02	3	0.533	0.01
11.5	A	Oct	33	0.524	0.01	16	0.524	0.01
		Sep	33	0.524	0.01	16	0.526	0.01
12.5		Oct	12	0.517	0.01	14	0.523	0.01
		Sep	12	0.522	0.01	14	0.527	0.01
13.5		Oct	2	0.531	0.00	14	0.533	0.01
		Sep	2	0.525	0.01	14	0.539	0.01
9.5		Oct	20	0.523	0.01	1	0.516	-
		Sep	20	0.525	0.01	1	0.536	-
10.5		Oct	56	0.523	0.01	2	0.518	0.00
		Sep	56	0.524	0.01	2	0.518	0.01
11.5	B	Oct	32	0.522	0.01	15	0.522	0.01
		Sep	32	0.521	0.01	15	0.527	0.02
12.5		Oct	20	0.517	0.01	25	0.526	0.02
		Sep	20	0.519	0.02	25	0.528	0.02
13.5		Oct	10	0.524	0.02	25	0.530	0.02
		Sep	10	0.526	0.02	25	0.534	0.01

The yearly evolution of sitting height ratio and leg length was calculated and the results can be observed in Tables 7.4 and 7.5. This information also demonstrates how the pubertal spurt was performing at that time.

As shown in Table 7.4, during the study year some girls who had not achieved menarche had smaller trunks, regardless of the social class compared to those post-menarcheal (the results of group A age 9.5 and 10.5 were exceptions, but it must be noticed that the results were based in a small number of individuals). However, there was not a consistent trend in differences in body proportion between social groups. It is possible that being an early maturer, late maturer or growth retarded made a contribution to this variation. No further investigation of this was made.

On the other hand, the contribution to annual standing height gain by trunk and leg length was calculated, and the result can be observed in Table 7.5 and Figure 7.3.

Table 7.5 Contribution to standing height gain by trunk and leg length in Alagoan girls without menarche by social class and age range

	Group A			Group B		
Age	No.	Trunk %	Leg %	No.	Trunk %	Leg %
9.5	15	54.2	45.8	20	56.9	43.1
10.5	33	61.2	38.8	56	54.7	45.3
11.5	33	52.2	47.8	32	49.1	50.9
12.5	12	61.4	38.6	20	56.2	43.8
13.5	2	37.3	61.7	10	60.5	39.5

From this table it is clear that, at this maturity stage, there was a tendency in both social groups for increasing trunk rather than leg length. In some cases, the results suggest that a spurt in leg was still occurring, such as in those aged 13.5 of high income and aged 11.5 of the low income group for instance. In others, there was a spurt in trunk length.

However, as previously mentioned, the result of the high income group at age 13.5 was derived from only two girls.

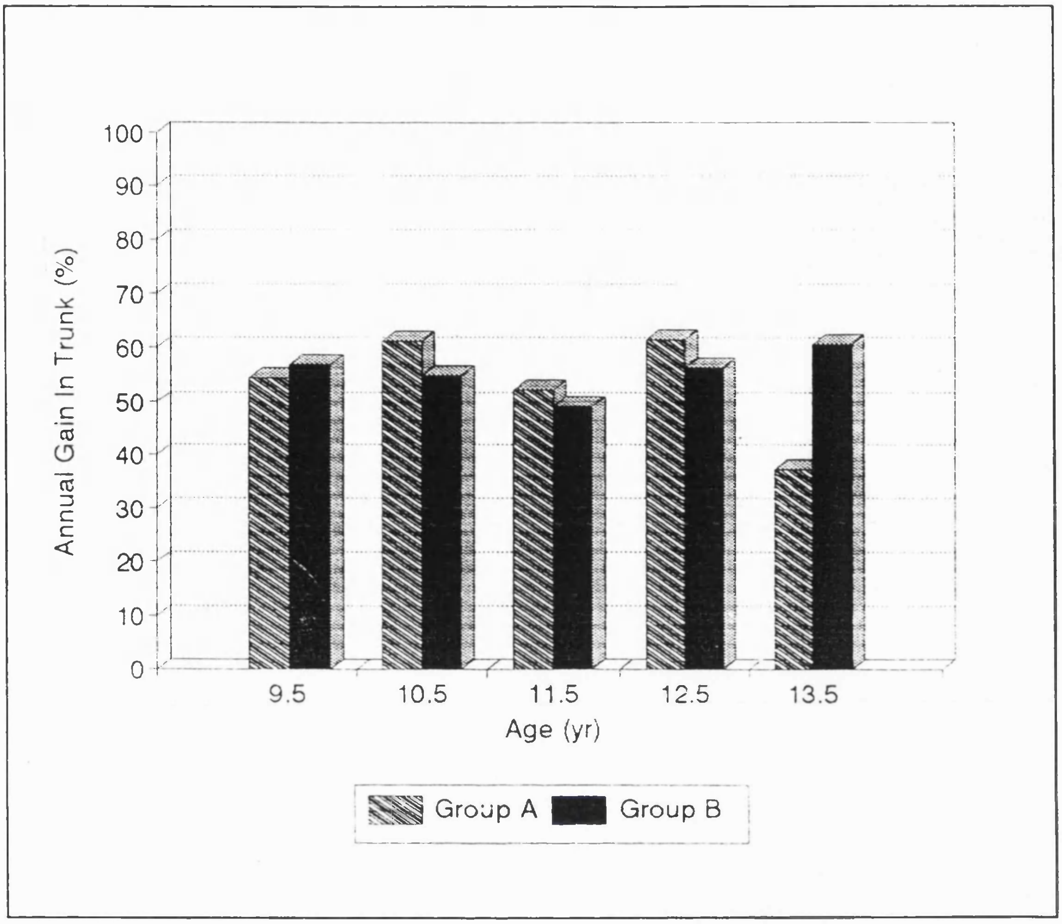


Figure 7.3 Proportional distribution of annual standing height gain throughout the trunk and the legs of girls without menarche by social class and age range

From Table 7.4 it can be seen that girls aged more than 11 years, who had experienced menarche already also had bigger trunk length regardless the social class. It is important to note that the results of ages 9 and 10 were not considered, because they were derived from a small number of individuals.

In addition, there was a clear increase in the annual sitting/standing height ratio in both social groups when the girls were aged between 11 and 13 years. This indicates that the girls were experiencing a spurt in the trunk.

The calculation of the proportional distribution of annual standing height through trunk and leg length supports this assumption and can be seen in Table 7.6 and Figure 7.4.

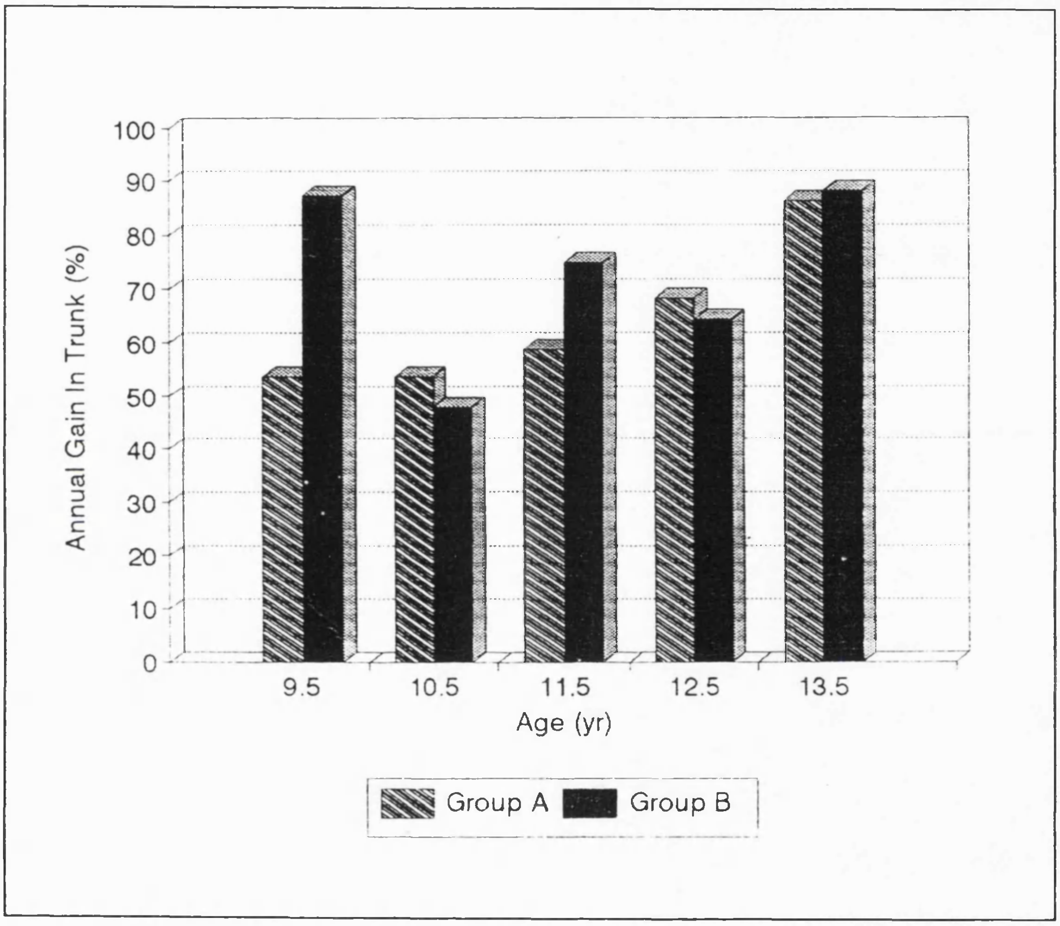


Figure 7.4 Proportional distribution of annual standing height gain throughout the trunk and the legs of girls who had attained menarche by social class and age range

It is clear from the figure that the biggest amount of annual gain in standing height was deposited in the trunk whatever the social status. The biggest gain in trunk was found in girls who had initiated the periods at age 13 regardless of social class.

Table 7.6 Contribution to standing height gain by trunk and leg length in Alagoan girls with menarche by social class and age

	Group A			Group B		
Age	No.	Trunk %	Leg %	No.	Trunk %	Leg %
9.5	3	53.6	46.4	1	87.3	12.7
10.5	3	53.6	46.4	2	47.9	52.1
11.5	16	58.6	41.4	15	75.0	25.0
12.5	14	68.3	31.7	25	64.3	35.7
13.5	14	86.2	13.8	25	88.2	11.8

7.2 Weight Results

Based on the results contained in Table 7.7. Figures 7.5.1 and 7.5.2 illustrate the result for the annual gain in weight for Alagoan girls according to their social class and menarcheal status.

Table 7.7 Mean and standard deviation for annual weight gain (kg/yr) of Alagoan girls by maturity stage (without and with menarche), age (midpoint of the age-range), and social class (A, B)

		Maturity Stage					
		Without Menarche*			With Menarche**		
Age (yr)	Social Class	No.	Mean	SD	No.	Mean	SD
9.5		15	3.8	2.4	3	7.0	1.8
10.5		33	5.4	2.3	3	7.5	2.5
11.5	A	33	4.0	4.5	16	5.7	2.7
12.5		12	6.1	2.2	14	4.6	1.9
13.5		2	4.5	3.2	14	2.8	1.9
9.5		20	4.2	2.6	1	4.4	-
10.5		56	3.5	1.6	2	3.6	1.1
11.5	B	32	4.1	1.8	15	5.2	3.1
12.5		20	4.5	1.9	25	4.0	2.0
13.5		10	5.0	1.6	25	3.2	2.4

* T-test without menarche $t = 3.19$ $df = 228$ $p = 0.002$

** T-test with menarche $t = 1.48$ $df = 112$ $p = 0.14$

Figure 7.5.1 displays the result for the girls without menarche.

The annual gain in weight is represented by the vertical axis of the graph, while horizontal axis shows the age-ranges: 9.5, 10.5, 11.5, 12.5, 13.5. Before achieving menarche, the annual gain in weight was heterogeneous between social classes; the low income family girls in general gained less weight. T-test of all ages combined confirmed the between group differences (p=0.002).

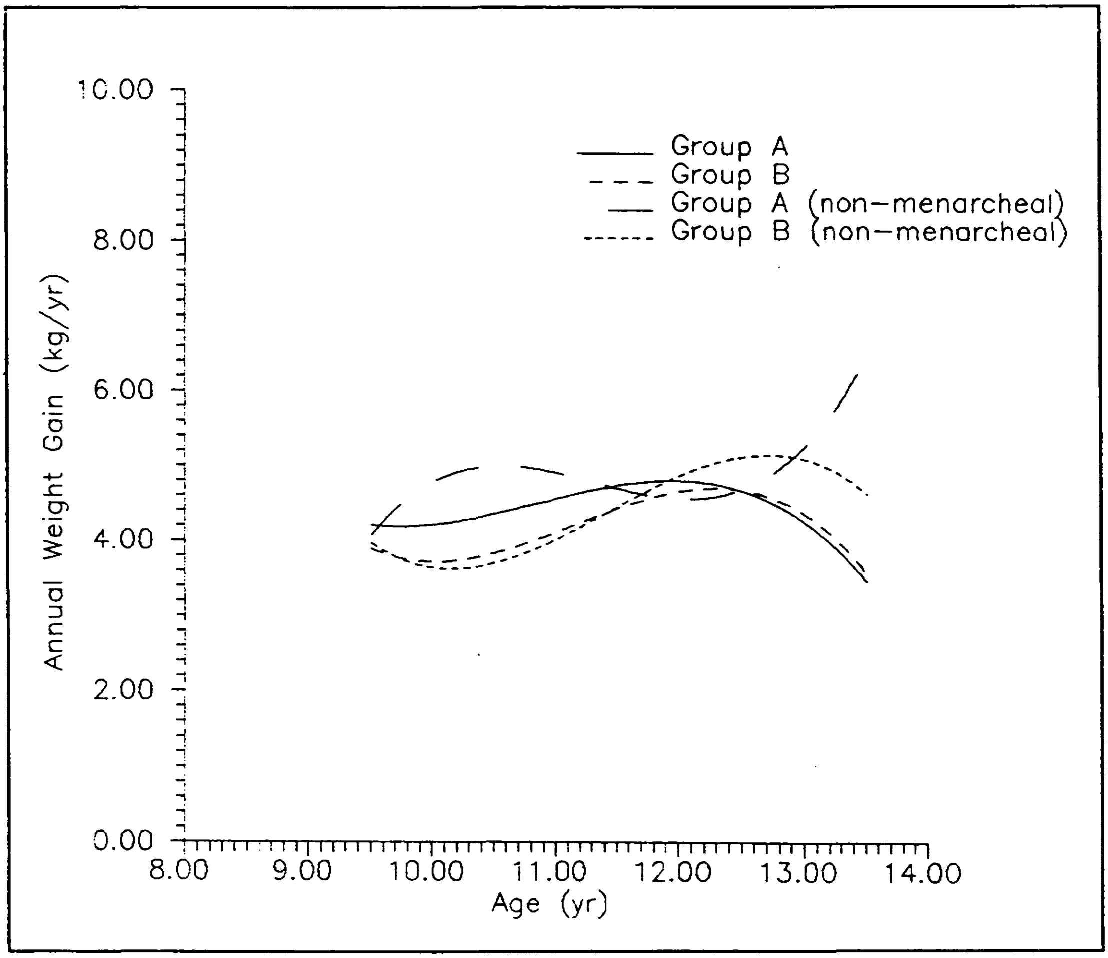


Figure 7.5.1 Annual weight gain of Alagoan girls without menarche according to social class and age range

On the other hand, as can be seen in Figure 7.5.2, there was no significant difference between social classes in yearly weight gain for those girls with menarche (p=0.14). But the lowest values for this gain were found in the low income group girls.

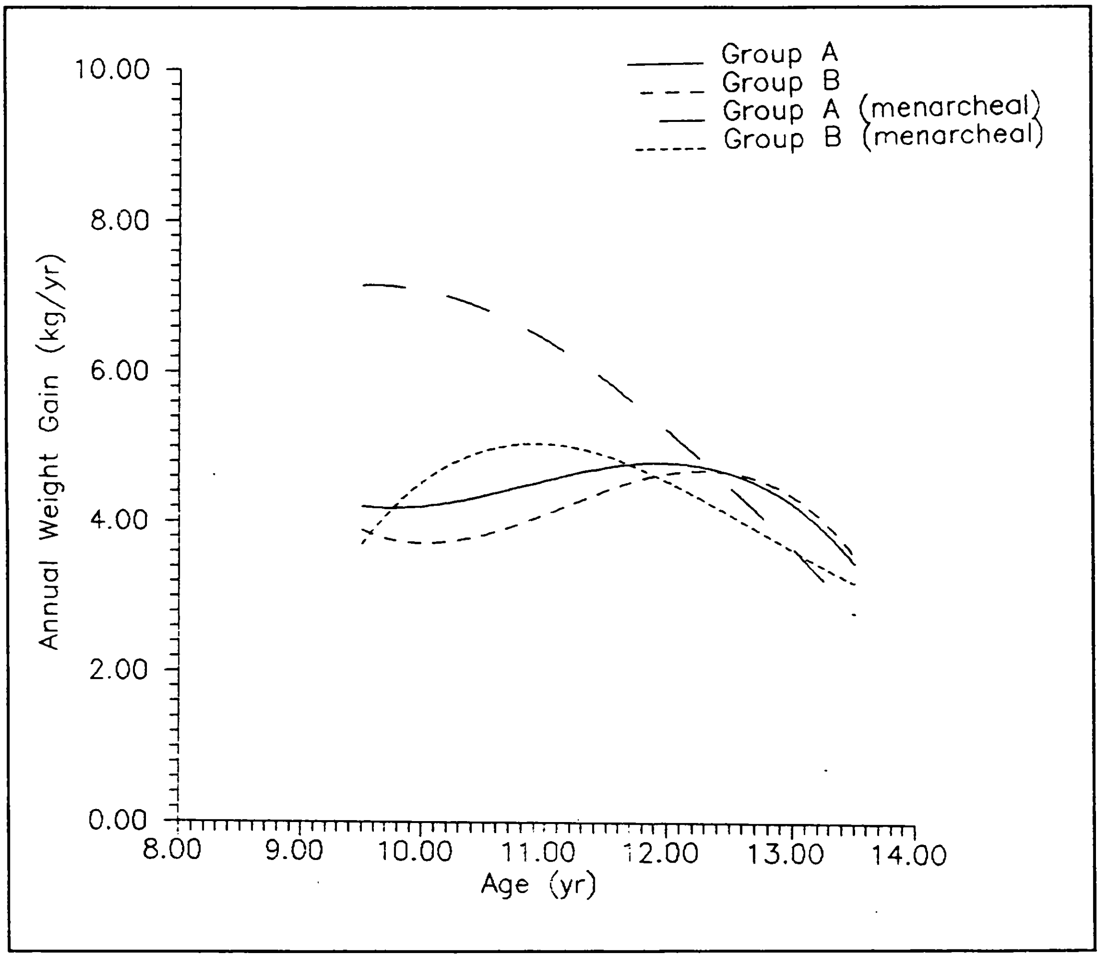


Figure 7.5.2 Annual weight gain of Alagoan girls with menarche by social class and age range

By multiple linear regression, it was possible to observe the contribution of socio-economic and anthropometric variables over the variation of yearly weight gain. Table 7.8 displays the results. Annual gain in standing height and age correlated positively with annual weight gain, while number of siblings correlated negatively, meaning that those who were adding more in standing height, were oldest and had fewer siblings, had a higher annual weight gain.

Table 7.8 Variables which contributed to variation in annual weight gain of Alagoan school girls

Dependent variable	Explanatory variable	Regression coefficient	SE B	R Square	P value
weight (gain)	height (gain)	1.27	0.17	0.234	0.001
	age	0.11	0.03	0.108	0.001
	siblings	-0.50	0.24	0.030	0.04

The major contributor to the variation of yearly weight gain was the annual gain in standing height (23.4 %). Besides yearly standing height gain, another contributor was the age. This variable correlated positively with the annual weight gain, meaning that the yearly gain in weight was higher in the oldest group of girls. Age explained 10.8 % of the variation of annual weight gain, while number of siblings explained 3.0 %.

7.2.1 Seasonal Effects

Repeated measures analysis of weight velocity of the girls from the group with menarche, indicated a significant seasonal variation for the within subject effect (F= 4.59 p=0.03). This was probably due the contrasting average weight velocities of the groups (Table 7.8.1). While the girls from the high income families increased their weight velocity during the rainy season. the girls from the low income group slightly decreased in weight velocity.

Table 7.8.1 Seasonal effects on weight velocity (Kg/mth) by social class and maturity stage

Season	Social class	Maturity Stage: Without Menarche* No.	Mean	SD	With Menarche** No.	Mean	SD
Dry (Oct - Mar)	A	95	1.7	2.5	50	2.0	1.5
	B	139	1.8	1.4	68	2.1	1.9
Rain (Mar - Sep)	A	95	3.0	1.8	50	2.8	1.9
	B	139	2.4	3.3	68	1.9	1.9

* (one-way analysis of variance)
dry F=0.06 p=0.8
rain F=2.6 p=0.1

** (one-way analysis of variance)
dry F=0.1 p=0.7
rain F=6.9 p=0.01

7.3 Fat Reserve Results

In order to understand the contribution of the weight gain to fat reserves deposition, particular attention was paid to the question of fat increments during the study year. The fat reserves can be assessed by evaluating the increment at specific sites (triceps, biceps, suprailiac and subscapular), and by the sum of all skinfolds. The collected data were analysed by considering the whole period of the study (one year), and the monthly changes. However, given the higher skinfold thicknesse variability existing within and between subjects, the results may be inaccurate and, therefore, it should be interpreted with caution.

7.3.1 Yearly Gain At Specific Sites

This section examines the annual gain at specific sites.

7.3.1.1 Triceps

Figure 7.6 shows the annual gain at the triceps site.

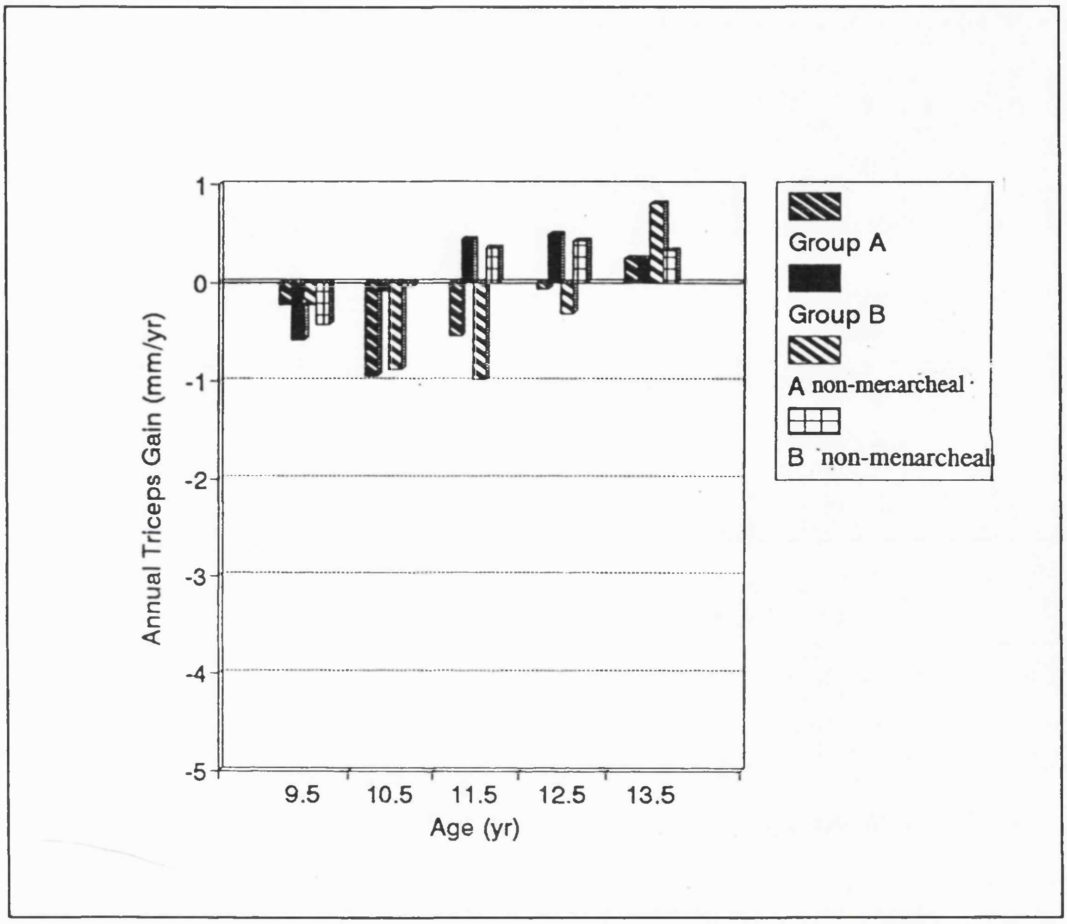


Figure 7.6 Annual gain at triceps skinfolds of Alagoan girls without menarche according to social status and age-ranges

The vertical axis displays the values for annual gain of Alagoan girls of different socio-economic status but with the same menarcheal condition, i.e., without menarche. Group A and Group B represent the social groups independent of occurrence of menarche. The horizontal axis displays the different age-ranges. During the study year, the girls from the low income group had higher increases in triceps than their peers. These increases were significant by T-test considering all ages ($p = 0.03$).

From the graph it can be seen that, in general, the girls without menarche from high income group had small overall increase in triceps skinfolds, and this can be observed after the loss at the ages 9, 10, 11 and 12. Gain was detected at the age 13.

The triceps gain characteristic in the low income group suggests that the late maturer girls, or those growth retarded, showed a greater tendency to accumulate fat at the triceps site than those at younger ages. The numerical details are contained in Table 7.9. In addition, at this maturity stage, no marked change was observed in the triceps/sum four skinfolds ratio during the study year, whatever the social class. This finding is based on the results shown in Table 7.10.1.

The group with menarche presented a different pattern in terms of the annual gain at the triceps site, as can be seen in Table 7.9 and Figure 7.7.

Table 7.9 Mean and standard deviation for yearly gain at specific sites, triceps and biceps (mm/yr) of Alagoan girls according to maturity stage (without and with menarche), age (midpoint of the age-range), and social class (A, B)

Age (yr)	Social Class	Without Menarche* No.	Without Menarche* Mean	Without Menarche* SD	With Menarche** No.	With Menarche** Mean	With Menarche** SD
				TRICEPS			
9.5		15	-0.2	2.6	3	-0.2	2.1
10.5		33	-0.9	2.8	3	-1.5	2.9
11.5	A	33	-1.0	2.6	16	0.4	1.5
12.5		12	-0.3	3.2	14	0.1	2.2
13.5		2	0.8	2.1	14	-0.5	1.8
9.5		20	-0.4	3.2	1	-3.6	-
10.5		56	-0.1	2.1	2	-1.8	1.7
11.5	B	32	0.3	3.7	15	0.6	2.7
12.5		20	0.4	1.4	25	0.5	1.8
13.5		10	0.3	1.8	25	0.2	2.4
				BICEPS			
9.5		15	-0.2	1.3	3	-1.1	0.9
10.5		33	-0.8	2.5	3	-1.5	2.9
11.5	A	33	-0.9	1.6	16	-0.6	2.2
12.5		12	-0.2	1.4	14	0.7	2.9
13.5		2	-0.3	0.8	14	-0.5	1.3
9.5		20	-0.1	2.0	1	-4.7	-
10.5		56	-0.6	1.7	2	0.1	0.5
11.5	B	32	0.1	3.1	15	-0.1	1.7
12.5		20	-0.9	2.3	25	-0.01	2.3
13.5		10	-0.8	2.7	25	0.01	1.4

* T-test all ages combined triceps t = -2.24 df = 232 p = 0.03
biceps t = -0.74 df = 232 p = 0.5
** T-test all ages combined triceps t = -1.03 df = 116 p = 0.3
biceps t = -0.52 df = 116 p = 0.6

T-test confirmed the similarity between groups (p = 0.3). In both social groups, there was a slight tendency to increase fat deposition at the triceps site especially in the low income group. This can be evidenced by gain at this site at ages 11, 12 and

13 in the low income group. As previously said, the results of ages 9 and 10 are based in a small sample and must not be considered. This trend caused a change in the ratio of triceps skinfolds to sum of 4 skinfolds. This means that, at this maturity stage, the yearly gain of sum of 4 skinfolds did not receive an important contribution from the triceps site. The numerical details for triceps/sum of 4 skinfolds ratios are contained in Table 7.10.2.

Table 7.10.1 Mean and standard deviation for specific sites (triceps, biceps)/sum of 4 skinfolds ratios of Alagoan girls without menarche by age (midpoint of the age-range), and social class (A, B)

Age (yr)	Social Class	Mth	No.	Triceps Mean	Triceps SD	Biceps Mean	Biceps SD
9.5		Oct	15	0.279	0.05	0.186	0.02
		Sep	15	0.279	0.04	0.184	0.02
10.5		Oct	33	0.286	0.04	0.192	0.04
		Sep	33	0.288	0.04	0.190	0.03
11.5	A	Oct	33	0.274	0.04	0.188	0.04
		Sep	33	0.274	0.03	0.179	0.03
12.5		Oct	12	0.304	0.03	0.186	0.03
		Sep	12	0.292	0.03	0.172	0.02
13.5		Oct	2	0.298	0.05	0.198	0.03
		Sep	2	0.325	0.02	0.195	0.03
9.5		Oct	20	0.294	0.04	0.201	0.04
		Sep	20	0.281	0.04	0.196	0.02
10.5		Oct	56	0.289	0.04	0.197	0.03
		Sep	56	0.291	0.04	0.185	0.03
11.5	B	Oct	33	0.296	0.03	0.193	0.03
		Sep	33	0.288	0.03	0.177	0.02
12.5		Oct	20	0.274	0.03	0.194	0.05
		Sep	20	0.283	0.04	0.167	0.02
13.5		Oct	10	0.296	0.04	0.194	0.05
		Sep	10	0.286	0.03	0.162	0.02

Table 7.10.2 Mean and standard deviation for specific sites (triceps and biceps) / sum of 4 skinfolds ratios of Alagoan girls with menarche by age range and social class (A,B)

Age (yr)	Social class	Mth	No.	Triceps Mean	Triceps SD	Biceps Mean	Biceps SD
9.5		Oct	3	0.266	0.01	0.166	0.03
		Sep	3	0.259	0.03	0.144	0.04
10.5		Oct	3	0.245	0.04	0.167	0.02
		Sep	3	0.237	0.03	0.154	0.02
11.5		Oct	16	0.271	0.04	0.186	0.03
		Sep	16	0.269	0.03	0.174	0.02
12.5		Oct	14	0.281	0.03	0.175	0.03
		Sep	14	0.274	0.03	0.174	0.02
13.5		Oct	14	0.301	0.05	0.178	0.03
		Sep	14	0.282	0.03	0.167	0.03
9.5		Oct	1	0.251	-	0.229	-
		Sep	1	0.242	-	0.178	-
10.5		Oct	2	0.303	0.03	0.183	0.03
		Sep	2	0.299	0.03	0.207	0.01
11.5		Oct	15	0.276	0.04	0.169	0.04
		Sep	15	0.270	0.04	0.154	0.03
12.5		Oct	25	0.280	0.04	0.166	0.03
		Sep	25	0.270	0.04	0.150	0.02
13.5		Oct	25	0.286	0.03	0.181	0.04
		Sep	25	0.272	0.04	0.165	0.03

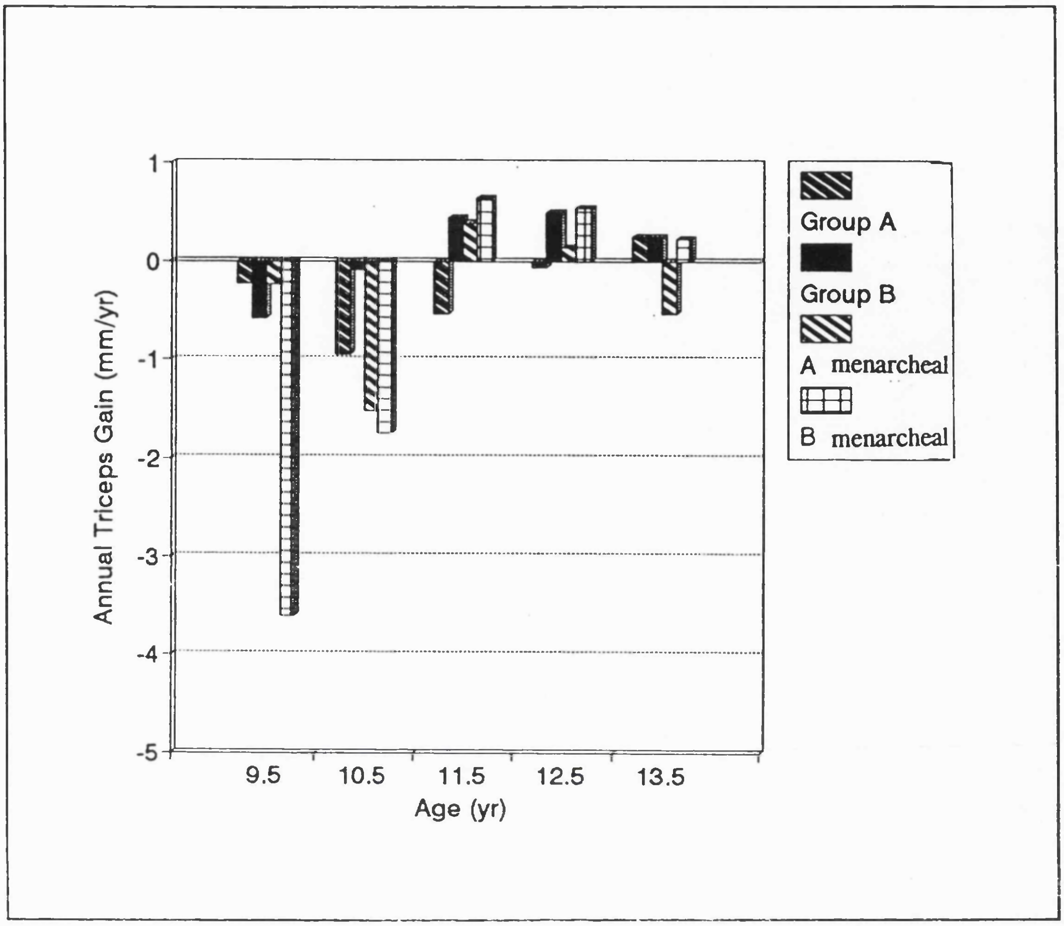


Figure 7.7 Annual gain at the triceps site of Alagoan school girls who had attained menarche by social class and age range

7.3.1.2 Biceps

There was a tendency for the girls during adolescence to lose fat at the biceps skinfolds site, regardless of social status and menarcheal condition.

Figures 7.8 and 7.9 and Table 7.9 show evidence of this trend.

Figure 7.8 illustrates the annual biceps skinfolds gain of the non-menarcheal groups. The vertical axis displays the values of the annual gain for girls from different socioeconomic status, while the horizontal presents the different age-ranges.

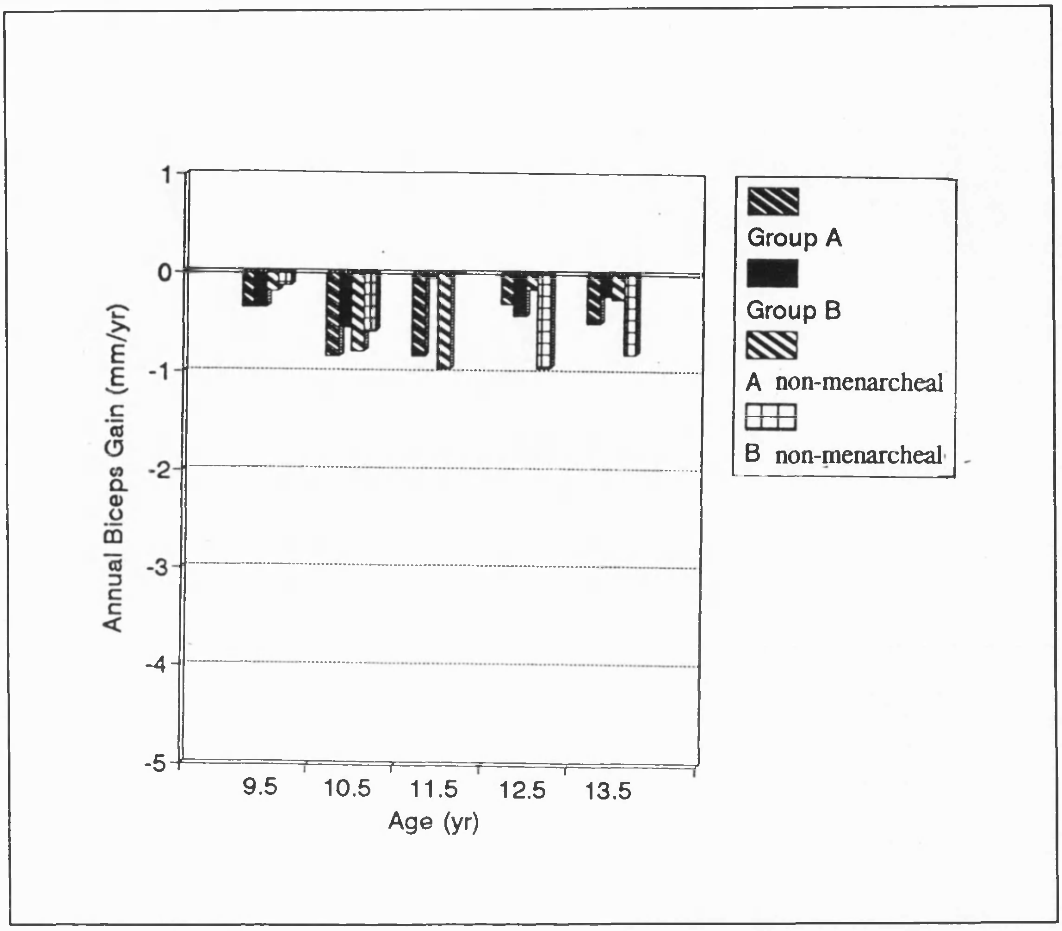


Figure 7.8 Yearly gain at biceps skinfolds site of Alagoan girls without menarche at different age-ranges by social class

The girls were homogeneous in relation to the annual gain at the biceps site, regardless of social class. T-test confirmed the similarity (p=0.5).

As can be seen from the graph, a loss was detected in all the age ranges in both social groups.

Table 7.10.1 shows the changes in biceps ratio throughout the year. This performance is consistent with the findings of the annual gain.

Figure 7.9 displays the results of the group with menarche. The vertical axis represents the values for the annual biceps skinfolds gain of girls from different social classes. The horizontal axis shows the different age-ranges.

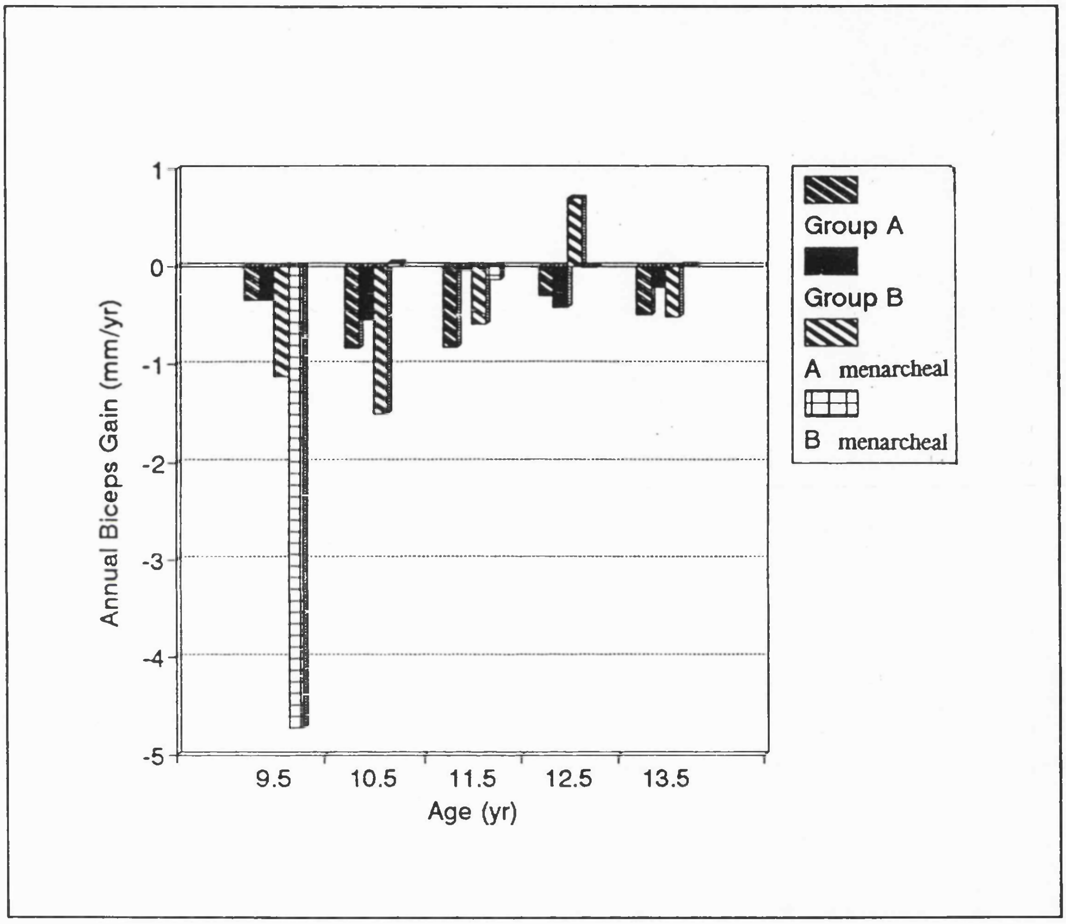


Figure 7.9 Annual gain at biceps site of Alagoan girls who attained menarche by social class and age range

Again, a loss was observed in all age groups in both social classes with the exception of the 12 years old group from the high income. (some attention has to paid for the results of the groups where few subjects were located).

As confirmed by T-test (p = 0.6) and shown by Table 7.10.2, after attaining menarche, there was a decrease in the biceps skinfolds ratio at all age-ranges and in both social groups.

7.3.1.3 Subscapular

The yearly gain at the subscapular skinfolds site presented the same trend in both social groups at all age-ranges regardless of the maturity stage.

Based on details of Table 7.11, Figure 7.10 demonstrates this characteristic in the non-menarcheal group, by showing in the vertical axis the annual values for subscapular site gain for both social classes with the same menarcheal condition. The different age-ranges can be observed in the horizontal axis.

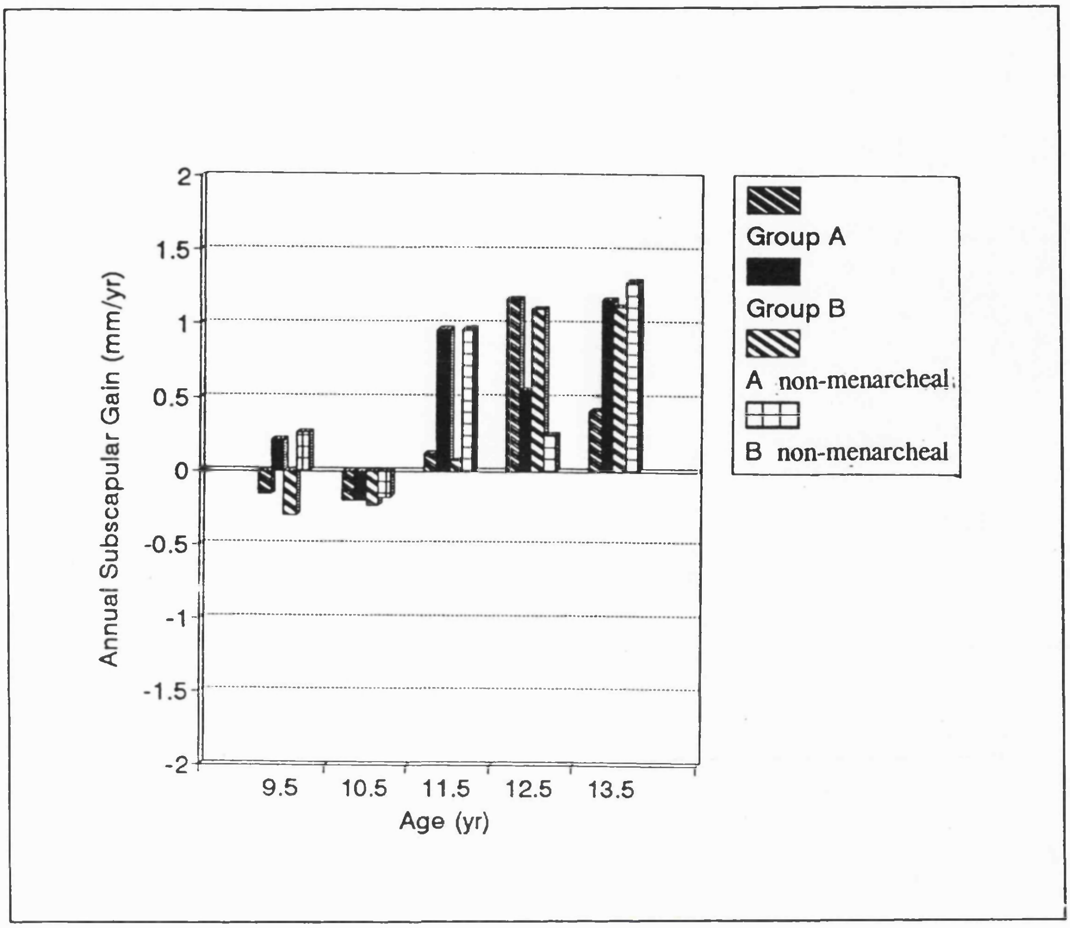


Figure 7.10 Annual gain at the subscapular site of Alagoan girls without menarche by social class and age range

Compared by the T-test, there was no significant difference in terms of annual gain at this specific site amongst the girls of different social status ($p = 0.5$). However, girls from low income deposited more fat at the subscapular skinfolds site when compared to their counterparts.

Table 7.11 Mean and standard deviation for yearly gain at subscapular and suprailiac sites (mm/yr) of Alagoan girls by maturity stage (without and with menarche), age, and social class (A, B)

		Maturity Stage					
		Without Menarche*			With Menarche**		
Age (yr)	Social Class	No.	Mean	SD	No.	Mean	SD
		SUBSCAPULAR					
9.5		15	-0.3	2.9	3	0.5	2.5
10.5		33	-0.2	2.1	3	0.3	2.7
11.5	A	33	0.1	2.4	16	0.2	2.6
12.5		12	1.1	2.5	14	1.2	1.8
13.5		2	1.1	2.3	14	0.3	1.9
9.5		20	0.2	2.3	1	-0.1	-
10.5		56	-0.2	2.6	2	-1.0	0.8
11.5	B	32	0.9	4.6	15	1.0	3.5
12.5		20	0.3	1.5	25	0.8	2.1
13.5		10	1.3	1.3	25	1.1	2.1
		SUPRAILIAC					
9.5		15	0.2	4.8	3	2.9	4.4
10.5		33	-1.7	4.4	3	-4.0	11.7
11.5	A	33	-1.9	4.2	16	0.7	3.5
12.5		12	1.0	2.3	14	0.1	2.7
13.5		2	-2.6	1.6	14	1.9	5.5
9.5		20	-0.1	3.7	1	-4.7	-
10.5		56	-0.2	3.5	2	-2.4	4.3
11.5	B	32	1.5	5.3	15	1.3	6.1
12.5		20	0.8	3.7	25	2.3	3.3
13.5		10	1.6	5.6	25	2.3	3.9

* T-test all ages combined subscapular $t = -0.73$ $df = 226$ $p = 0.5$
suprailiac $t = -2.93$ $df = 232$ $p = 0.004$
** T-test all ages combined subscapular $t = -0.79$ $df = 116$ $p = 0.4$
suprailiac $t = -1.36$ $df = 116$ $p = 0.2$

An upward trend was evidenced in relation to the performance of the annual subscapular/sum of 4 skinfolds ratio in both social groups at all age-ranges. Details are given in Table 7.10.3. During the year of the study the girls without menarche showed a tendency to deposit more fat at the subscapular site than those of a more advanced sexual maturity.

Table 7.10.3 Mean and standard deviation for subscapular and suprailiac / sum of 4 skinfolds ratios of Alagoan girls without menarche by age range according to the social class (A, B)

Age (yr)	Social Class	Mth	No.	Subscapular Mean	Subscapular SD	Suprailiac Mean	Suprailiac SD
9.5		Oct	15	0.257	0.04	0.278	0.07
		Sep	15	0.259	0.03	0.278	0.05
10.5		Oct	33	0.232	0.03	0.289	0.05
		Sep	33	0.244	0.04	0.279	0.05
11.5	A	Oct	33	0.239	0.04	0.299	0.06
		Sep	33	0.259	0.04	0.288	0.03
12.5		Oct	12	0.244	0.03	0.266	0.03
		Sep	12	0.257	0.02	0.279	0.03
13.5		Oct	2	0.212	0.00	0.292	0.07
		Sep	2	0.244	0.04	0.236	0.05
9.5		Oct	20	0.234	0.04	0.270	0.05
		Sep	20	0.243	0.04	0.280	0.04
10.5		Oct	56	0.262	0.04	0.253	0.05
		Sep	56	0.266	0.03	0.258	0.05
11.5	B	Oct	33	0.259	0.03	0.253	0.05
		Sep	33	0.261	0.03	0.274	0.04
12.5		Oct	20	0.265	0.05	0.266	0.07
		Sep	20	0.272	0.03	0.278	0.06
13.5		Oct	10	0.263	0.03	0.247	0.05
		Sep	10	0.277	0.02	0.275	0.04

Table 7.10.4 Mean and standard deviation for subscapular and suprailiac / sum of 4 skinfolds ratios of Alagoan girls with menarche by age range according to the social class (A,B)

Age (yr)	Social Class	Mth	N	Subscapular Mean	Subscapular SD	Suprailiac Mean	Suprailiac SD
9.5		Oct	3	0.285	0.04	0.283	0.04
		Sep	3	0.288	0.02	0.308	0.02
10.5		Oct	3	0.253	0.03	0.336	0.04
		Sep	3	0.280	0.08	0.330	0.09
11.5	A	Oct	16	0.257	0.03	0.286	0.05
		Sep	16	0.254	0.04	0.303	0.05
12.5		Oct	14	0.243	0.03	0.300	0.06
		Sep	14	0.255	0.03	0.296	0.04
13.5		Oct	14	0.224	0.02	0.296	0.06
		Sep	14	0.226	0.03	0.324	0.04
9.5		Oct	1	0.212	-	0.309	-
		Sep	1	0.290	-	0.289	-
10.5		Oct	2	0.222	0.01	0.292	0.02
		Sep	2	0.225	0.01	0.269	0.05
11.5	B	Oct	15	0.267	0.03	0.288	0.06
		Sep	15	0.267	0.04	0.309	0.03
12.5		Oct	25	0.276	0.02	0.278	0.05
		Sep	25	0.274	0.04	0.306	0.05
13.5		Oct	25	0.258	0.03	0.276	0.05
		Sep	25	0.260	0.03	0.303	0.05

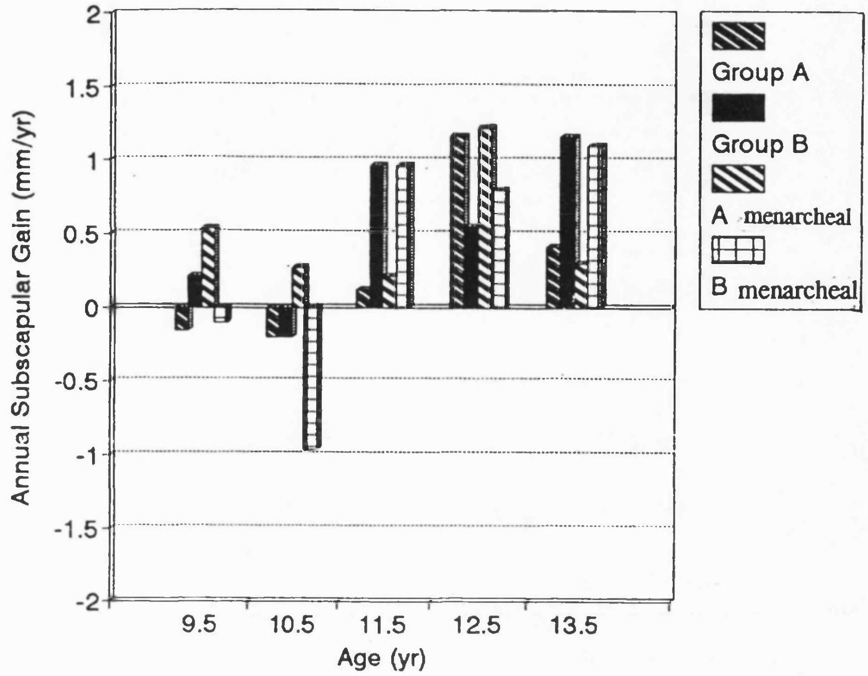


Figure 7.11 Yearly gain at the subscapular site of Alagoan girls with menarche by social class and age ranges

The annual gain at the subscapular skinfolds site for the girls group with menarche can be observed in Figure 7.11. The vertical axis shows the values for annual gain in the different social classes. The horizontal axis displays the age-ranges: 9.5, 10.5, 11.5, 12.5 and 13.5. As can be seen from the figure, the small number of subjects located at 9 and 10 years old group could be responsible for the contrastive shape of the curve at these positions. From the age 11 on, a similar pattern of gain was observed in both social groups, and the overall comparative analysis confirms such trend ($p = 0.4$).

When looking specifically to the question of how the subscapular ratio had performed throughout the year (see Table 7.10.4), there was found no well- defined trend. The subscapular skinfolds ratio performed differently across the age-ranges in both social classes. It may be that sample size at ages 9 and 10 in both social groups played a role in this inconsistent result. Nevertheless, a different result is still obtained in the other age-groups.

7.3.1.4 Suprailiac

Based on details contained in the Table 7.11, the Figure 7.12 illustrates how annual gain at the suprailiac skinfolds site occurred in Alagoan girls who had not attained menarche.

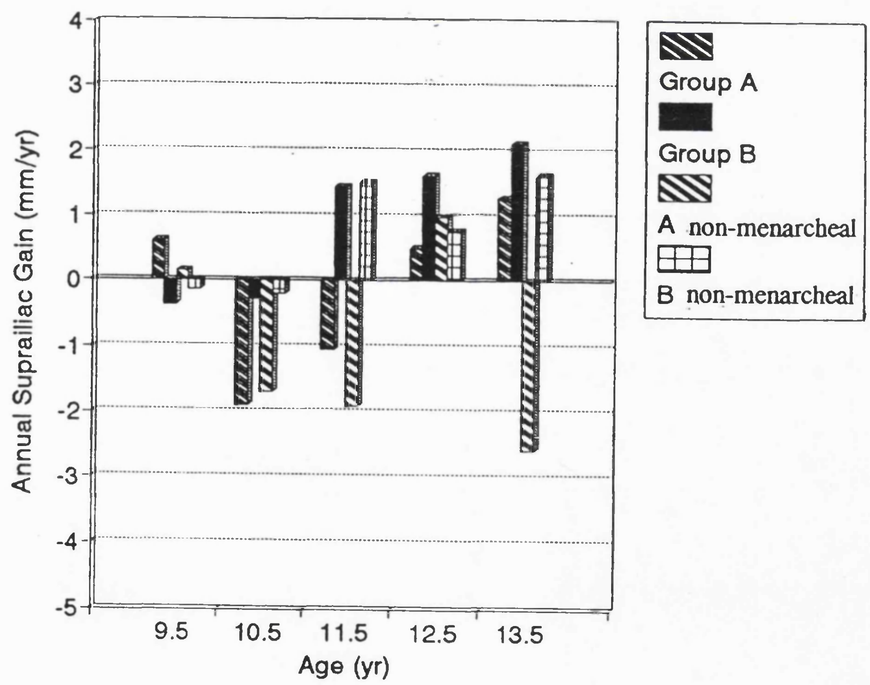


Figure 7.12 Annual gain at suprailiac site of Alagoan girls without menarche according to social class and age

The vertical axis shows the values for the annual gain in both social classes. The horizontal axis presents the different age-ranges. As can be seen from the figure, girls from the low income group deposited significantly more fat at the suprailiac site in comparison to their counterparts. T-test with all ages combined confirmed such finding ($p = 0.004$). This was evidenced by the gain observed at ages 11, 12 and 13 in this group.

In contrast, in comparison to the other social group, girls from the high income group lost more fat at this specific site. Some indication of this is demonstrated by the loss in ages 10, 11 and 13. This pattern of performance was reflected in the changes of the suprailiac/sum of 4 skinfolds ratio (see Table 7.10.3). Only group B (low income) showed a trend characterized by an increase in the ratio at all age-ranges. The results for Group A (high income) were ambiguous and inconclusive.

Figure 7.13 displays the results for the group with menarche. The vertical axis shows the values for annual gain at this specific site in different social classes. The horizontal axis presents the different age-ranges.

Unfortunately, some inconsistent results are given by the data from the initial age-ranges. This was due the small number of subjects at this position of the curve. In general, at this maturity stage the girls were homogeneous in annual gain at the suprailiac site. This conclusion was confirmed by T-test ($p = 0.2$). However, it is interesting to note that the highest increments were observed in the low income group girls, especially at ages 11, 12 and 13.

Possibly this limitation in sample size is reflected also in the result of changes in the annual ratio of suprailiac / sum of 4 skinfolds (see Table 7.10.4). For example, if the result of initial ages (9 and 10) are excluded, an upward trend is observed in the low income group. Nevertheless, the trend is less intense in the high income group.

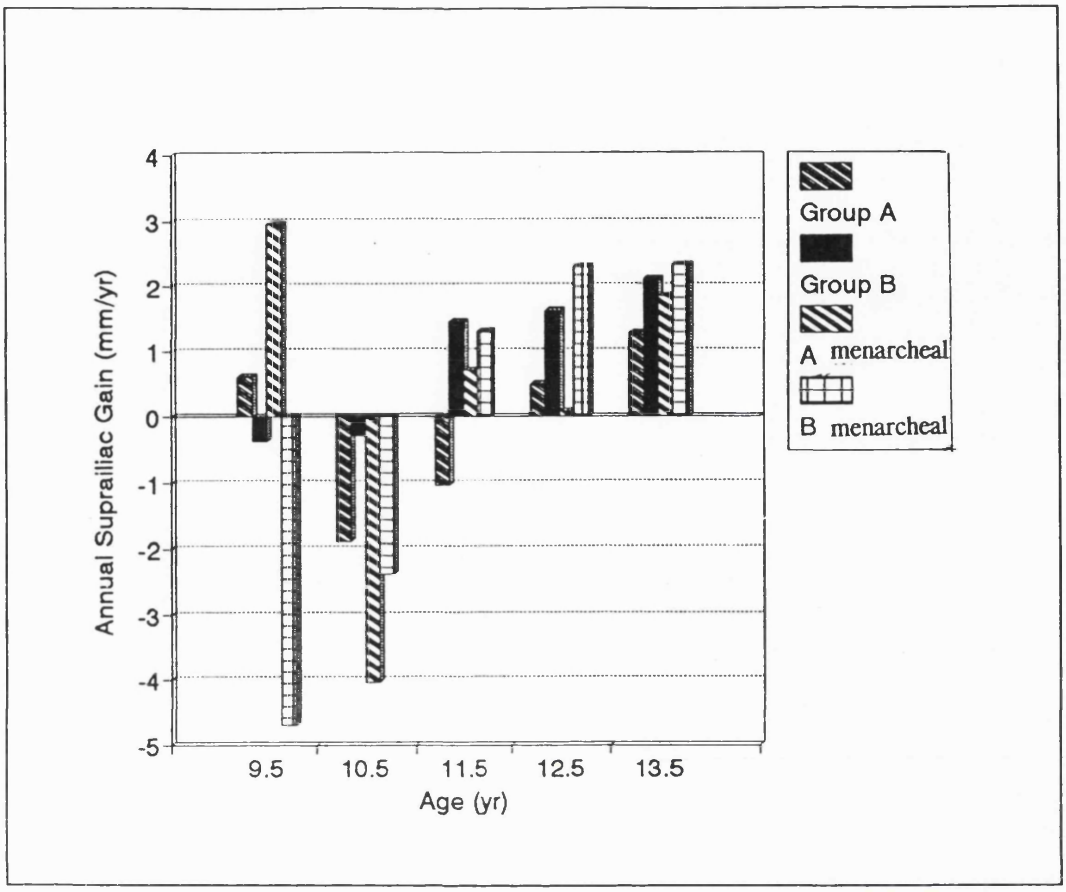


Figure 7.13 Annual gain at suprailiac skinfold site of Alagoan girls with menarche according to social class and age

7.3.2 Annual Gain of Sum of 4 Skinfolds

Table 7.12 and Figures 7.14 and 7.15 show the results for yearly gain in the sum of 4 skinfolds.

The vertical axis of the Figure 7.14 represents the annual gain in sum of 4 skinfolds for girls without menarche from the different social classes. The horizontal axis shows the different age ranges: 9.5, 10.5, 11.5, 12.5 and 13.5.

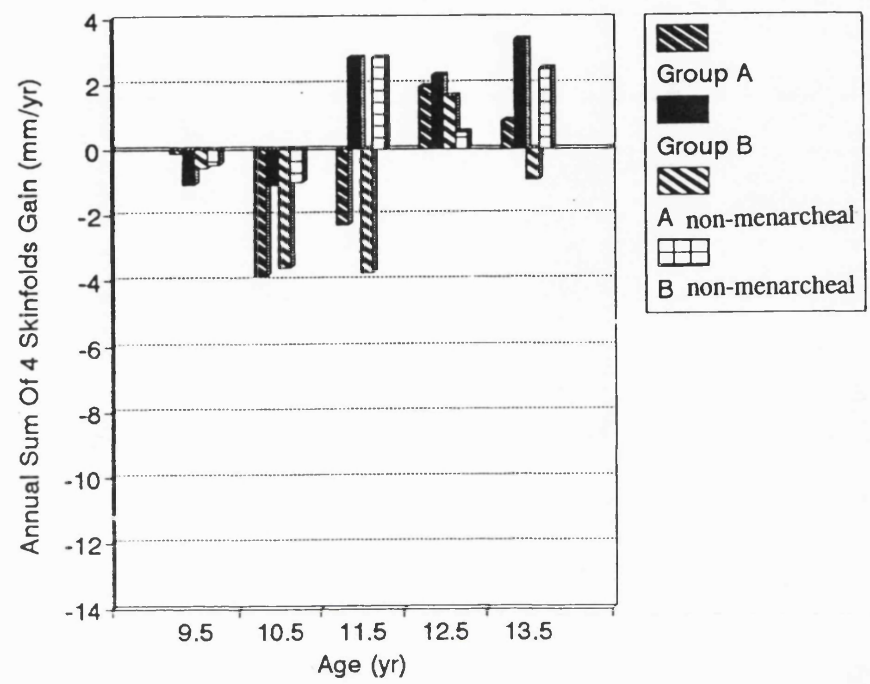


Figure 7.14 Annual sum of 4 skinfolds gain of Alagoan girls without menarche by social class and age range

Girls from the low income families showed the tendency of accumulating more fat than did the girls from high income group ($p = 0.03$). Although on enrolment to the study they displayed the smallest values for fat reserves, it seems that during the year they had a bigger gain in fat in comparison to their counterparts.

By the graph also it can be seen that, at this maturity stage, the girls from the low income increased the fat reserves with the increase of age. However, there was an exception for the age 13 from the high income group, where there was a sharp drop in the curve. It is possible that such inversion was due to the fact that there were few subjects located at this age group, 2 girls.

Table 7.12 Mean and standard deviation for annual sum of 4 skinfolds gain (mm/yr) of Alagoan girls by maturity stage (without and with menarche), age and social class (A, B)

		Maturity Stage					
		Without Menarche*			With Menarche**		
Age (yr)	Social Class	No.	Mean	SD	No.	Mean	SD
9.5		15	-0.6	8.7	3	2.1	7.3
10.5		33	-3.6	9.3	3	-6.8	17.9
11.5	A	33	-3.8	8.7	16	0.7	7.5
12.5		12	1.6	8.2	14	2.1	7.8
13.5		2	-0.9	2.7	14	1.1	7.3
9.5		20	-0.5	9.2	1	-13.2	-
10.5		56	-1.0	7.8	2	-5.1	6.3
11.5	B	32	2.8	15.8	15	2.8	11.6
12.5		20	1.6	8.2	25	3.6	7.2
13.5		10	2.4	8.2	25	3.7	7.6

* T-test all ages combined $t = -2.26$ $df = 232$ $p = 0.03$
** T-test all ages combined $t = -1.33$ $df = 116$ $p = 0.2$

In Figure 7.15, the vertical axis presents the annual gain for the sum of 4 skinfolds and the horizontal axis shows the different age ranges: 9.5, 10.5, 11.5, 12.5 and 13.5.

In general, at this maturity stage, the girls from both social groups showed a tendency to accumulate fat, and in terms of gain there was no significant difference between social groups ($p = 0.2$). However, the low income group girls showed the highest values for gain.

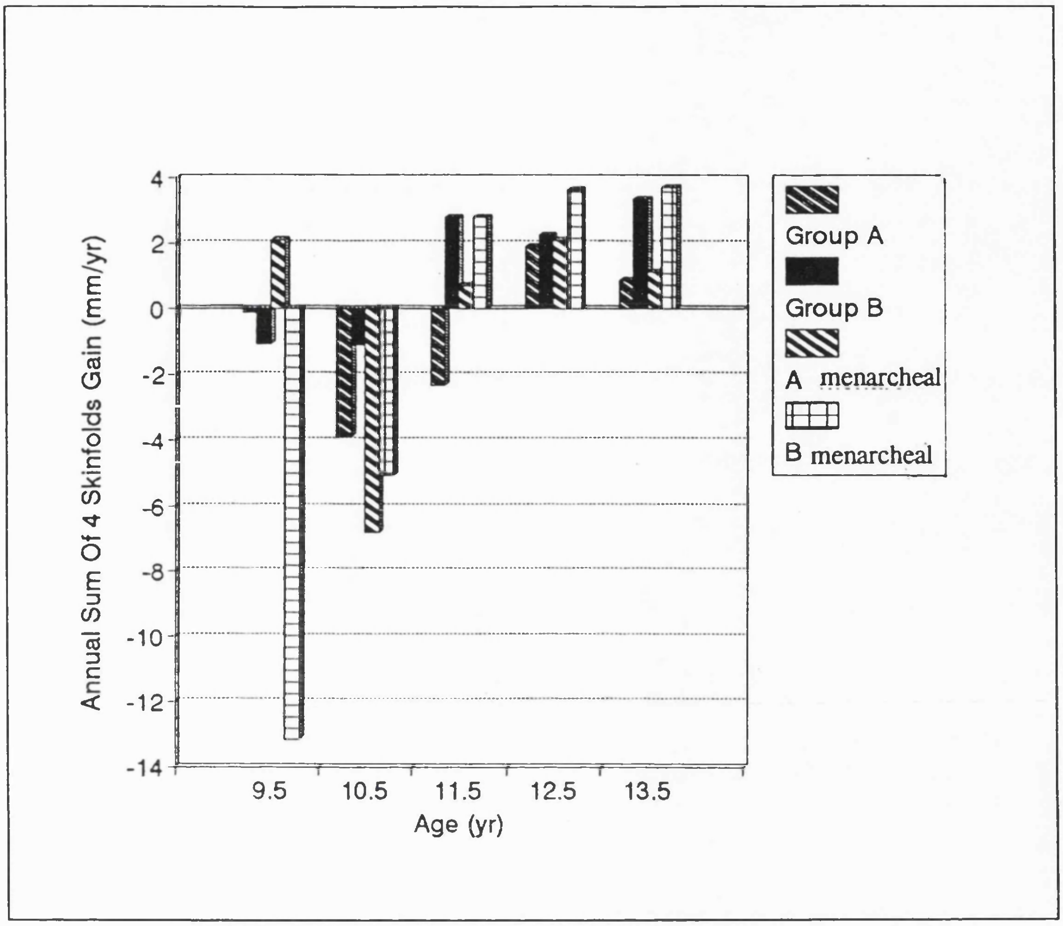


Figure 7.15 Annual gain in sum of 4 skinfolds of Alagoan girls with menarche according to social status and age ranges

7.3.3 Monthly Changes At Specific Sites And Seasonal Aspects

The monthly changes at specific sites are presented in Tables 7.13 to 7.32.
As can be seen from the tables, the small (and perhaps biologically not significant) monthly differences obtained throughout the year, resulted in small values obtained for the yearly increment. However, it must be borne in mind when condidering yearly and monthly gains that the small values of means are a consequence of positive (gain) and negative (loss) increments.

It can be observed that there were fluctuations in the values of fat increments throughout the year across the social groups in the different age ranges. In addition, the large standard deviation values indicate big fluctuations in terms of positive increments (gain) and negative increments (loss) of fat throughout the months, within and between the social groups, expressing a very strong heterogeneity.

Further analysis on the raw data was not carried out because the relations between the standard deviations and respective means were very high, not only for every month but also for all the skinfolds and all the ages.

Nevertheless, the collected data were summarised by the annual increment analysis for the purpose of comparing the social groups in terms of fat gain during the study year. In addition, in trying to seek evidences of seasonal effects, some comments on the frequency distribution of gain and loss is presented in the next section, considering the fat increments at different skinfold sites across the months of the year.

Table 7.13 Mean and standard deviation for monthly increments (mm/month) at triceps skinfold site of girls from social group A without menarche according to the age range

	Age (yr) *									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.2	0.3	0.1	0.3	0.3	1.1	0.0	0.2	0.1	0.2
Nov-Feb	0.6	1.6	-0.1	2.0	-0.9	1.7	-0.4	1.5	1.1	0.1
Feb-Mar	0.2	0.4	0.1	0.9	0.1	0.8	0.2	0.3	0.2	0.1
Mar-Apr	-0.7	1.3	-0.3	1.3	-0.5	1.5	-0.9	1.6	0.4	0.8
Apr-May	-0.2	0.9	-0.4	1.0	-0.3	0.9	-0.1	0.5	0.1	0.1
May-Jun	-0.1	0.6	-0.4	1.4	0.1	0.6	0.0	1.0	0.1	0.1
Jun-Jul	0.1	0.6	-0.1	1.4	0.5	0.8	0.8	1.3	-0.1	0.1
Jul-Aug	0.1	0.9	0.2	0.8	0.1	0.4	0.1	0.2	0.2	0.1
Aug-Sep	-0.4	0.6	0.1	0.9	-0.3	1.1	0.1	1.4	-1.0	1.4

* 9.5 - n=15 10.5 - n=33 11.5 - n=33 12.5 - n=12 13.5 - n=2

Table 7.14 Mean and standard deviation for monthly increments (mm/month) at triceps skinfold site of girls from social group B without menarche according to the age range

	Age (yr) *									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.3	0.2	0.1
Nov-Feb	-1.1	1.8	-0.5	1.5	-0.5	1.7	0.1	1.0	-0.7	1.2
Feb-Mar	0.3	0.2	0.4	1.5	0.4	0.6	0.1	0.4	0.5	0.9
Mar-Apr	0.5	1.7	0.1	1.5	0.4	3.0	-0.2	1.1	0.1	0.9
Apr-May	-0.1	1.5	-0.1	1.6	-0.1	0.8	-0.1	1.0	-0.2	1.0
May-Jun	-0.3	1.0	0.1	0.8	-0.1	0.4	-0.1	0.8	0.1	0.1
Jun-Jul	0.1	1.1	-0.3	0.8	-0.1	0.8	0.1	0.3	-0.2	0.3
Jul-Aug	0.1	0.8	0.2	0.7	0.4	0.9	0.4	0.7	0.3	0.7
Aug-Sep	-0.3	1.3	0.1	0.6	-0.1	0.4	-0.1	0.4	0.3	0.6

* 9.5 - n=20 10.5 - n=56 11.5 - n=33 12.5 - n=20 13.5 - n=10

Table 7.15 Mean and standard deviation for monthly increments (mm/month) at biceps skinfold site of girls from social group A without menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	-0.1	0.2	-0.1	0.2	0.1	0.4	-0.1	0.2	-0.1	0.1
Nov-Feb	0.3	0.8	-0.1	1.9	-0.7	1.5	-0.1	1.0	0.6	0.6
Feb-Mar	-0.5	0.9	0.1	1.2	0.1	0.6	0.1	0.2	0.1	0.1
Mar-Apr	-0.6	1.1	-1.0	1.3	-0.9	1.7	-0.5	1.3	-0.5	0.6
Apr-May	0.1	0.8	0.1	0.8	0.2	0.9	-0.7	1.4	-0.1	0.1
May-Jun	0.1	0.8	-0.2	1.0	0.2	0.8	1.0	1.8	0.1	0.1
Jun-Jul	0.7	2.1	0.3	1.1	0.1	1.4	-0.1	0.6	-	-
Jul-Aug	0.3	0.8	0.1	0.3	0.1	0.4	-0.1	0.3	-0.5	0.7
Aug-Sep	-0.5	1.3	-0.1	1.3	-0.1	0.6	-0.1	0.9	0.1	0.2

* 9.5 - n=15 10.5 - n=33 11.5 - n=33 12.5 - n=12 13.5 - n=2

Table 7.16 Mean and standard deviation for monthly increments (mm/month) at biceps skinfold site of girls from social group B without menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.1
Nov-Feb	-0.9	1.4	-0.5	1.4	-0.4	1.3	-1.0	2.1	-0.2	1.5
Feb-Mar	0.2	0.1	0.2	1.0	0.1	0.2	0.2	0.5	0.3	0.3
Mar-Apr	0.3	1.4	-0.3	1.0	0.1	2.5	-0.1	1.0	0.2	1.3
Apr-May	-0.1	0.7	0.1	0.6	-0.1	0.7	-0.3	0.5	-0.9	2.2
May-Jun	0.2	0.8	0.2	0.7	-0.1	0.4	0.1	0.6	-0.3	0.7
Jun-Jul	0.1	0.6	-0.4	0.7	-0.1	0.6	-0.1	0.2	-0.1	1.0
Jul-Aug	0.2	0.7	0.2	0.5	0.5	1.1	0.1	0.6	0.3	0.3
Aug-Sep	-0.2	0.7	-0.1	0.5	-0.1	0.7	-0.1	0.6	-0.1	0.7

* 9.5 - n=20 10.5 - n=56 11.5 - n=33 12.5 - n=20 13.5 - n=10

Table 7.17 Mean and standard deviation for monthly increments (mm/month) at subscapular skinfold site of girls from social group A without menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.1	0.2	0.1	0.4	0.3	0.9	-0.1	0.1	0.2	0.2
Nov-Feb	-0.1	1.1	-0.1	1.7	-0.8	1.8	-0.1	1.4	0.5	0.4
Feb-Mar	-0.4	1.1	-0.1	1.0	-0.1	1.0	0.4	0.5	0.3	1.8
Mar-Apr	-0.6	1.7	-0.6	1.7	-0.4	1.3	-0.4	1.3	-0.8	0.9
Apr-May	-0.2	0.6	-0.2	0.5	0.2	0.8	-0.7	1.8	0.1	0.1
May-Jun	-0.2	0.8	-0.2	1.3	0.1	1.0	0.7	1.2	0.1	0.1
Jun-Jul	0.5	0.8	0.4	2.3	0.2	1.4	0.5	1.1	0.1	0.1
Jul-Aug	0.2	0.4	0.1	0.7	-0.1	0.4	-0.1	0.2	-0.5	0.7
Aug-Sep	0.2	1.3	0.3	1.8	0.6	1.4	0.7	0.9	1.3	1.8

* 9.5 - n=15 10.5 - n=33 11.5 - n=33 12.5 - n=12 13.5 - n=2

Table 7.18 Mean and standard deviation for monthly increments (mm/month) at subscapular skinfold site of girls from social group B without menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nov-Feb	-0.9	1.2	-0.8	2.1	-0.3	1.2	-0.7	2.0	-0.2	1.6
Feb-Mar	-0.2	1.8	0.4	1.3	0.2	0.2	0.2	0.1	0.1	0.4
Mar-Apr	0.8	2.1	-0.4	1.3	0.7	3.6	-0.1	1.0	0.1	1.7
Apr-May	0.2	1.2	0.1	0.7	-0.1	0.6	0.1	0.7	-0.3	1.0
May-Jun	-0.1	0.6	0.1	1.0	-0.1	0.4	-0.3	0.8	-0.2	0.8
Jun-Jul	0.2	1.7	-0.2	0.9	-0.3	1.6	0.1	0.6	0.2	0.7
Jul-Aug	0.4	0.6	0.4	0.9	0.7	1.1	0.4	0.7	1.1	1.8
Aug-Sep	-0.4	1.8	0.2	0.6	0.1	1.0	0.4	0.7	0.3	1.0

* 9.5 - n=20 10.5 - n=56 11.5 - n=33 12.5 - n=20 13.5 - n=10

Table 7.19 Mean and standard deviation for monthly increments (mm/month) at suprailiac skinfold site of girls from social group A without menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.1	0.3	0.4	0.8	0.8	2.6	0.3	0.8	0.1	0.1
Nov-Feb	-0.9	3.3	-1.7	3.1	-2.3	3.5	-0.9	3.4	0.6	0.5
Feb-Mar	-0.1	1.6	-0.2	2.0	0.3	0.6	0.3	0.4	0.1	0.1
Mar-Apr	-1.7	2.1	-1.1	2.3	-2.2	2.0	-1.7	1.9	-2.2	2.9
Apr-May	0.5	1.5	-0.5	1.6	-0.2	1.6	0.7	1.9	-0.1	0.1
May-Jun	0.1	0.8	-0.6	1.7	0.2	1.1	-0.4	1.7	-	-
Jun-Jul	0.3	0.8	1.4	2.2	0.8	2.2	1.1	2.2	8.8	0.1
Jul-Aug	1.2	2.0	-0.2	3.0	0.7	2.1	1.6	1.8	0.1	0.1
Aug-Sep	0.8	1.6	0.7	2.3	0.2	0.7	-0.1	0.2	-1.3	1.8

* 9.5 - n=15 10.5 - n=33 11.5 - n=33 12.5 - n=12 13.5 - n=2

Table 7.20 Mean and standard deviation for monthly increments (mm/month) at suprailiac skinfold site of girls from social group B without menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.1	0.2	0.1	0.2	0.2	0.3	0.1	0.2	-0.1	0.3
Nov-Feb	-2.3	3.0	-1.0	2.5	-0.4	2.7	-0.1	3.1	-0.1	2.3
Feb-Mar	0.2	0.2	0.3	1.2	0.2	0.3	0.5	0.8	0.5	1.1
Mar-Apr	0.4	1.7	-0.8	2.2	-0.4	3.9	-1.2	2.2	-1.4	3.1
Apr-May	-0.1	1.2	-0.1	0.9	-0.1	1.0	-0.1	0.9	-0.1	1.0
May-Jun	-0.4	1.3	0.3	1.3	-0.1	0.3	0.1	0.9	0.8	3.0
Jun-Jul	0.8	3.0	0.1	1.4	-0.1	1.3	-0.1	0.5	0.4	0.8
Jul-Aug	0.8	3.8	0.4	1.2	0.7	1.5	0.4	1.3	0.5	1.0
Aug-Sep	0.3	1.7	0.6	1.0	1.6	2.6	1.2	1.9	2.0	3.1

* 9.5 - n=20 10.5 - n=56 11.5 - n=33 12.5 - n=20 13.5 - n=10

Table 7.21 Mean and standard deviation for monthly increments (mm/month) of sum of four skinfolds of girls from social group A without menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.2	0.6	0.5	1.2	1.4	4.9	0.2	1.0	0.3	0.1
Nov-Feb	-0.1	5.0	-1.8	7.0	-4.7	6.8	-1.4	6.4	2.7	1.6
Feb-Mar	-0.7	3.0	-0.2	4.0	0.3	1.3	1.0	1.1	0.7	0.1
Mar-Apr	-3.5	4.5	-3.0	4.4	-4.0	4.1	-3.4	5.1	-3.1	3.6
Apr-May	0.2	0.9	-1.1	2.8	-0.1	1.7	-0.9	2.1	-0.1	0.1
May-Jun	-0.1	1.1	-1.3	4.0	0.6	1.6	1.4	3.5	0.1	0.2
Jun-Jul	1.6	3.3	2.0	5.7	1.6	4.1	2.3	3.2	-0.1	0.1
Jul-Aug	1.3	2.4	1.1	3.7	0.2	1.0	-0.1	0.8	-2.2	3.2
Aug-Sep	0.5	2.5	0.1	4.3	0.9	3.6	2.4	2.6	0.6	0.7

* 9.5 - n=15 10.5 - n=56 11.5 - n=33 12.5 - n=12 13.5 - n=2

Table 7.22 Mean and standard deviation for monthly increments (mm/month) of sum of four skinfolds of girls from social group B without menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.6	0.3	0.6	0.3	0.6	0.6	0.7	0.5	0.4	0.3
Nov-Feb	-5.2	5.1	-2.9	5.3	-1.7	5.0	-1.8	3.9	-1.1	5.4
Feb-Mar	0.5	1.9	1.3	4.6	0.9	0.9	1.0	1.4	1.3	2.4
Mar-Apr	2.1	5.3	-1.5	3.7	0.8	12.1	-1.4	3.1	-1.0	3.6
Apr-May	0.1	2.6	-0.1	2.3	-0.4	1.8	-0.3	1.7	-1.6	3.1
May-Jun	-0.5	1.6	0.6	2.7	-0.4	0.9	-0.2	1.9	-0.7	1.8
Jun-Jul	1.0	5.8	-0.9	2.6	-0.6	3.9	-0.1	1.0	0.3	0.9
Jul-Aug	1.0	2.4	1.3	2.2	3.1	4.9	2.1	2.3	3.8	5.0
Aug-Sep	-0.1	6.7	0.6	1.9	0.7	2.4	0.6	1.2	1.1	1.4

* 9.5 - n=20 10.5 - n=56 11.5 - n=33 12.5 - n=20 13.5 - n=10

Table 7.23 Mean and standard deviation for monthly increments (mm/month) at triceps skinfold site of girls from social group A with menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.1	0.1	0.3	0.2	0.1	0.2	-0.6	2.6	0.1	0.5
Nov-Feb	-0.5	1.0	-1.3	3.1	-0.2	1.5	0.5	2.9	-0.1	2.0
Feb-Mar	-0.7	0.8	0.2	0.1	0.1	0.2	-0.3	0.9	-0.1	0.6
Mar-Apr	1.3	0.1	-1.2	2.7	-0.4	1.9	-0.5	1.4	-0.6	1.3
Apr-May	-1.8	0.9	0.1	0.1	-0.1	0.9	0.3	0.5	-0.1	0.7
May-Jun	1.4	2.0	0.1	0.2	-0.1	0.6	-0.3	0.7	0.3	0.8
Jun-Jul	-0.7	1.6	1.0	1.9	1.1	2.2	0.8	2.2	0.1	1.0
Jul-Aug	0.1	0.1	0.1	0.1	0.2	0.5	-0.1	0.1	-0.1	0.2
Aug-Sep	0.4	1.2	-0.6	1.4	-0.5	1.0	0.2	1.0	-0.3	1.4

* 9.5 - n=3 10.5 - n=3 11.5 - n=16 12.5 - n=14 13.5 - n=14

Table 7.24 Mean and standard deviation for monthly increments (mm/month) at triceps skinfold site of girls from social group B with menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.2	-	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.1
Nov-Feb	-2.8	-	-2.0	2.5	1.0	1.8	-0.3	1.5	-0.4	1.5
Feb-Mar	0.2	-	0.6	0.6	0.7	0.8	0.5	0.7	0.3	0.6
Mar-Apr	0.1	-	-0.1	0.3	-0.6	1.9	-0.8	1.1	-0.6	1.1
Apr-May	0.2	-	-0.2	1.7	0.5	2.4	0.5	1.0	0.1	0.5
May-Jun	-0.1	-	1.3	2.4	-0.1	0.9	-0.3	0.9	-0.1	0.5
Jun-Jul	-0.1	-	-0.3	0.3	-0.2	0.3	0.1	0.9	0.4	2.5
Jul-Aug	-1.4	-	-0.4	0.5	0.4	1.0	0.5	0.8	0.5	2.8
Aug-Sep	0.1	-	-0.8	1.1	-0.5	1.3	0.1	1.1	-0.3	0.9

* 9.5 - n=1 10.5 - n=2 11.5 - n=15 12.5 - n=25 13.5 - n=25

Table 7.25 Mean and standard deviation for monthly increments (mm/month) at biceps skinfold site of girls from social group A with menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.1	0.1	0.1	0.3	-0.1	0.2	0.1	0.2	-0.1	0.3
Nov-Feb	-0.2	0.5	-1.7	1.4	-0.9	2.4	-0.3	1.7	0.6	1.2
Feb-Mar	1.6	4.5	0.1	0.1	0.1	0.1	-0.1	0.9	0.1	0.2
Mar-Apr	-3.0	4.8	-0.9	0.9	-0.4	0.7	-0.5	1.0	-0.7	1.6
Apr-May	0.7	4.1	0.1	0.1	-0.3	0.7	0.2	0.7	-0.7	0.8
May-Jun	0.4	1.2	0.6	1.0	0.6	1.5	0.2	1.0	0.9	1.2
Jun-Jul	0.2	2.0	1.3	2.2	0.5	0.9	0.4	1.2	-0.1	1.1
Jul-Aug	0.3	0.1	-0.1	0.2	0.1	0.3	-0.1	0.2	-0.1	0.2
Aug-Sep	-1.2	4.2	-0.8	0.7	-0.1	0.8	0.7	1.5	-0.5	1.8

* 9.5 - n=3 10.5 - n=3 11.5 - n=16 12.5 - n=14 13.5 - n=14

Table 7.26 Mean and standard deviation for monthly increments (mm/month) at biceps skinfold site of girls from social group B with menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	-0.2	-	-0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Nov-Feb	-3.2	-	-0.4	0.1	0.6	2.5	0.3	2.0	-0.4	1.3
Feb-Mar	0.2	-	0.1	0.2	0.3	0.4	0.1	0.6	0.2	0.8
Mar-Apr	-1.6	-	0.1	0.1	-0.4	3.1	-0.7	1.3	-0.1	1.0
Apr-May	-0.1	-	0.5	1.0	-0.3	2.1	0.1	0.9	0.5	1.3
May-Jun	-0.1	-	0.6	0.6	-0.1	0.5	0.1	0.4	-0.1	0.4
Jun-Jul	-0.2	-	-0.4	0.5	0.1	0.8	-0.1	0.5	0.4	2.2
Jul-Aug	0.2	-	0.1	0.2	0.1	1.4	0.1	1.0	-0.2	2.5
Aug-Sep	-0.1	-	-0.5	0.9	-0.5	0.8	-0.1	1.1	-0.2	0.7

* 9.5 - n=1 10.5 - n=2 11.5 - n=15 12.5 - n=25 13.5 - n=25

Table 7.27 Mean and standard deviation for monthly increments (mm/month) at subscapular skinfold site of girls from social group A with menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.4	0.5	0.3	0.5	0.2	0.3	0.1	0.2	0.2	0.3
Nov-Feb	-1.1	2.1	-2.2	2.0	-1.2	1.9	-0.9	1.3	0.4	1.5
Feb-Mar	-1.9	2.9	0.1	0.1	0.1	0.2	0.3	0.3	-0.1	0.5
Mar-Apr	1.1	4.0	-0.2	0.7	-0.3	1.9	-0.2	1.3	-0.8	1.0
Apr-May	0.1	1.7	-0.1	0.2	0.1	1.3	-0.3	1.4	-0.2	0.7
May-Jun	-0.2	1.6	0.4	0.6	-0.1	0.7	0.4	1.0	0.3	0.9
Jun-Jul	0.4	5.4	2.9	5.1	1.3	1.9	1.3	1.8	0.3	1.5
Jul-Aug	0.2	0.3	0.1	0.3	0.1	0.2	0.1	0.2	-0.1	0.3
Aug-Sep	1.4	4.8	-1.0	1.7	0.1	2.0	0.5	1.2	0.2	1.8

* 9.5 - n=3 10.5 - n=3 11.5 - n=16 12.5 - n=14 13.5 - n=14

Table 7.28 Mean and standard deviation for monthly increments (mm/month) at subscapular skinfold site of girls from social group B with menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.3	-	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1
Nov-Feb	-1.5	-	0.1	0.8	0.1	2.7	-0.4	1.9	-0.4	1.4
Feb-Mar	0.3	-	0.2	0.2	0.7	1.1	0.2	0.9	0.7	1.5
Mar-Apr	0.6	-	-0.1	0.3	-1.2	1.7	-0.1	1.8	-0.3	1.0
Apr-May	-0.1	-	-8.9	0.8	0.3	1.0	-0.3	1.3	-0.3	0.7
May-Jun	0.1	-	0.3	1.3	-0.1	1.1	-0.4	0.7	0.1	0.7
Jun-Jul	-0.3	-	-0.3	0.2	-0.3	0.4	0.2	0.7	0.5	2.5
Jul-Aug	0.6	-	-0.7	0.9	-0.7	0.9	1.3	1.6	0.6	1.5
Aug-Sep	0.1	-	-0.6	0.8	0.1	1.4	0.9	2.3	-0.1	0.7

* 9.5 - n=1 10.5 - n=2 11.5 - n=15 12.5 - n=25 13.5 - n=25

Table 7.29 Mean and standard deviation for monthly increments (mm/month) at suprailiac skinfold site of girls from social group A with menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.2	0.2	0.4	0.2	0.4	0.7	0.3	0.7	1.1	3.1
Nov-Feb	1.4	2.1	-5.1	5.4	-1.6	2.9	-2.0	3.1	-0.2	5.1
Feb-Mar	1.0	4.5	0.1	0.1	0.2	0.8	0.1	1.2	0.1	1.0
Mar-Apr	-4.4	1.4	-2.6	2.2	-2.1	2.5	-1.1	2.1	-2.6	2.3
Apr-May	2.1	1.1	0.1	0.2	-0.3	2.2	-0.5	1.6	-0.5	1.2
May-Jun	-2.5	5.8	4.0	6.9	0.5	2.3	0.8	3.0	0.4	0.9
Jun-Jul	6.8	12.1	2.0	3.4	2.3	3.1	0.8	2.8	2.1	3.0
Jul-Aug	0.3	0.4	0.1	0.1	0.6	1.3	0.1	0.1	-0.1	0.4
Aug-Sep	-1.9	4.9	-2.9	2.6	0.7	1.9	1.6	3.2	1.5	3.2

* 9.5 - n=3 10.5 - n=3 11.5 - n=16 12.5 - n=14 13.5 - n=14

Table 7.30 Mean and standard deviation for monthly increments (mm/month) at suprailiac skinfold site of girls from social group B with menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.3	-	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2
Nov-Feb	-6.0	-	-3.2	3.6	-1.5	5.6	-0.6	2.8	-0.3	2.4
Feb-Mar	1.0	-	-0.1	0.1	1.0	2.4	0.5	0.9	0.9	2.4
Mar-Apr	-1.3	-	-0.6	1.0	-1.2	2.0	-1.0	2.5	-1.0	2.5
Apr-May	-0.2	-	0.4	1.0	-0.5	1.8	-0.3	1.8	-0.1	1.1
May-Jun	0.1	-	0.6	0.2	0.2	1.3	-0.1	0.5	0.5	2.2
Jun-Jul	-0.2	-	-0.6	0.3	-0.2	0.5	0.6	1.4	0.4	1.4
Jul-Aug	1.6	-	0.7	0.9	3.1	3.1	1.6	1.8	1.7	3.1
Aug-Sep	0.1	-	0.2	0.5	0.4	3.3	1.6	2.0	0.1	2.6

* 9.5 - n=1 10.5 - n=2 11.5 - n=15 12.5 - n=25 13.5 - n=25

Table 7.31 Mean and standard deviation for monthly increments (mm/month) of sum of four skinfolds of girls from social group A with menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.8	0.2	1.0	0.6	0.6	1.0	-0.1	2.6	1.3	3.7
Nov-Feb	-0.4	1.5	-10.2	8.6	-3.9	7.6	-2.7	6.0	0.7	8.0
Feb-Mar	0.1	6.9	0.3	0.2	0.5	1.0	0.1	2.4	-0.1	1.9
Mar-Apr	-4.9	6.4	-4.9	5.8	-3.1	5.5	-2.4	3.0	-4.6	4.5
Apr-May	1.1	5.1	-0.1	0.5	-0.7	3.1	-0.2	2.8	-1.5	2.1
May-Jun	-0.9	6.6	5.1	8.6	0.9	3.4	1.1	4.3	1.9	2.4
Jun-Jul	6.8	14.7	7.2	12.7	5.2	6.3	3.3	5.1	2.5	4.1
Jul-Aug	1.0	0.5	0.1	0.6	1.0	2.1	0.1	0.5	-0.2	1.1
Aug-Sep	-1.3	6.1	-5.3	5.1	0.3	3.1	3.0	5.1	0.9	5.5

* 9.5 - n=3 10.5 - n=3 11.5 - n=16 12.5 - n=14 13.5 - n=14

Table 7.32 Mean and standard deviation for monthly increments (mm/month) of sum of four skinfolds of girls from social group B with menarche according to the age range

	Age (yr)*									
	9.5		10.5		11.5		12.5		13.5	
Month	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Oct-Nov	0.9	-	0.4	0.3	0.5	0.3	0.5	0.3	0.6	0.3
Nov-Feb	-13.5	-	-5.5	6.9	-0.8	7.4	-1.0	6.0	-1.5	4.5
Feb-Mar	1.6	-	0.8	0.9	2.7	4.6	1.2	2.0	2.1	4.3
Mar-Apr	-2.3	-	-0.7	1.6	-3.5	5.2	-2.6	5.1	-2.0	3.4
Apr-May	-0.2	-	0.7	1.2	-0.1	2.1	0.1	3.2	0.2	1.7
May-Jun	-0.1	-	2.8	2.9	-0.1	1.8	-0.6	1.6	0.2	2.4
Jun-Jul	-0.8	-	-1.5	1.3	-0.5	1.4	0.7	2.6	1.7	8.4
Jul-Aug	1.0	-	-0.4	0.2	4.9	4.9	2.8	2.9	2.7	1.4
Aug-Sep	0.1	-	-1.7	2.2	-0.6	4.5	2.6	5.0	-0.4	3.7

* 9.5 - n=1 10.5 - n=2 11.5 - n=15 12.5 - n=25 13.5 - n=25

7.3.3.1 Seasonal Effect On Monthly Fat Gain

The frequency distribution of the positive (gain) and negative (loss) increments can be seen from Table 7.33 to Table 7.52. The calculation was made considering 1 month interval, with the exception of November to February which considered 3 months.

Table 7.33 Distribution of monthly gain and loss * of fat at triceps skinfold site of girls from the social group A without menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	3	20	7	21	9	27	6	50	1	50
	0G	-		1	3	2	6	-		-	
	+G	12	80	25	75	22	67	6	50	1	50
Nov-Feb	-G	3	20	14	42	21	63	4	33	-	
	0G	-		1	3	-		-		-	
	+G	12	80	18	55	12	37	8	67	2	100
Feb-Mar	-G	4	27	8	24	10	30	1	8	-	
	0G	1	7	3	9	3	9	-		-	
	+G	10	66	22	67	20	61	11	92	2	100
Mar-Apr	-G	12	80	19	66	22	66	8	66	1	50
	0G	-		-		-		-		-	
	+G	3	20	14	34	11	34	4	34	1	50
Apr-May	-G	9	60	18	54	17	51	5	42	1	50
	0G	1	7	3	9	1	3	2	16	-	
	+G	5	33	12	37	15	46	5	42	1	50
May-Jun	-G	6	40	18	54	12	36	4	33	-	
	0G	1	7	2	6	3	9	1	8	1	50
	+G	8	53	13	40	18	55	7	59	1	50
Jun-Jul	-G	4	27	16	48	8	24	4	33	1	50
	0G	2	13	2	6	3	9	-		1	50
	+G	9	60	15	46	22	67	8	67	-	
Jul-Aug	-G	8	54	11	33	10	30	4	33	-	
	0G	1	7	2	6	6	18	2	16	-	
	+G	6	40	20	61	17	52	6	51	2	100
Aug-Sep	-G	9	60	12	37	15	45	5	42	1	50
	0G	-		3	9	2	6	-		1	50
	+G	6	40	18	54	16	49	7	58	-	

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.34 Distribution of monthly gain or loss * of fat at triceps skinfold site of girls from social group B without menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	-		1	2	1	3	-		-	
	0G	-		1	2	2	6	1	5	-	
	+G	20	100	54	96	30	91	19	95	10	100
Nov-Feb	-G	15	75	41	73	17	52	9	45	6	60
	0G	-		2	4	2	6	1	5	1	10
	+G	5	25	13	23	14	42	10	50	3	30
Feb-Mar	-G	1	5	8	14	3	9	3	15	1	10
	0G	-		4	7	3	9	1	5	-	
	+G	19	95	44	79	27	82	16	80	9	90
Mar-Apr	-G	10	50	29	52	13	39	11	55	2	20
	0G	-		6	11	5	15	1	5	1	10
	+G	10	50	21	37	15	46	8	40	7	70
Apr-May	-G	6	30	21	38	17	52	11	55	5	50
	0G	-		7	13	1	3	9	45	-	
	+G	14	70	28	49	15	45	-		5	50
May-Jun	-G	10	50	22	39	20	61	10	50	3	30
	0G	3	15	9	16	4	12	-		2	20
	+G	7	35	25	45	9	27	10	50	5	50
Jun-Jul	-G	8	40	33	59	20	61	8	40	7	70
	0G	3	15	11	20	5	15	4	20	1	10
	+G	9	45	12	21	9	24	8	40	2	20
Jul-Aug	-G	7	35	15	27	9	27	4	20	2	20
	0G	-		9	16	3	9	1	5	1	10
	+G	13	65	32	57	21	64	15	75	7	70
Aug-Sep	-G	11	65	20	36	14	42	9	45	3	30
	0G	-		8	14	4	12	2	10	2	20
	+G	9	35	28	50	15	46	9	45	5	50

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.35 Distribution of monthly gain or loss * of fat at biceps skinfold site of girls from social group A without menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	12	80	18	55	13	39	6	50	2	100
	0G	-		1	3	2	6	-		-	
	+G	3	20	14	42	18	55	6	50	-	
Nov-Feb	-G	2	13	14	42	18	55	5	42	-	
	0G	2	13	1	3	2	6	-		-	
	+G	11	74	18	55	13	39	7	58	2	100
Feb-Mar	-G	11	74	9	27	9	27	3	25	-	
	0G	-		3	9	3	9	3	25	1	50
	+G	4	26	21	64	21	64	6	50	1	50
Mar-Apr	-G	11	74	25	76	27	82	8	67	2	100
	0G	-		-		1	3	-		-	
	+G	4	27	8	24	5	15	4	33	-	
Apr-May	-G	7	47	13	39	12	36	7	58	1	50
	0G	1	6	5	15	4	12	3	25	1	50
	+G	7	47	15	54	17	52	2	17	-	
May-Jun	-G	7	47	14	42	12	36	1	8	-	
	0G	4	27	3	9	4	12	1	8	1	50
	+G	4	27	16	49	17	52	10	84	1	50
Jun-Jul	-G	2	13	13	39	11	33	5	42	-	
	0G	3	20	3	9	3	9	-		2	100
	+G	10	67	17	48	19	58	7	58	-	
Jul-Aug	-G	3	20	8	24	9	27	6	50	1	50
	0G	5	33	5	15	9	27	-		1	50
	+G	7	47	20	61	15	46	6	50	-	
Aug-Sep	-G	7	46	14	42	12	36	7	58	1	50
	0G	-		2	6	1	3	-		-	
	+G	8	54	17	52	20	61	5	42	1	50

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.36 Distribution of monthly gain or loss * of fat at biceps skinfold site of girls from social group B without menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	2	10	11	20	9	27	1	5	1	10
	0G	4	20	9	16	5	15	-		5	50
	+G	14	70	36	64	19	58	19	95	4	40
Nov-Feb	-G	14	70	38	68	20	61	10	50	6	60
	0G	-		1	2	1	3	1	5	2	20
	+G	6	30	17	30	12	38	9	45	2	20
Feb-Mar	-G	-		15	27	6	18	3	15	1	10
	0G	2	10	3	5	-		2	10	-	
	+G	18	90	38	68	27	82	15	75	9	90
Mar-Apr	-G	11	55	26	46	18	54	8	40	4	40
	0G	-		8	14	2	6	2	10	1	10
	+G	9	45	22	40	13	40	10	50	5	50
Apr-May	-G	8	40	22	39	17	51	13	65	5	50
	0G	3	15	11	20	3	9	2	10	-	
	+G	9	45	23	41	13	40	5	25	5	50
May-Jun	-G	9	45	17	30	18	54	8	40	4	40
	0G	1	5	12	21	5	15	4	20	5	50
	+G	10	50	27	49	10	31	8	40	1	10
Jun-Jul	-G	9	45	34	62	15	45	8	40	3	30
	0G	3	15	11	19	8	24	5	25	4	40
	+G	8	40	11	19	10	31	7	35	3	30
Jul-Aug	-G	9	45	11	19	10	30	3	15	1	10
	0G	-		11	19	6	18	5	25	-	
	+G	11	55	34	62	17	52	12	60	9	90
Aug-Sep	-G	10	50	24	43	13	39	9	45	4	40
	0G	2	10	6	11	6	18	4	20	1	10
	+G	8	40	26	46	14	43	7	35	5	50

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.37 Distribution of monthly gain or loss * of fat at subscapular skinfold site of girls from social group A without menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	4	27	13	39	14	42	7	58	-	
	0G	1	7	1	3	2	6	1	8	-	
	+G	10	66	19	58	17	52	4	34	2	100
Nov-Feb	-G	6	40	12	36	19	58	2	17	-	
	0G	1	7	-		2	6	-		-	
	+G	8	53	21	64	12	36	10	83	2	100
Feb-Mar	-G	8	53	13	39	9	27	2	17	-	
	0G	2	13	5	15	6	18	-		-	
	+G	5	34	15	46	18	55	10	83	2	100
Mar-Apr	-G	10	67	22	67	20	61	5	42	2	100
	0G	-		-		-		-		-	
	+G	5	33	11	33	13	39	7	58	-	
Apr-May	-G	7	47	19	58	16	48	8	67	-	
	0G	3	20	3	9	4	12	-		1	50
	+G	5	33	11	33	13	40	4	33	1	50
May-Jun	-G	6	40	14	42	17	52	-		-	
	0G	4	27	4	12	4	12	3	25	1	50
	+G	5	33	15	46	12	36	9	75	1	50
Jun-Jul	-G	1	7	11	33	11	33	3	25	-	
	0G	4	27	4	12	-		1	8	-	
	+G	10	66	18	55	22	67	8	67	2	100
Jul-Aug	-G	1	7	11	33	11	33	3	25	-	
	0G	4	27	4	12	-		1	8	-	
	+G	10	66	18	55	22	67	8	67	2	100
Aug-Sep	-G	2	13	6	18	10	30	6	50	2	100
	0G	3	20	9	27	8	24	2	17	-	
	+G	10	67	18	55	15	46	4	33	-	

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.38 Distribution of monthly gain or loss * of fat at subscapular skinfold site of girls from social group B without menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	-		5	5	3	9	1	5	1	10
	0G	2	10	-		-		-		1	10
	+G	18	90	51	95	30	91	19	95	8	80
Nov-Feb	-G	18	90	35	63	19	58	12	60	5	50
	0G	-		2	4	-		1	5	-	
	+G	2	10	19	33	14	42	7	35	5	50
Feb-Mar	-G	2	10	7	13	3	9	-		3	30
	0G	-		5	9	1	3	1	5	-	
	+G	18	90	44	78	29	88	19	95	7	70
Mar-Apr	-G	5	25	32	57	18	54	10	50	5	50
	0G	1	5	3	5	1	3	1	5	1	10
	+G	14	70	21	38	14	43	9	45	4	40
Apr-May	-G	8	40	26	46	18	54	8	40	5	50
	0G	2	10	8	14	2	6	-		-	
	+G	10	50	22	40	13	40	12	60	5	50
May-Jun	-G	9	45	22	39	19	58	13	65	5	50
	0G	1	5	8	14	5	15	-		1	10
	+G	10	50	26	47	9	27	7	35	4	40
Jun-Jul	-G	11	55	30	54	20	61	8	40	5	50
	0G	4	20	11	20	7	21	6	30	2	20
	+G	5	25	15	26	6	18	6	30	3	30
Jul-Aug	-G	5	25	15	27	8	24	2	10	1	10
	0G	1	5	3	5	2	6	4	20	-	
	+G	14	70	38	68	23	70	14	70	9	90
Aug-Sep	-G	12	60	19	34	11	33	4	20	2	20
	0G	1	5	5	9	3	9	2	10	-	
	+G	7	35	32	57	19	58	14	70	8	80

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.39 Distribution of monthly gain or loss * of fat at suprailiac skinfold site of girls from social group A without menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	6	40	9	27	8	24	4	33	-	
	0G	1	7	2	6	1	3	-		-	
	+G	8	53	22	67	24	73	8	67	2	100
Nov-Feb	-G	8	53	19	58	23	70	4	33	-	
	0G	-		-		-		1	8	-	
	+G	7	47	14	42	10	30	7	59	2	100
Feb-Mar	-G	5	33	7	18	12	36	-		-	
	0G	4	27	3	9	3	9	1	8	1	50
	+G	6	40	23	73	18	55	11	92	1	50
Mar-Apr	-G	13	87	25	76	29	88	8	68	2	100
	0G	1	7	1	3	1	3	2	16	-	
	+G	1	7	7	21	3	9	2	16	-	
Apr-May	-G	6	40	18	55	16	49	4	33	1	50
	0G	2	13	3	9	2	6	1	8	-	
	+G	7	47	12	36	15	45	7	59	1	50
May-Jun	-G	9	60	19	58	12	36	3	25	-	
	0G	-		2	6	3	9	2	17	2	100
	+G	6	40	12	36	18	55	7	58	-	
Jun-Jul	-G	5	33	8	24	12	36	2	17	1	50
	0G	1	7	2	6	2	6	-		-	
	+G	9	60	23	70	19	58	10	83	1	50
Jul-Aug	-G	1	7	5	15	12	36	5	42	2	100
	0G	4	27	7	21	6	18	1	8	-	
	+G	10	66	21	64	15	46	6	50	-	
Aug-Sep	-G	5	33	13	39	12	36	4	33	-	
	0G	-		2	6	-		-		-	
	+G	10	67	18	55	21	64	8	67	2	100

* Inc = Increment   -G = loss   0G = no increment   +G = gain

Table 7.40 Distribution of monthly gain or loss * of fat at suprailiac skinfold site of girls from social group B without menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	4	20	6	11	2	6	5	25	3	30
	0G	-		8	14	2	6	1	5	1	10
	+G	16	80	42	75	29	88	14	70	6	60
Nov-Feb	-G	16	80	36	66	16	48	12	60	4	40
	0G	-		2	4	3	9	8	40	2	20
	+G	4	20	18	30	14	43	8	40	4	40
Feb-Mar	-G	1	5	12	21	3	9	-		1	10
	0G	1	5	9	16	3	9	2	10	1	10
	+G	18	90	35	63	24	82	18	90	8	80
Mar-Apr	-G	6	30	33	58	26	79	12	60	6	60
	0G	1	5	1	2	2	6	1	5	-	
	+G	13	65	22	40	5	15	7	35	4	40
Apr-May	-G	9	45	31	55	15	45	13	65	6	60
	0G	4	20	4	7	2	6	1	5	-	
	+G	7	35	21	38	16	49	6	30	4	40
May-Jun	-G	11	55	19	34	13	39	8	40	6	60
	0G	3	15	9	16	9	27	3	15	1	10
	+G	6	30	28	50	11	34	9	45	3	30
Jun-Jul	-G	8	40	26	46	13	39	10	50	2	20
	0G	4	20	13	23	4	12	5	25	2	20
	+G	8	40	17	31	16	49	5	25	6	60
Jul-Aug	-G	9	45	13	23	7	21	7	35	1	10
	0G	-		5	9	1	3	1	5	1	10
	+G	11	55	38	68	25	76	12	60	8	80
Aug-Sep	-G	3	15	13	23	11	33	7	35	1	10
	0G	4	20	5	9	3	9	1	5	1	10
	+G	13	65	38	68	19	58	12	60	8	80

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.41 Distribution of monthly gain or loss * of fat expressed as sum of four skinfolds of girls from social group A without menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	5	33	9	27	8	24	6	50	1	50
	0G	-		1	3	-		-		-	
	+G	10	67	23	70	25	76	6	50	1	50
Nov-Feb	-G	5	33	17	52	22	67	4	33	1	50
	0G	-		-		-		-		-	
	+G	10	67	16	48	11	33	8	67	1	50
Feb-Mar	-G	7	47	9	27	9	27	1	8	1	50
	0G	-		-		1	3	-		-	
	+G	8	53	24	73	23	70	11	92	1	50
Mar-Apr	-G	13	87	24	73	28	85	8	67	2	100
	0G	-		-		-		-		-	
	+G	2	13	9	27	5	15	4	33	-	
Apr-May	-G	8	53	20	61	18	55	8	67	1	50
	0G	-		-		-		-		-	
	+G	7	47	13	39	15	45	4	33	1	50
May-Jun	-G	7	47	16	48	10	30	3	25	-	
	0G	1	6	-		-		-		-	
	+G	7	47	17	52	23	70	9	75	2	100
Jun-Jul	-G	3	20	11	33	10	30	3	25	1	50
	0G	-		-		-		-		-	
	+G	12	80	22	67	23	70	9	75	1	50
Jul-Aug	-G	4	27	12	36	11	33	5	42	1	50
	0G	-		-		-		-		-	
	+G	11	73	21	64	22	67	7	58	1	50
Aug-Sep	-G	5	33	15	46	13	39	3	25	-	
	0G	-		-		-		-		-	
	+G	10	67	18	54	20	61	9	75	2	100

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.42 Distribution of monthly gain or loss * of fat expressed as sum of four skinfolds of girls from social group B without menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	1	5	-		1	3	-		1	10
	0G	-		-		-		1	5	-	
	+G	19	95	56	100	32	97	19	95	9	90
Nov-Feb	-G	17	85	41	73	21	64	12	60	8	80
	0G	-		-		-		-		-	
	+G	3	15	15	27	9	36	8	40	2	20
Feb-Mar	-G	2	10	10	18	2	6	2	10	1	10
	0G	-		1	2	-		-		-	
	+G	18	90	45	80	31	94	18	90	9	90
Mar-Apr	-G	7	35	30	54	23	70	13	65	6	60
	0G	-		-		-		-		-	
	+G	13	65	26	46	10	30	7	35	4	40
Apr-May	-G	8	40	29	52	19	58	11	55	6	60
	0G	1	5	1	2	-		-		-	
	+G	11	55	26	46	14	42	9	45	4	40
May-Jun	-G	11	55	26	46	22	67	9	45	6	60
	0G	1	5	2	4	-		-		1	10
	+G	8	40	28	50	11	33	11	55	3	30
Jun-Jul	-G	11	55	38	68	20	61	9	45	5	50
	0G	1	5	-		-		-		-	
	+G	8	40	18	32	13	39	11	55	5	50
Jul-Aug	-G	6	30	13	23	11	33	3	15	1	10
	0G	-		-		-		-		-	
	+G	14	70	43	77	22	67	17	85	9	90
Aug-Sep	-G	7	35	19	34	13	39	6	30	1	10
	0G	-		1	2	-		-		-	
	+G	13	65	36	64	20	61	14	70	9	90

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.43 Distribution of monthly gain or loss * of fat at triceps skinfold site of girls from social group A with menarche according to the age range

Month	Inc	9.5 No.	9.5 %	10.5 No.	10.5 %	11.5 No.	11.5 %	12.5 No.	12.5 %	13.5 No.	13.5 %
Oct-Nov	-G		-		-	4	31	4	29	2	14
	0G		-		-	2	12		-		-
	+G	3	100	3	100	10	57	10	71	12	86
Nov-Feb	-G	1	33	2	67	9	56	7	50	5	36
	0G		-		-		-		-	1	7
	+G	2	67	1	33	7	44	7	50	8	57
Feb-Mar	-G	2	67		-	1	6	5	36	5	36
	0G		-		-	3	20		-	2	14
	+G	1	33	3	100	12	74	9	64	7	50
Mar-Apr	-G		-	2	67	6	37	10	71	8	57
	0G		-		-	1	6		-	1	7
	+G	3	100	1	33	9	57	4	29	5	36
Apr-May	-G	3	100	1	33	7	44	4	29	8	57
	0G		-		-	3	20		-		-
	+G		-	2	67	6	36	10	71	6	43
May-Jun	-G		-	1	33	7	44	7	50	5	36
	0G		-		-		-	4	30		-
	+G	3	100	2	67	9	56	3	20	9	64
Jun-Jul	-G	2	67	1	33	2	12	4	29	5	36
	0G		-		-	3	20		-		-
	+G	1	33	2	67	11	68	10	71	9	64
Jul-Aug	-G		-		-	4	25	7	50	7	50
	0G		-	2	67	2	12	3	21	4	30
	+G	3	100	1	33	10	63	4	29	3	20
Aug-Sep	-G	1	33	1	33	11	68	5	36	8	57
	0G		-		-	1	6		-	1	7
	+G	2	67	2	67	4	26	9	61	5	36

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.44 Distribution of monthly gain or loss * of fat at triceps skinfold site of girls from social group B with menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	-		-		1	7	1	4	-	
	0G	-		-		-		-		-	
	+G	1	100	2	100	14	93	24	96	25	100
Nov-Feb	-G	1	100	2	100	5	33	16	64	19	76
	0G	-		-		1	7	1	4	-	
	+G	-		-		9	60	8	32	6	24
Feb-Mar	-G	-		-		-		1	4	3	12
	0G	-		-		1	7	2	8	2	8
	+G	1	100	2	100	14	93	22	88	20	80
Mar-Apr	-G	-		1	50	10	67	19	76	16	64
	0G	-		-		1	7	1	4	2	8
	+G	1	100	1	50	4	26	5	20	7	28
Apr-May	-G	-		-		6	40	5	20	10	40
	0G	-		-		1	7	3	12	3	12
	+G	1	100	2	100	8	53	17	68	12	48
May-Jun	-G	1	100	2	100	8	53	13	52	9	36
	0G	-		-		1	7	7	28	6	24
	+G	-		-		6	40	5	20	10	40
Jun-Jul	-G	1	100	2	100	9	60	9	36	11	44
	0G	-		-		2	13	5	20	8	32
	+G	-		-		4	27	11	44	6	24
Jul-Aug	-G	1	100	2	100	3	20	5	20	7	28
	0G	-		-		1	7	2	8	2	8
	+G	-		-		11	73	15	72	16	64
Aug-Sep	-G	-		1	50	10	67	13	52	13	52
	0G	-		-				-		3	12
	+G	1	100	1	50	5	33	12	48	9	36

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.45 Distribution of monthly gain or loss * of fat at biceps skinfold site of girls from social group A with menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	1	33	1	33	7	44	5	36	6	43
	0G	-		-		-		1	7	2	14
	+G	2	67	2	67	9	56	8	57	6	43
Nov-Feb	-G	1	33	3	100	9	56	5	36	5	36
	0G	-		-		1	6	-		1	7
	+G	2	67	-		6	38	9	61	8	57
Feb-Mar	-G	2	67	1	33	4	25	4	29	4	30
	0G	-		-		4	25	1	7	3	20
	+G	1	33	2	67	8	50	9	64	7	50
Mar-Apr	-G	2	67	3	100	11	69	8	57	8	57
	0G	-		-		1	6	1	7	1	7
	+G	1	33	-		4	25	5	36	5	36
Apr-May	-G	1	33	1	33	8	50	3	21	10	71
	0G	-		-		2	12	7	50	-	
	+G	2	67	2	67	6	38	4	29	4	29
May-Jun	-G	1	33	1	33	2	12	6	43	1	7
	0G	-		-		2	12	2	14	2	14
	+G	2	67	2	67	12	76	6	43	11	79
Jun-Jul	-G	2	67	1	33	4	25	3	21	7	50
	0G	-		-		4	25	3	21	3	21
	+G	1	33	2	67	8	50	8	58	4	29
Jul-Aug	-G	-		2	67	4	25	4	29	6	43
	0G	-		-		3	20	7	50	6	43
	+G	3	100	1	33	9	55	3	21	4	14
Aug-Sep	-G	2	67	2	67	7	44	6	43	8	57
	0G	-		-		-		-		2	14
	+G	1	33	1	33	9	56	8	57	4	29

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.46 Distribution of monthly gain or loss * of fat at biceps skinfold site of girls from social group B with menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	-		2	100	3	20	1	4	3	12
	0G	-		-		1	7	2	8	5	20
	+G	1	100	-		11	73	22	88	17	68
Nov-Feb	-G	1	100	2	100	7	47	9	36	17	68
	0G	-		-		-		1	4	-	
	+G	-		-		8	53	15	60	8	32
Feb-Mar	-G	-		-		-		5	20	5	20
	0G	-		-		1	7	-		2	8
	+G	1	100	2	100	14	93	20	80	18	72
Mar-Apr	-G	1	100	2	100	8	53	18	68	13	52
	0G	-		-		2	13	2	8	4	16
	+G	-		-		5	34	5	24	8	32
Apr-May	-G	1	100	1	50	7	47	8	32	8	32
	0G	-		-		-		2	8	3	12
	+G	-		1	50	8	53	15	60	13	56
May-Jun	-G	1	100	-		7	46	7	28	10	40
	0G	-		-		4	27	7	28	8	32
	+G	-		2	100	7	27	11	44	7	28
Jun-Jul	-G	1	100	2	100	8	53	9	36	11	44
	0G	-		-		4	27	7	28	9	36
	+G	-		-		3	20	9	36	5	20
Jul-Aug	-G	-		1	50	3	20	8	32	8	32
	0G	-		-		3	20	2	8	3	12
	+G	1	100	1	50	9	60	15	60	14	56
Aug-Sep	-G	1	100	2	100	11	72	12	48	13	52
	0G	-		-		2	14	3	12	2	8
	+G	-		-		2	14	10	40	10	40

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.47 Distribution of monthly gain or loss * of fat at subscapular skinfold site of girls from social group A with menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	-		-		3	20	3	21	7	50
	0G	-		-		-		-		-	
	+G	3	100	3	100	13	80	11	79	7	50
Nov-Feb	-G	1	33	3	100	11	69	10	71	5	36
	0G	-		-		-		-		-	
	+G	2	67	-		5	31	4	29	9	64
Feb-Mar	-G	2	67	-		4	25	1	7	4	30
	0G	-		-		3	20	-		5	35
	+G	1	33	3	100	9	55	13	93	5	35
Mar-Apr	-G	1	33	2	67	7	44	8	57	10	71
	0G	-		-		-		-		-	
	+G	2	67	1	33	9	56	6	43	4	29
Apr-May	-G	2	67	1	33	7	44	6	43	9	64
	0G	-		-		-		-		2	14
	+G	1	33	2	67	9	56	8	57	3	22
May-Jun	-G	1	33	1	33	6	37	5	36	5	36
	0G	-		-		3	20	1	7	-	
	+G	2	67	2	67	7	43	8	57	9	64
Jun-Jul	-G	2	67	2	67	4	25	2	14	5	36
	0G	-		-		-		1	7	1	7
	+G	1	33	1	33	12	75	11	79	8	57
Jul-Aug	-G	-		2	67	5	31	4	29	4	29
	0G	-		-		2	12	3	21	3	21
	+G	3	100	1	33	9	57	7	50	7	50
Aug-Sep	-G	1	33	2	67	10	62	3	21	7	50
	0G	-		-		-		-		-	
	+G	2	67	1	33	6	38	9	65	11	79

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.48 Distribution of monthly gain or loss * of fat at subscapular skinfold site of girls from social group B with menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	-		-		-		2	8	-	
	0G	-		-		-		2	8	2	8
	+G	1	100	2	100	15	100	21	84	23	92
Nov-Feb	-G	1	100	1	50	8	53	15	60	17	68
	0G	-		-		-		2	8	-	
	+G	-		1	50	7	47	8	32	8	32
Feb-Mar	-G	-		-		1	7	2	8	1	4
	0G	-		-		1	7	-		4	16
	+G	1	100	2	100	13	86	23	92	20	80
Mar-Apr	-G	-		1	50	9	60	17	68	12	48
	0G	-		-		2	13	2	8	3	12
	+G	1	100	1	50	4	27	6	24	10	40
Apr-May	-G	1	100	2	100	4	27	12	48	15	60
	0G	-		-		2	13	3	12	3	12
	+G	-		-		9	60	10	40	7	28
May-Jun	-G	-		-		6	40	16	64	10	40
	0G	-		-		3	20	3	12	5	20
	+G	1	100	2	100	6	40	6	24	10	40
Jun-Jul	-G	1	100	2	100	9	60	8	32	13	52
	0G	-		-		3	20	3	12	7	28
	+G	-		-		3	20	13	56	5	20
Jul-Aug	-G	-		-		3	20	5	20	6	24
	0G	-		-		-		1	4	2	8
	+G	1	100	2	100	12	80	19	76	17	68
Aug-Sep	-G	-		-		9	60	6	24	13	52
	0G	-		-		1	7	2	8	2	8
	+G	1	100	2	100	5	33	17	68	10	40

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.49 Distribution of monthly gain or loss * of fat at suprailiac skinfold site of girls from social group A with menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	-		-		3	20	3	21	3	21
	0G	-		-		-		2	14	-	
	+G	3	100	3	100	13	80	9	65	11	79
Nov-Feb	-G	-		2	67	9	56	8	57	5	36
	0G	-		-		-		-		2	14
	+G	3	100	1	33	7	44	6	43	7	50
Feb-Mar	-G	1	33	-		5	31	4	29	4	29
	0G	-		-		2	12	4	29	1	7
	+G	2	67	3	100	9	57	6	42	9	64
Mar-Apr	-G	3	100	3	100	12	75	10	71	11	79
	0G	-		-		-		-		-	
	+G	-		-		4	25	4	29	3	21
Apr-May	-G	-		2	67	9	56	7	50	6	43
	0G	-		-		-		2	14	1	7
	+G	3	100	1	33	7	44	5	36	7	50
May-Jun	-G	2	67	-		5	31	5	36	4	29
	0G	-		-		1	6	1	7	1	7
	+G	1	33	3	100	10	63	8	57	9	64
Jun-Jul	-G	1	33	1	33	3	20	5	36	3	21
	0G	-		-		1	6	-		-	
	+G	2	67	2	67	12	74	9	64	11	79
Jul-Aug	-G	-		-		2	13	1	7	4	29
	0G	-		-		2	13	6	43	3	21
	+G	3	100	3	100	12	74	7	50	7	50
Aug-Sep	-G	2	67	3	100	5	31	5	36	5	36
	0G	-		-		1	6	-		-	
	+G	1	33	-		10	63	9	64	9	64

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.50 Distribution of monthly gain or loss * of fat at suprailiac skinfold site of girls from social group B with menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	-		-		2	13	3	12	2	8
	0G	-		-		3	20	6	24	1	4
	+G	1	100	2	100	10	67	16	64	22	88
Nov-Feb	-G	1	100	2	100	8	53	16	64	16	64
	0G	-		-		1	7	1	4	-	
	+G	-		-		6	40	8	32	9	36
Feb-Mar	-G	-		-		1	7	2	8	2	8
	0G	-		-		1	7	-		2	8
	+G	1	100	2	100	13	86	23	92	21	84
Mar-Apr	-G	1	100	1	50	12	80	19	76	16	64
	0G	-		-		-		-		4	16
	+G	-		1	50	3	20	6	24	5	20
Apr-May	-G	1	100	2	100	10	67	14	56	14	56
	0G	-		-		-		2	8	1	4
	+G	-		-		5	33	9	36	10	40
May-Jun	-G	-		-		8	53	10	40	7	28
	0G	1	100	-		2	13	4	16	11	44
	+G	-		2	100	5	34	11	44	7	28
Jun-Jul	-G	1	100	2	100	8	53	8	32	6	24
	0G	-		-		4	27	4	16	7	28
	+G	-		-		3	20	15	52	12	48
Jul-Aug	-G	-		-		1	7	2	8	3	12
	0G	-		-		1	7	3	12	3	12
	+G	1	100	2	100	13	86	20	80	11	76
Aug-Sep	-G	-		1	50	6	40	2	8	8	32
	0G	-		-		-		2	8	5	20
	+G	1	100	1	50	9	60	21	84	12	48

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.51 Distribution of monthly gain or loss * of fat expressed as sum of four skinfolds of girls from social group A with menarche according to the age range

		Age (yr)									
		9.5		10.5		11.5		12.5		13.5	
Month	Inc	No.	%	No.	%	No.	%	No.	%	No.	%
Oct-Nov	-G	-		-		4	25	5	36	4	29
	0G	-		-		-		-		-	
	+G	3	100	3	100	12	75	9	64	10	71
Nov-Feb	-G	1	33	3	100	8	50	7	50	6	43
	0G	-		-		-		-		-	
	+G	2	67	-		8	50	7	50	8	57
Feb-Mar	-G	1	33	-		3	19	3	21	6	43
	0G	-		-		-		-		-	
	+G	2	67	3	100	13	81	11	79	8	57
Mar-Apr	-G	2	67	3	100	8	50	11	79	10	71
	0G	-		-		-		-		-	
	+G	1	33	-		8	50	3	21	4	29
Apr-May	-G	1	33	1	33	8	50	7	50	9	64
	0G	-		-		-		-		-	
	+G	2	67	2	67	8	50	7	50	5	36
May-Jun	-G	1	33	1	33	5	31	7	50	2	14
	0G	-		-		1	6	-		-	
	+G	2	67	2	67	10	63	7	50	12	86
Jun-Jul	-G	1	33	1	33	4	25	3	21	3	21
	0G	-		-		-		-		-	
	+G	2	67	2	67	12	75	11	79	11	79
Jul-Aug	-G	-		2	67	4	25	7	50	6	43
	0G	-		-		-		1	7	2	14
	+G	3	100	1	33	12	75	6	43	6	43
Aug-Sep	-G	1	33	2	67	9	56	4	29	7	50
	0G	-		-		-		-		1	7
	+G	2	67	1	33	7	44	10	71	6	43

* Inc = Increment -G = loss 0G = no increment +G = gain

Table 7.52 Distribution of monthly gain or loss * of fat expressed as sum of four skinfolds of girls from social group B with menarche according to the age range

Month	Inc	9.5 No.	9.5 %	10.5 No.	10.5 %	11.5 No.	11.5 %	12.5 No.	12.5 %	13.5 No.	13.5 %
Oct-Nov	-G	-		-		1	7	1	4	-	
	0G	-		-		-		-		-	
	+G	1	100	2	100	14	93	24	96	25	100
Nov-Feb	-G	1	100	2	100	7	47	15	60	17	68
	0G	-		-		-		-		-	
	+G	-		-		8	53	10	40	8	32
Feb-Mar	-G	-		-		-		2	8	2	8
	0G	-		-		-		-		1	4
	+G	1	100	2	100	15	100	23	92	22	88
Mar-Apr	-G	1	100	1	50	11	73	20	80	19	76
	0G	-		-		-		-		-	
	+G	-		1	50	4	27	5	20	6	24
Apr-May	-G	1	100	1	50	9	60	11	44	9	44
	0G	-		-		-		1	4	-	
	+G	-		1	50	6	40	13	52	16	56
May-Jun	-G	1	100	-		10	67	17	68	11	44
	0G	-		-		-		-		-	
	+G	-		2	100	5	33	8	32	14	56
Jun-Jul	-G	1	100	2	100	10	67	10	40	11	44
	0G	-		-		-		1	4	4	16
	+G	-		-		5	33	14	56	10	40
Jul-Aug	-G	-		2	100	1	7	4	16	6	24
	0G	-		-		-		1	4	1	4
	+G	1	100	-		14	93	20	80	18	72
Aug-Sep	-G	-		2	100	10	67	6	24	11	44
	0G	-		-		-		-		2	8
	+G	1	100	-		5	33	19	76	12	48

* Inc = Increment   -G = loss   0G = no increment   +G = gain

The distribution of the number of cases of gains and losses occurring in each month is largely influenced by the sample size. Therefore, the following analysis can not be interpreted as being representative of the Alagoan population but only of the studied sample.

The findings presented in Tables 7.13 to 7.32 suggest that there were large fluctuations of fat increments at the specific skinfold sites throughout the months in both social groups. These variations were related to the respective distribution of gain and loss cases, independent of the growth phase (Tables 7.33 to 7.52).

The low income family girls of the non-menarcheal group had their peak of fat loss at triceps, biceps and subscapular between the months of May and July. The suprailiac skinfold site had its peak during the month of April. The high income family girls had their peak of fat loss at all skinfolds sites in April.

The fat loss peak in the menarcheal group occurred in April irrespectively of the social condition, at all studied skinfolds (Tables 7.33 to 7.52).

In order to observe whether there was any seasonal relation between the pattern of fat gain at specific sites and weight gain during the studied year, a 6 months interval was considered for deriving the increment values of the dry (October to March) and rainy (March to September) seasons.

Although body fat increments at specific skinfolds sites correlated positively with body weight increments in both seasons, irrespective of social class and growth phase, there were marked differences in the strength of the association. For instance, during the dry season the high income family girls from the non-menarcheal group had a very weak relation between their fat increments at all studied skinfold sites and the body weight increments (Table 7.53). The low income girls of the same growth phase presented a weak relation between increments at biceps, subscapular and suprailiac skinfold sites and body weight increments, and a moderate relation in respect to triceps.

During the rainy season, there was an increase in the strength of the association between fat gain at all the skinfolds sites and weight increments in both social groups.

Table 7.53 Correlation coefficient for fat increment at specific sites (and sum of four skinfolds) and body weight increments of Alagoan girls by social group (A and B) and menarcheal condition during the dry season

			Maturity Stage					
			Without Menarche			With Menarche		
Social class	Season	Site	No.	r	p	No.	r	p
		triceps	95	0.07	-	50	0.29	-
		biceps	95	0.03	-	50	0.30	-
		subscapular	95	0.07	-	50	0.40	0.01
A	Dry	suprailiac	95	0.10	-	50	0.10	-
		sum of four skinfolds	95	0.10	-	50	0.28	
		triceps	139	0.61	0.001	68	0.60	0.001
		biceps	139	0.38	0.001	68	0.22	-
		subscapular	139	0.30	0.001	68	0.61	0.001
B	Dry	suprailiac	139	0.30	0.001	68	0.20	
		sum of four skinfolds	139	0.50	0.001	68	0.61	0.001
		triceps	95	0.50	0.001	50	0.51	0.001
		biceps	95	0.20	-	50	0.41	0.001
		subscapular	95	0.41	0.001	50	0.50	0.001
A	Rainy	suprailiac	95	0.40	0.001	50	0.40	0.001
		sum of four skinfolds	95	0.50	0.001	50	0.64	0.001
		triceps	139	0.81	0.001	68	0.62	0.001
		biceps	139	0.70	0.001	68	0.40	0.001
		subscapular	139	0.71	0.001	68	0.50	0.001
B	Rainy	suprailiac	139	0.72	0.001	68	0.51	0.001
		sum of four skinfolds	139	0.82	0.001	68	0.71	0.001

During the dry season there was a weak relation between the fat increments at all sites and body increments in the high income family girls of the menarcheal group. This relation was a little bit stronger during the rainy season. In the social group B the relation between the increase in fat at biceps and suprailiac skinfolds fluctuated from 0.2 in the dry season to 0.4 and 0.5 respectively during the rain season.

7.4 Discussion

The analysis of the longitudinal data clearly showed contrast between social groups in the annual gain of the anthropometric variables.

7.4.1 Social Class And Annual Height Gain

The girls from the high income families had higher annual height gain in comparison to their low income counterparts, regardless of the maturity stage, i.e., whether before achieving menarche (when peak height velocity occurs), or after menarche (when the linear growth is supposed to be finishing).

On the other hand, when the girl achieves menarche, she is already experiencing a deceleration in growth velocity. In fact, the girls who did not achieve menarche had the highest annual height gain in both social groups. In part, multiple regression confirmed such trend. In both social groups age correlated negatively with annual gain in height, while sexual maturity (absence of menarche coded as dummy=1) correlated positively. This means that the most important gain occurred in the period before menarche.

Another point concerns the relative weight of the associations which contributed to the annual variation of height gain. Age was an important factor for the analysis of height gain during adolescence. Table 7.2.1 indicates this trend. This suggests that age acted as a link between the association of annual height gain (growth velocity per year) and "growth status" (height-for-age). In this sense, it is important to remember that, the low income group is composed of girls who were previously identified as being "normal" and "stunted" in relation to NCHS references. Therefore, the existence of growth retardation in the low income group is a concrete reality.

The status of being an "early" or "late" maturer is quite distinct from being considered "growth retarded", because these characteristics are supposed to be determined by different health conditions. The individual who is a "late" maturer can have a slight delay in achieving maturation, but she/he is expected to have a similar increment in height during the pubertal period in comparison to the "early" maturer. But, this aspect is still unclear in relation to the "growth retarded", and the open question is the identification of the "critical period" for determining consequences for adult stature.

The recognition of growth velocity as a sensitive indicator of growth retardation, at least in children, has already been pointed out by Waterlow (1992). In addition Waterlow (1992, page 197) says that "Growth in height is not only affected in the long term by environmental factors; it is also sensitive to short-term changes...Thus, stunting can be reversed and catch-up can occur if conditions become favourable". What remains to be answered is whether this assumption can be applied to adolescence.

If in one hand "catch-up growth" means acceleration in growth velocity (Tanner,1981), then, the lower annual gain in standing height of the low income group does not indicate that "true complete catch-up growth" (see Chapter 1 page 9) was occurring in this sample, at least during the study year. On the other hand, the delay in menarche suggests that perhaps a "catch-up growth with delay" mechanism was activated in the "growth retarded" group. It seems unlikely that the "growth retarded" girls and/or those living in less favourable economic conditions, experienced the same growth performance of those of opposite social condition.This finding appears to be consistent with the assumptions that: first, growth from 5 years on, i.e., in later childhood, pre-pubescent phase and adolescent period, is not independent of the degree of growth retardation established previous to this age and second, that differences in rate of growth between social groups increase during the adolescent spurt and limit the possibility of "complete catch-up growth" (Bogin et al., 1989, 1992). It must be considered in addition that, in this study, the girls from the low income families lived in a less safe environment. This fact, demanded a higher level of physical responsiveness from the subjects, which is reflected in the prevalence of reported morbidity for instance.

It is interesting to note that, the acceleration in the linear growth was more strongly associated with the sexual maturity stage and higher weight gain rather than with age and number of siblings. This is consistent with the theory that, in general, the intensity of pubertal spurt is strongly related to factors such as adequacy of nutritional status, earlier maturation condition and higher levels of weight gain (Tanner, 1962).

This result leads to three possible alternative inferences: first, it is possible that the underprivileged condition played a significant role in the growth performance of the low income group girls. Second, it is possible that the lower height velocity in the low income group suggests a less intense pubertal spurt and/or a "catch-up growth with delay" mechanism, and finally, if the same trend persists throughout adolescence, it is probable that the low income girls will not catch up completely the difference in attained standing height detected between social groups, therefore remaining shorter than their counterparts.

Because the present data did not cover the whole adolescent period but only one year, it was not possible to apply the Preece-Baines function, through which minimal prepubertal velocity of growth and velocity at peak height velocity could be calculated. Therefore, in this work, only partial height gain could be observed. Nevertheless, even considering this limitation, the pattern of growth found in this study is consistent with previous works which indicate that growth retarded children do not catch-up growth completely in the period subsequent to childhood and perhaps the height differences between social groups increase from childhood to adulthood (Satyanarayana et al., 1981, Bogin et al., 1989, Bogin and MacVean, 1992).

Bogin et al.(1989). report in their work that the growth increments in Guatemalan girls' height, of high socio-economic status Ladino origin, low socio-economic status Ladino origin and low socio-economic status Indian origin, during adolescence were markedly different across social status, the high income individuals presenting a higher rate of growth in height than their counterparts. However, even considering that an ethnic factor was introduced by the comparison between Ladinos and Indians, it is important to note that a difference in rates of height growth persisted between high and low status Ladino girls.

In a complementary work with the same populations (Ladino and Mayans), Bogin and MacVean (1992), compared longitudinally growth during adolescence. This time, the goals were first, to test whether adolescent growth was more responsive to genetic rather than environmental factors and second, to test for a higher sensitivity of girls than boys to environmental stresses. According to the authors, although genetic determinants of amount of growth could be responsible for the differences observed between groups, the overall environmental effects could not be excluded, since chronic mild to moderate malnutrition, higher rates of disease and unfavourable environmental conditions were found to exist in the Mayan sample. Although the Mayan and Ladina girls had similar minimal prepubertal velocities of growth, the former gained less in height during adolescent period. The authors explained that this occurred because the Mayan girls had a less intense pubertal spurt.

Other longitudinal studies also reported differences in growth velocities amongst populations. Some compared populations resident in different settings and from different socio-economic backgrounds, as the one of Billewicz and McGregor (1982), in which the authors compared West African (Gambian) individuals with British data. In their work, although Gambian girls had lower values for peak height velocity (i.e., 6.0 cm/yr for the Gambian girls against 7.5 cm/yr of the British data) in comparison to British girls, they added similar amount of height during the whole adolescence period.

Also comparing the populations to British data there is the work of Hauspie et al.(1980) which was based on a mixed longitudinal study of a middle-class semi-urban sample from West Bengal. There, the authors found that Indian girls had a similar adolescent growth spurt, in terms of growth velocity. According to the authors, differences in height detected in post-adolescence were determined before the occurrence of the pubertal spurt. However, it is important to notice that this result was recognized by the authors as not representative of the Indian population.

In contrast, as cited in Chapter 1, some authors raise the possibility of catch-up in growth during adolescence (Satyanarayana et al., 1981, Brown and Towsend, 1982). In the work of Satyanarayana et al. (1981), catch-up growth was found to occur partially in Indian females who were classified as having different degrees of stunting during early childhood. According to the authors, the higher increment in height, which reflected catch-up in growth during adolescence, could be explained by the delay of menarche and resulting delayed epiphyseal fusion.

Brown and Towsend (1982) studying Australian Aboriginal found evidence of the occurrence of a slight catch-up growth during the girls' adolescence. According to the authors, on average the Aboriginal girls had a greater acceleration during the peak height velocity (0.9 cm/yr), in comparison to the British children. The authors speculated that the infant mortality and morbidity pattern of the community could indicate previous growth retardation. Nevertheless, it is not clear what was the "growth status" profile of the sample during the study.

What is important to be borne in mind is that all the studies demonstrate that something important still occurs during the later childhood and adolescence period. These recent findings suggest that some points have to be considered separately. First, to consider that the older children or adolescents are able to feed themselves does not mean that they will be able to provide their foods, especially if they live in an urban area, and are not engaged as the food supplier of the household. Second, the maintenance of unsafe environmental conditions during the whole linear growth process may increase the risk of infections. Therefore, even considering the possibility of different levels of responsiveness among individuals, the question of the impact of environmental stress on the individual is still unclear.
In addition, knowledge of whether puberty is or not the critical period for

determining adult stature depends on further exhaustive investigation.

7.4.2 Social Class And Annual Sitting Height Gain

Theoretically, the leg reaches a growth spurt before the trunk. When menarche is reached, the girl might be ceasing to grow and therefore might be finishing the spurt in trunk length. As the spurt in standing height is supposed to be more related to spurt of trunk length, rather than of legs, a higher trunk gain would be expected in girls who are experiencing a spurt in trunk length.

The results of this study are consistent with this theory. The girls who attained menarche had lower gain in sitting height but, presented bigger values for trunk when compared to those without menstruation.
Nevertheless, when considering the difference between girls of distinct social status but with the same menarcheal condition, contrastive characteristics were observed, for instance, in body proportion. As indicated in the previous section of results, in the group without menarche, the girls from the high income group had a tendency to display bigger trunks than their counterparts. By this it is meant that, in general, during the study year, the girls without menarche from the low income group gained proportionally more in legs than in trunk. This result is evidence for believing that, in the year of the study, the girls from high income who had not achieved menarche were experiencing a spurt in trunk, while girls from low income group with the same menarcheal condition were experiencing a spurt in legs, or at least gaining still in leg length. This condition at this period of adolescence before attaining menarche, especially considering the results at older ages (12 and 13), confirms a delay in pubertal spurt and possibly explains the later onset of menarche of low income group.

In the case of those who had achieved menarche, some questions have to be pointed out. For instance, the question of final body proportion, i.e., do girls from low income have the same body proportion as their counterparts?

The findings of the present research suggest that it is possible that, when reaching maturity, the high income girls display bigger trunk size in comparison to the low income group. This conclusion is based in the following reasons: first, it is possible that the early age ranges (9 and 10) may be not representative of what could occur at this period. Second, there is one point to be observed in relation to the quantitative gain in sitting-standing ratio displayed in ages 12 and 13. That is, at these two ages the high income girls increased in trunk quantitatively more than their counterparts, although the high income girls presented at age 12 the smallest value.

It has to be noted however that, in terms of gain, the well-to-do group presented the biggest amount. Therefore, if the high income group gained more in standing height, and the low income group stopped growing before their counterparts, it is possible that when reaching maturity girls from low income present relatively longer legs than girls from high income.

7.4.3 Social Class And Annual Weight And Fat Gain

Increase in weight is characteristic of adolescence. However, its value is derived from many different tissues (Tanner, 1989), so interpretation of the obtained values is difficult.

In trying to have a better idea of what was occurring in terms of weight gain, the annual weight gain and the annual gain at specific skinfolds sites as well as the sum of 4 skinfolds were observed.

The analysis of the yearly weight gain clearly demonstrated that weight increment was strongly associated with the maturation process of the girls. This can be evidenced by the results of the multiple linear regression. Those who had a bigger acceleration in linear growth during the study year, had higher annual weight increments. In addition, the girls of underprivileged conditions had the lowest values.

Before reaching menarche, they gained less weight than their counterparts. After menarche, the gain was similar between social groups, but even so the lowest values were presented by the low income group. However, it is important to note that there was no significant imbalance in terms of annual weight gain. These findings are consistent with those reported by Bogin et al. (1989), who did not find significant differences in the rate of growth in weight of Guatemalan Ladino and Indian adolescent school girls from different social classes. This trend was already discussed in Chapter 4, where it was shown that neither wasting nor underweight conditions seem to play an important role in Latin American countries.

On the other hand, to determine with precision how much of the added weight gain could be translated in terms of fat deposition at specific sites is a quite difficult task. Much of the difficulty is related to skinfold thicknesses variability. Although skinfold thicknesses provide measures of subcutaneous fat at the sites chosen, it should be borne in mind that the concentration of fat in subcutaneous adipose tissue varies notably among individuals, and that skinfolds are exposed to variations in the compressibility of adipose tissue. As a consequence, the interpretation of the fat data may be inaccurate.

In this thesis, the evaluation of fat deposition at specific sites considered one year interval because it was assumed that this result would summarise the variation throughout the year.

When the data were analyzed considering one year interval it was observed that, although the low income girls from the non-menarcheal group deposited significantly more fat at triceps and suprailiac sites in comparison to their high income counterparts, they continued presenting the lowest scores for the attained skinfold values (APPENDIX G1 and G2). However, the result considering the difference between groups in terms of fat deposition has to be considered with caution. This is because although the small values obtained by the longitudinal analysis (considering one year interval) is statistically significant, it may be not biologically meaningful. On the other hand, the finding concerning the difference between absolute values (skinfold thicknesses and attained height) of the social groups, corroborates the findings of Himes and Roche (1986). They reported that subcutaneous fat thickness is associated with attained length and height, the leanest individuals being shorter than those with higher values of fat thicknesses. In addition, the magnitude of this relationship varies according to age, and in females the peak correlation coincides with the mean age of peak height velocity.

In this study, it was not practicable to estimate the age at peak height velocity, but it was possible to analyze separately the results according to maturation stage. Even considering the limitation of the results, it was clear that the increase in fat deposition at specific sites developed, during the study year, according to the characteristic of the growth phase.

The variation in strength of the relation between fat increments at specific sites and body weight increments in different seasons of the year, could be an indication that perhaps other factors were involved in the weight growth process. For instance, it may be that the weak correlation between fat and body increments in the high income girls of the non-menarcheal group could be related to the fact that they were gaining more in terms of height increments (perhaps adding more material in bones instead of fat in the body) than their low income counterparts of the same maturity stage during the dry season. However this assumption is speculative.

On the other hand, although the peak of fat losses occurred in different months of the year for the different social conditions it did not coincide with the peak of reported morbidity. Therefore, more investigation is necessary in order to seek more precise evidence of seasonal effect.

In summary, it appears that the large fluctuation of the monthly fat increments could be a consequence of three major factors. First, that there was a very strong heterogeneity within and between subjects in terms of fat gain. Second, that it is possible that the pattern of fat gain could be influenced by seasonal effects and, third, that a measurement error effect was included in the results.

7.5 Conclusion

The longitudinal analysis of the anthropometrical data shows that not only the social condition but also the "growth status" in terms of height-for-age, of the Alagoan school girls still play important roles during the adolescence period.

The girls from the low income families had slower rates of linear growth and growth in weight, but only the impact of the former was significant. This result suggests that the height deficit evidenced on the enrolment to the study was not caught-up during the study year. This finding contradict partially **Hypothesis 2** which predicted similar increments among girls of distinct social classes during adolescence.

As the present study did not cover the whole adolescence this assumption can not be conclusive. Nevertheless, this will be discussed further in Chapter 9, when occurrence of menarche, morbidity pattern and dietary intake will be considered jointly.

On the other hand, although the low income girls showed the lowest values for annual weight increment, this difference was only significant in the group without menarche. The food intake pattern could contribute to this result.

The pattern of fat deposition at specific sites also was similar at all sites for girls who had attained menarche. In the non-menarcheal group, the girls of the low income families had higher gains at triceps and suprailiac sites than their counterparts. Nevertheless, this result should be interpreted with caution since the small values obtained by the longitudinal analysis (considering one year interval) may be biologically not significant.

Chapter 8

Dietary Intake

This chapter analyses the results of the dietary intake survey. The main goal is to estimate the nutrient intake of the study sample.

As already discussed in Chapter 2, dietary surveys are one of the commonest ways of assessing the nutritional status of a population (Kretsch and Fong, 1990). Nevertheless, the assessment of the individual habitual dietary intake is usually controversial. This is particularly because first, there are marked differences between persons in pattern and level of food consumption, and second, there is sometimes large day-to-day variation in dietary intake of each individual (Todd et al., 1983; Marr and Heady, 1986; Basiots et al., 1989; Borrelli et al., 1989).

However, the nutrient and energy consumption of the study group were estimated, to get an idea of the nutritional adequacy of their diet. As previously explained in Chapter 2, 24-hour dietary recall was used.

8.1 Social Class And Average Daily Energy Intake

The mean daily energy intake (kcal) estimated from 24-hour recall repeated over four days is displayed in Table 8.1.

Table 8.1 Average energy intake (kcal) over 4 days by social group

Social group	Day	Average daily energy intake * (kcal)	Range
A	1	1986	1355 - 2946
	2	1992	1147 - 2934
	3	2011	1127 - 3097
	4	2062	1209 - 3178
	Mean	2013	
	SD	359	
B	1	1628	583 - 2970
	2	1578	1415 - 2330
	3	1538	960 - 2320
	4	1563	921 - 2328
	Mean	1576	
	SD	325	

* T-test $t = 6.40$ $df = 101$ $p < 0.001$

In general, the average daily intake of both social groups (A and B) differed significantly when tested by T-test ($p < 0.001$), the girls from the low income families displayed the lowest value when compared to their counterparts. Table 8.2 shows the mean daily energy intake and intake of nutrients, while Table 8.3 displays the corrections for available energy and of dietary protein digestibility. The nutritional quality of the protein was not assessed because there is no available information referring to the adolescent group.

Table 8.2 Mean daily intake of energy and other nutrients calculated from repeated and averaged 24-hour recall

	Group A (n=41)		Group B (n=62)		
Nutrient	Mean	SD	Mean	SD	P value
Energy (kcal)	2027	359	1600	325	0.0001
Protein (g)	84	26	66	14	0.0001
Carbohydrate (g)	254	51	226	57	0.014
Fat (g)	75	17	48	11	0.0001
% Energy * as:					
Protein	16.6	3	16.5	3	
Carbohydrate	50.1	21	56.5	6	
Fat	33.3	5	27.0	11	

* Mann-Whitney test $p < 0.001$

The low income group girls had the average daily energy intake significantly below their requirements of 1908 kcal ($p < 0.001$). The deficit was found to be 331 kcal, being the 95 % confidence interval for the energy deficit 249 - 414 kcal. This means that the energy intake of these girls achieved 82.6 % of their energy requirements. The 95 % confidence interval for the mean intake shows that the range 1494-1659 kcal does not include the required level of 1908 kcal/per day. This confirms that in the low income group, the mean daily energy consumption is less than is recommended.

Table 8.3 Corrections of the diet for available energy and of dietary protein for digestibility

Available energy (kcal)	Group A	Group B
protein	337	262
carbohydrate	1015	905
fat	675	430
Correction for fibre (kcal)	1976	1557
Correction for dietary protein digestibility (kcal) *	277	216

* Using factor value for Brazilian mixed diet, digestibility relative to reference proteins=82 (FAO/WHO/UNU, 1985 page 119)

For the girls from the high income families findings differed markedly. The average daily energy intake from the high income group girls slightly surpassed the recommended level of 2000 kcal, but this difference was not significant by T-test ($p = 0.8$). The 95 % confidence interval for the energy excess was 100 - 126.8 kcal. The 95 % confidence interval for the mean intake reveals that the observed range of 1900-2126 kcal includes the required level of 2000 kcal. This corroborates the finding that in general, their average daily energy consumption meets their average requirements.

The proportion of the dietary energy derived, for the low income group girls, from protein. carbohydrate and fat is estimated to be 16.5, 56.5 and 27.0 % of the total energy. respectively. In the high income group the estimated proportion is 16.6 % for protein, 50.1 % for carbohydrates and 33.3 % for fat. Mann-Whitney test indicates that the social groups were heterogeneous in relation to carbohydrate and fat contribution to the food energy ($p < 0.001$). Figure 8.1 illustrates this average percentage contribution to food energy.

8.1.1 Correction Of The Diet

In addition, as recommended by FAO/WHO/UNU (1985) the diet was corrected for available energy and dietary protein digestibility. Thus, the total available energy after correcting for fibre is 1557 kcal for the low income group girls and 1976 kcal for the high income group girls. The correction for digestibility of dietary protein is 277 kcal for the low income group diets and 216 kcal for the high income diets. It is important to note that these corrections do not alter the overall results.

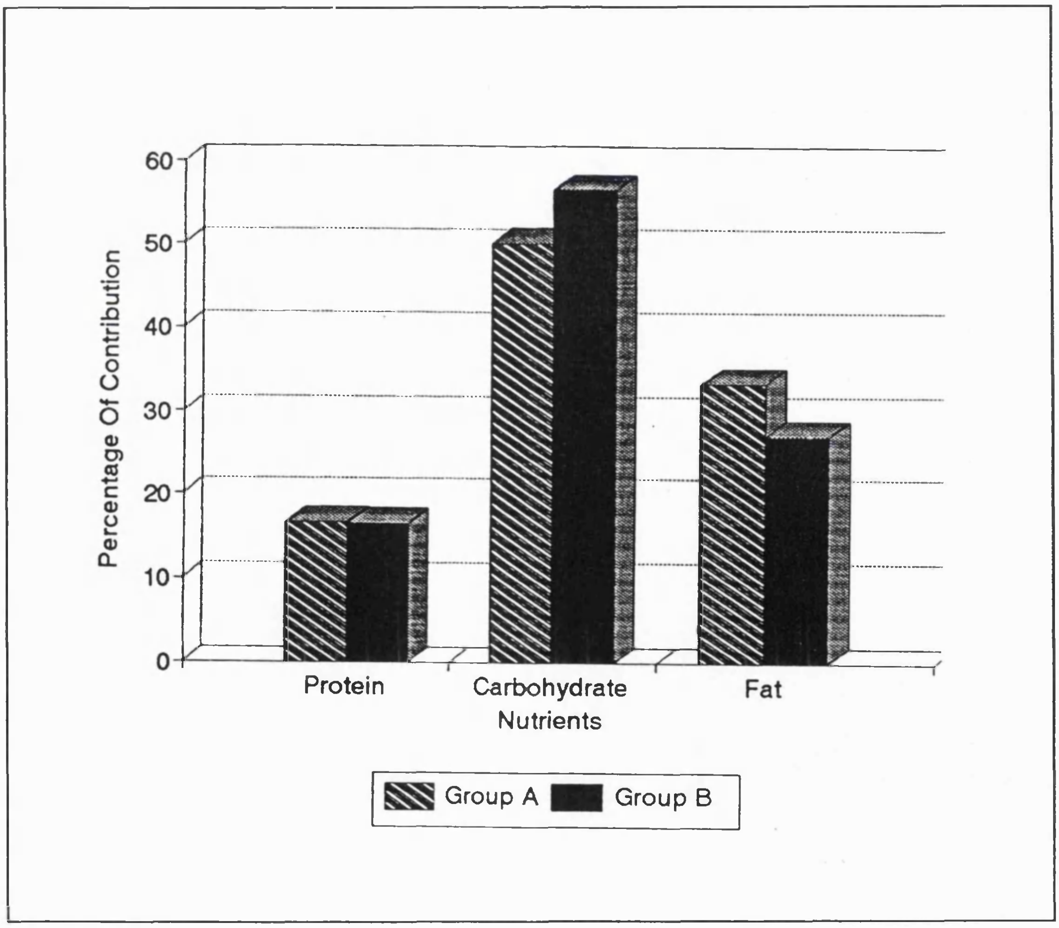


Figure 8.1 Percentage of protein, carbohydrates and fat contribution to the energy intake

8.1.2 The Safe Level Of Protein Intake

In general, the girls from both social groups met the recommended safe level of protein intake. The girls from the high income group achieved 2.2g protein/kg per day, while their counterparts attained 2.0 g protein/kg per day.

8.1.3 Vitamins And Minerals Daily Intakes

Table 8.4 shows the mean daily dietary intakes of vitamins and minerals according to the social group, and Table 8.5 displays the 95 % confidence interval for the nutrients by social groups.

Table 8.4 Mean daily dietary intakes and adequacy of vitamins and minerals

	Group A			Group B			
Nutrient	Mean	SD	% Ad.	Mean	SD	% Ad.	WHO R.I.
Vitamin A (μg)	869	887	120	1461	1659	201	575-725
Thiamin (mg)	0.9	0.3	100	0.7	0.2	78	0.9
Riboflavin (mg)	1.2	0.4	86	1.0	0.6	71	1.4
Niacin (mg)	16.6	11.6	107	16.9	4.2	109	15.5
Vitamin C (mg)	105.8	75.1	432	93.1	69.3	372	25.0
Iron (mg)	15.9	5.0	100	13.0	3.0	100	5 - 24
Calcium (mg)	0.6	0.2	100	0.3	0.1	50	0.6 - 0.7

For the girls of the high income families, the mean intakes of vitamin A, thiamin, niacin, vitamin C, iron and calcium were in agreement with the recommended levels. In addition, the mean intake of riboflavin was marginally below the recommended level.

In the low income group, the recommended intake level was achieved in relation to vitamin A, niacin, vitamin C and iron. There was a deficit in the mean daily intake of thiamin, riboflavin, and most markedly of calcium.

Table 8.5 Confidence interval (95 %) for the nutrient intakes

Nutrients	WHO	Group A range	Group B range
Vitamin A	600	589 - 1149	1039 - 1883
Vitamin C	25	81 - 129	76 - 111
Iron	14.8	14.3 - 17.5	12.2 - 13.8
Calcium	0.6	0.54 - 0.66	0.27 - 0.32
Thiamin	0.9	0.8 - 1.0	0.7 - 0.8
Riboflavin	1.4	1.1 - 1.3	0.9 - 1.2
Niacin	15.5	13.0 - 20.2	15.8 - 18.0

As can be seen, for the girls of the high income families average daily nutrients consumption met the recommendations of almost all the nutrients, with the exception of riboflavin which was less than is recommended.

In contrast, for the low income group girls, average daily nutrients consumption was less than is recommended for iron, calcium, thiamin and riboflavin.

8.2 Qualitative Properties Of The Diet

Table 8.6 shows a typical daily diet of the girls according to the social class. This typical meal was based on the information provided by the 24-hour recall.

Table 8.6 Typical daily diet of the Alagoan school girls according to the social class

Meals	Group A Food consumed	Group B Food consumed
breakfast	Banana milk-shake, egg, white bread, orange juice	white bread, margarine coffee, sugar
snack	soft drink, ice-cream cake or sandwich (ham and/or cheese)	popcorn, soft drink fruit (banana, mango, orange)
lunch	rice, beans, meat, soft drink or fruit juice	rice, beans, manioc farina, meat, macaroni
snack	soft drink, popcorn, (ham and/or cheese) sandwich, sweet	popcorn, soft drink
dinner	vegetable or bean soup cassava, meat, coffee, sugar, white bread, butter	cassava or sweet potato, dried meat white bread, coffee sugar

8.2.1 Milk And Milk Products

In the high income group milk was mainly consumed jointly with fruit, usually banana, or Nescau (chocolate mix) in the breakfast. Dairy products such as cheese, butter, condensed milk pudding, yogurt and other items were also often consumed.

In contrast in the low income group, milk and its products were poorly consumed.

8.2.2 Eggs

Another very typical breakfast item of the girls from the high income group was the

egg, which could be consumed fried, boiled or in egg-based dishes such as omelets for instance.
The low income girls did not mention very much the use of egg. According to the girls, in their income level, egg is considered an expensive item to be consumed daily. Sometimes it was used as a substitute for meat.

8.2.3 Meats

In the low income group chicken was the most frequently cited meat. Fish, especially sardine and crab were also frequently mentioned.
When beef was cited, it was mainly consumed as a typical dried preparation namely "carne de charque", which is not very expensive and can be easily found in the open markets. Liver was also often consumed.

In the high income group beef was the most consumed meat, especially as a "buttered fillet" at lunch time. Chicken was the second most cited meat. Fish and liver were poorly cited in this group. "Carne de sol" (dried meat) was often consumed in this group.

8.2.4 Vegetables

The consumption of vegetables in the low income group was more commonly beans, cassava, boiled sweet potato and yam than green vegetables.

A similar pattern was found in the high income group. The difference, however, was that the beans in this income group were used in different kinds of preparations and not only simply boiled. Only lettuce and tomato were cited as being used in salads.

8.2.5 Cereals

The most cited item in the breakfast and dinner of the low income group was white bread, which was usually consumed with margarine. At lunch time, polished rice and macaroni were the most usual preparations. Manioc flour was much used for lunch with boiled beans.

In the high income group, macaroni was consumed as a change from polished rice. White bread also was often cited as a base for sandwiches (ham and or cheese). Corn flour was used in both social groups for preparing "cuzcuz", a very typical dish from the Northeast region of Brazil.

8.2.6 Fruits

The use of fruit as a fresh juice was very common in the high income group breakfast, the orange being the most used fruit. Apple, grape, melon and banana were the most cited fruits in this group. However, during the day it did not appear so often as it did in the low income group. The girls from the low income families reported fruit intake during the whole day. Mango, water melon, orange and banana were the most cited fruits in this group.

8.2.7 Fats

The use of margarine was reported only in the low income group.

8.2.8 Cakes, Confectionary And Sugar

Sweets were mostly consumed by the high income group girls as snacks. The use of cakes, puddings, ice-cream, jam and savouries also occurred frequently.

In the low income group, sweets did not appear so often. Refined sugar was importantly cited by the low income girls as added to coffee.

8.2.9 Beverages

Coffee was the most consumed hot beverage in the low income group during breakfast and dinner time. In addition, soft drinks as "fanta", "guarana" and "coca-cola" were widely used in both social groups.

8.3 Discussion

The limitation imposed by the use of the 24-hour recall method for estimating nutrient and energy consumption must be borne in mind when interpreting the results of this section. Very little information is available regarding adolescent energy and nutrient intakes as well as food intake patterns in Brazil, especially for the Northeast region.

In this study, dietary information was translated to energy and nutrient intakes by using food composition values from Brazilian and Latin America tables. As the sub-sample studied (30 %) was randomly selected from the entire sample (n=352), the findings can be considered a reflection of intake for the sample as a whole. However, given the limitations of the 24-hour recall method, the results are not conclusive and inferences cannot be made.

The present findings demonstrate that in comparison to the well-off group girls, the low income group had lower intakes of calories and nutrients. The estimation of the 95 % confidence interval confirmed the energy deficit in this group in relation to their requirements as well. The exception was for the vitamin A of which intake was in average higher in this group. It is possible that the consumption of liver, mango and sweet potato helped the increase of vitamin A intake in this group.

In contrast, energy requirements were achieved by the high income group girls. Nevertheless, both social groups met the safe level of protein intake. Therefore, an energy deficit was more common than a protein deficit in the low income group. From the total available energy, the major caloric contribution came from the carbohydrate group regardless of the social condition, although the low income group showed significantly higher values. Coffee and sugar and soft drinks complemented the contribution. This finding, although related to adolescence, is in line with previous results for the Northeast region of Brazil, particularly referring to the low income group diet, in which the energy deficit was the most important problem (Lucena et al., 1964, Romani and Amigo, 1986). Also, in other developing countries the energy deficit was identified to occur in less privileged populations (Gopalan et al., 1983, Martorell et al., 1978).

Desai et al. (1980) found similar pattern of food intake among migrant worker families from the Northeast region of Brazil. Their typical diet also was based on rice, beans, white bread, macaroni, coffee and sugar. These items were responsible for providing the requisites for energy and protein.

It has been suggested that iron is essential for the process of skeletal maturation and therefore its deficiency can be a limiting factor for growth during adolescence (Brabin and Brabin, 1992, Harrison et al., 1985). Iron deficiency also has been related to reduced resistance to infection (Whitney and Rolfes, 1993). During adolescence, the iron requirements are increased not only because of the peak growth but also because in the case of females, iron intake must replace iron losses caused by the menstruation. The results indicated that iron deficiency was not apparently a problem in the high income group. The estimation of the 95 % confidence interval showed that the range included the recommended level. By contrast, the estimated range for the low income family girls did not included the recommended level. However, as neither parasite infestation nor biochemical investigations were carried out, any speculation about iron bioavailability seems inappropriate.

In the case of vitamin A, the results indicated that either social groups met the recommended intake. The large consumption of yellow fruits such as oranges and mangos in both social groups, as well as liver in the low income group helped the mean vitamin A intake to be met and even exceeded.

The intake of thiamin in the high income group was adequate in relation to the recommended level. In contrast, in the low income group the estimated 95 % confidence interval range did not included the recommended level. Thiamin is the vitamin which assists in energy metabolism. Prolonged thiamin deficiency has been linked to impairment of blood/circulatory system and nervous/muscular systems (Whitney and Rolfes, 1993; Bender, 1993). It is possible that the habit of eating white bread and polished rice has contributed to a such finding, since these two items are poor sources of thiamin (MAFF, 1992).

The low intake of riboflavin occurred in either social groups, although the apparent riboflavin and niacin sources such as milk, chicken, potatoes, white bread, beef, liver were present at the diet. Riboflavin has an important role in the release of energy from nutrients in all body cells. However, there is not much available information at the present time about the impact of riboflavin deficit.

The low consumption of milk and its products in the low income group possibly was responsible by their lower intake of calcium. The requirements for calcium reaches its peak at puberty during the adolescent growth spurt. This is because calcium is crucial for bone development. Low intakes of calcium has been linked to stunted growth in children (Bender, 1993; Whitney and Rolfes, 1993) and bone loss (osteoporosis) in adults (Whitney and Rolfes, 1993; Passmore and Eastwood, 1986). The dietary calcium absorption is dependent on vitamin D. Although the vitamin D intake was not analyzed it is possible that there was not a significant deficiency of this vitamin in the study sample. This is because vitamin D exists as a cholecalciferol form which can be obtained from sources such as oily fish, eggs, butter and margarine and as well as formed in the skin in sunlight. All these sources were present at the study sample. According to Bender (1993 page 283) "calcium-deficient children with adequate vitamin D nutritional status do not develop rickets but have a much reduced rate of growth." It seems than that more than vitamin D, calcium possibly is a limiting factor that contributes to an inadequate anthropometric performance. This corroborates the findings of slower rates of growth in the low income group girls who had low dietary calcium intakes.

8.4 Conclusion

The high consumption of vegetables, especially beans, potatoes and cassava may be the most important contributors of energy, protein, iron, thiamin and niacin daily intakes for the low income group. Vitamin C requirements were met in both social groups. Cereals also contributed to the intake of energy, protein and carbohydrates of both social groups, especially in the low income group.

The diets of the high income group seem to be balanced at least in terms of energy and protein intakes. The deficit registered for other nutrients demonstrates that being from an urban area and from a high income family does not necessarily signify to have good dietary quality. The formation of the dietary pattern largely occurs during the adolescent period. Woodward (1986) studying dietary patterns in Australia found that there were many factors which influenced adolescent food intakes: age, weight and fatness were the most important factors between the girls of the study. According to the author, the intake of non-bread cereals decreased with the increase of age. The intakes of cakes and desserts decreased with the increase in weight.

The low income group girls had a low energy intake and did not meet their energy requirements. This could imply that they had lower rate of energy expenditure. However, what remains unclear is whether such an energy and nutrient intake deficits are appropriate for responding to the incidence of reported morbidity and the growth phase requirements. The slower rates of growth and higher incidence of reported morbidity detected in the low income families girls suggest that perhaps diet played an important role during this phase of growth. Nevertheless, the precarious living conditions of the girls from the low income families make this question difficult to answer. This is mainly because the complexity of the environmental stresses can influence the relationship between nutrition and growth, and the evaluation of the diet sometimes is not able to express the long term effect of environmental exposure.

The present findings corroborates Hypothesis 5 which predicted deficient intake of energy in the poorest sector of the population. However, although the present study does not provide conclusive evidence implicating diet and rate of linear growth, it suggests that specific nutrient deficits can be a limiting factor that contributes to an inadequate anthropometric performance.

Chapter 9

Conclusion

This thesis has addressed the health, maturation and anthropometric issues related to the linear growth during adolescence in a developing country urban context. The discussion started with pointing out the significant lack of information about the performance of linear growth during adolescence in a developing country. By consequence, the contribution of puberty in determining adult stature has been neglected.

In Brazil, recent data indicated that there has been a reduction in the prevalence of malnutrition related to weight-for-height (wasting) in the last decade. By contrast, low height-for-age (stunting) is still prevalent in a large percentage of the Brazilian population. In addition, Brazilian children height-for-age deficits at age 7 in relation to the NCHS references seem to remain at adult age.

The controversy about the body size seems to be important not with reference to final adult body size, but in relation to the slowing of the rate of linear growth causing the growth impairment.

Based on this information one opportune question has been raised: Does stunting or mild growth retardation stage carry any additional risk or repercussion in the adolescent group?

Some recent studies comprising the contribution of the pubertal spurt to the final adult stature suggest the possibility of a "catch up" growth during adolescence. Although these studies are not conclusive, they indicate that perhaps different environmental conditions would lead to differential responses that would or would not limit the possibility of a "catch up" occurring. Therefore, more investigation is necessary in this particular area.

Based on this fact, one more question has emerged: Is there a possibility of a "catch up" growth occurring during adolescence in a growth retarded subject?

The longitudinal approach was used in this thesis to study growth performance during adolescence. However,in addressing linear growth performance in the urban context of a developing country, a wide spread of variables need to be represented and considered. Therefore, comparisons between adolescents of different social status seems to be appropriate because it expresses not only differences of income but also differences in environmental stresses. A brief analysis of the social conditions presented in Chapter 3 corroborates this expectation. The low income family girls lived in a poor housing conditions, where the basic sanitary conditions were not ever achieved.

One consequence of this can be related to the higher incidence of reported respiratory infections, which has been attributed to overcrowded conditions in the habitat (Victora et al., 1986, Passmore and Eastwood, 1986, Grantham-Mcgregor, 1990).

On the other hand, as discussed in Chapter 6, the "growth status" also contributed to the morbidity profile of the Alagoan school girls. It can be noted that the interactions among environment, health and linear growth are complex and difficult to interpret precisely. That is why in this thesis, the approach used to evaluate the growth performance was the longitudinal comprising comparisons between distinct social status considering the characteristic of the maturity stage. As discussed before in Chapter 2, this division by maturity stage makes the data analysis rather static, however, it allows comparisons independent of discrepancies in the attained height values, but considering its effect. Consequently, menarcheal age reflected not only the maturity stage, but also was used as a proxy for the growth phase.

The cross-sectional analysis of the anthropometric profile of the sample on enrolment to the study indicated that the low income family girls were significantly shorter than their counterparts from the age 9 to 13 years. Nevertheless, although the low income group girls displayed the lowest values for weight and BMI, the between group differences were not significant.

These findings support the hypothesis that underweight and wasting are not expected to have high incidence in Latin American countries (Victora, 1992, Monteiro et al., 1991, United Nations, 1990, Keller, 1988).

Therefore the confounding effect of a weight deficit over the growth during the adolescence was excluded. The question was raised as to whether growth retardation would contribute to differential response in the growth performance of the social groups.

When the annual standing height increments were compared between social groups in Chapter 7, it was seen that the low income group girls had slower rates of growth in comparison to their peers regardless of the maturity stage (pre-menarcheal, post-menarcheal or even without considering menarche). This finding could be an indicative of maturation delay. Thus, in trying to seek evidence for such a maturation delay, the menarcheal age and the annual sitting height gain were investigated.

The low income group girls experienced menarche 5 months later than the girls from the high income families. Although the annual gain in fat at the suprailiac site was identified by multiple regression as the most important contributor to age at menarche, the post-migration environment and "growth status" influences can not be neglected. This assumption is based on the fact that an acceleration in age at menarche was found in the girls in relation to their mothers. Previous studies have associated this acceleration between mothers and daughters to changes in environmental conditions (Damon et al., 1969). On the other hand, the impact of the gain at the suprailiac site in the age at menarche can be explained by the assumption that the endocrine factors responsible for the puberty may be dependent on body fat (Passmore and Eastwood, 1986).

The estimation of the annual sitting height gain demonstrated that the pre-menarcheal group from the low income families gained proportionally more in legs than in trunk. This finding suggests that during the study year they were experiencing a spurt in legs, or still gaining in leg length. This fact related to the older ages 12 and 13 may be an indicative of a delay in pubertal spurt.

The present findings do not however necessarily resolve the question of whether "true complete catch-up" growth occurs during the adolescent spurt. This evidence would be obtained only if the whole pubertal spurt had been covered.

In addition, during the study year the higher incidence of reported morbidity was found in the low income group. Income, age, "growth status" and number of siblings were associated with this higher incidence of morbidity. Nevertheless, morbidity did not have a significant impact neither on height gain nor on weight gain.

The annual weight gain was associated more with the maturation process rather than with other factor. For instance, in the pre-menarcheal phase the low income group girls gained less weight than their counterparts. In the post-menarcheal phase the annual gain was similar in either social groups.

The analysis of fat increments during the study year, demonstrated that the yearly fat gain was statistically significant in some of the specific skinfold sites, as presented in Chapter 7. Nevertheless, the biological importance of these results could be interpreted as being minimal due to the small values obtained as a consequence of the fluctuation of the positive and negative increments. The monthly changes at specific sites presented a very high variability not only troughout the months but also across the social groups in the different age ranges. The fluctuation across the months suggests the possibility of a seasonal effect. However, the contribution of the heterogeneity within and between the subjects and the inclusion of measurement errors on the results can not be neglected. The overall results of the monthly fat changes could be an indication that perhaps the analysis of fat increments considering the period of one year may not be accurate to detect differences in fat deposition during adolescence.

It is important to notice that given the innacuracy of the 24-hour recall method, the dietary results need to be treated with caution. Diet did not seem to be a limiting factor to the annual weight gain of the low income group, although an energy deficit has been identified. This could be an indication that in this sample, the dietary energy deficit could be matched by a lower rate of energy expenditure. In this study, the physical activity level was not measured but cross information given by the mothers indicate that the girls were not engaged in heavy physical activity related to working condition. This could explain the tendency of the low income girls to display similar annual fat gains as their peers. However, this assumption is speculative.
On the other hand, diet may have contributed to slower rates of linear growth in this group. The estimation of the 95 % confidence interval indicated that the low income group diets had low intakes of calcium and iron. These nutrients have been associated with slower rates of growth and stunting (Bender, 1993, Whitney and Rolfes, 1993, Brabin and Brabin, 1992, Harrison et al., 1985).

Finally, the findings of this thesis tend to re-enforce the impression that socio-economic factors still play important role on linear growth during puberty. An assumption that underlies most of the discussion on the interpretation of the growth performance in different social groups during adolescence is that, after excluding any impairment of body weight, there is a high association between "growth status" and rate of growth. This finding corroborates the one reported by Monteiro et al. (1992) which indicated that the Brazilian children height deficit found at age 7 would persist until adult age. What remains answered is if the maturation delay would allow the height deficit to be maintained or if the slowing of the rate of growth would increase the height deficit.

Nevertheless, although this thesis has given an important contribution to the understanding of the linear growth of the Brazilian population of the Northeast region it does not provide conclusive information about the issue. Consequently, more longitudinal investigation has to be made in this group to access the causality of such performance. The results suggest that possibly the inclusion of the adolescent group in the monitoring health policies of Alagoas state may be an appropriate strategy for controlling the performance of the whole linear growth of the Alagoan population and of the Northeast region itself.

APPENDIX A

THE SOCIAL QUESTIONNAIRE FORMAT

SECTION 1 - IDENTIFICATION AND FAMILY DATA

NAME OF ADOLESCENT : ________________________________

NUMBER : _______________ GROUP : ____________
AGE : ________ YEARS : _______ MONTHS : __________

"Could you tell me your status in relation to this girl?"
STATUS OF RESPONDENT : MOTHER ___ FATHER ___ OTHER ___

"Good! Now I would like to ask you a few questions about your family, as well as about your home. All right?
How many siblings does this girl have?"
BROTHERS _____ SISTERS ______ TOTAL _____

"What is the age of the sib that follows her?"
AGE ______ YEARS _____ MONTHS _____

SECTION 2 - PLACE OF BIRTH AND MIGRATION

"Now, could you tell me please the name of the place you, your husband and the girl were born?"

	NAME OF PLACE	URBAN	RURAL	FEDER. UNIT
MOTHER	______________	____	____	__________
FATHER	______________	____	____	__________
GIRL	______________	____	____	__________

TO THOSE GIRLS WHO ARE NOT BORN IN MACEIO:

"Could you tell me please, the age of your daughter in the time of the migration to maceio?"
AGE _______ BEFORE 5 YEARS ___ AFTER 5 YEARS ___

"Could you tell me please, what made you leave the place you were born?"

JOB _____ EDUCATION ____ IMPROVING LIFE ____ NSR ____
OTHER REASON ____

"Now could you express your opinion about your present situation, i.e., after moving to Maceio has your life..."
IMPROVED ____ STAYED THE SAME ____ WORSENED ____
DO NOT KNOW EVALUATE ____

"Very good! Now could you help me to explore the housing conditions? All right, let's begin."
"Is there any toilet here?" YES ____ NO ____
"How many?" NUMBER ____
"Where is it?" INSIDE HOUSEHOLD ____ OUTSIDE ____ BOTH ___

"How many rooms, including kitchen and bathroom does this house have?"
NUMBER OF ROOMS _____

ENVIRONMENTAL CONDITIONS:
A - WATER SOURCE SPRING WATER/STATE WATER BOARD ____ 2
LORRY/COMMUNITY TAP ____ 1
ALL OTHERS ____ 0

B - ELECTRICITY YES ____ 1
NO ____ 0

C- DOMESTIC WASTE DISPOSAL DOOR COLLECTION ____ 2
SKIPS ____ 1
OPEN PLACE/OTH. ____ 0

D - WASTE LEAVING HOUSE CLOSED SYSTEM (PIPED) ____ 1
ALL OTHER ____ 0

E - WASTE LEAVING THE AREA SEWAGE SYSTEM ____ 2
PIT LATRINE ____ 1
ALL OTHERS ____ 0

TOTAL ______

"Very good! Now we are just finishing this inquire. Before we end, I would like to say that it is very important for this research to know how much is the income of this household. I know that this is a question of your privacy, hence no one else will know specifically what you tell me. All right? Would it be possible for us together to calculate how much this income is? Who contributes to the budget? Is his/her job earning paid: daily, weekly or monthly basis?"

INDIVIDUAL SUM/DAY DAYS WORKED L.WEEK TOTAL AMOUNT

________ _______ ________________ ________

________ _______ ________________ ________

INDIVIDUAL SUM/WEEK WEEKS WORKED L.MONTH TOTAL AMOUNT

________ ______ ________________ ________

________ ______ ________________ ________

INDIVIDUAL SALARY/MONTH TOTAL AMOUNT

________ ________

DAILY _______ WEEKLY ______ MONTHLY ______
TOTAL __________

"Thank you very much for your attention, and help. Could you please tell me the better day, in some weekend, for you to meet the main investigator?"

DATE OF MEETING SATURDAY _____ SUNDAY _____ HOUR ____

APPENDIX B

PARENT'S LETTER

FROM : MARIA DE FATIMA MACHADO DE ALBUQUERQUE
TO : PARENTS

Dear parents,

The main aim of this letter is to ask your permission for your daughter to participate of a research namely "GROWTH PERFORMANCE OF ADOLESCENTS IN MACEIO". This investigation is the PhD thesis' theme of Maria de Fatima Machado de Albuquerque, lecturer of the Universidade Federal de Alagoas - Department of Nutrition. If you allow, then your daughter shall be examined in the aspects related to her nutritional status, as well as her growth performance. I shall measure her, once every month during one year. As a complement of the work, it will be necessary to measure the parents once in a year. Of course I would not like to disturb you so, all the measurements of the girl will be made in the school and yours shall be made in your house, in a convenient day to you. Also, I would like to say that all the results shall be of your knowledge any time you want. It is only necessary to make an appointment with me with an antecedence of 2 weeks.

Thank you very much for your attention.

Yours sincerely

Fatima Albuquerque

MARK X WHERE CONVENIENT YES ____ NO ____

APPENDIX C.1

DIETARY INTAKE FORM

"Welcome to our dietary survey. I would like to ask you a few questions about your feeding, all right? Please, give me the name of everything you ate and drank yesterday. It is important that you make an effort to remember and give the specific names and amounts of foods,e.g., not only salad but onion, tomato, and lettuce salad. Well, let's begin:

NAME: ____

NUMBER:______________ GROUP: ____________
AGE: _________ YEARS: _________ MONTH: ____________
DATE: _________

BREAKFAST: TIME OF DAY: _______

NAME OF FOOD	AMOUNT	NAME OF FOOD	AMOUNT
____________	_________	______________	_________
____________	_________	______________	_________
____________	_________	______________	_________

BETWEEN MEALS: TIME OF DAY: ________

NAME OF FOOD	AMOUNT	NAME OF FOOD	AMOUNT
____________	_________	______________	_________
____________	_________	______________	_________

NOON MEAL: TIME OF DAY: ________

NAME OF FOOD	AMOUNT	NAME OF FOOD	AMOUNT
____________	_________	______________	_________
____________	_________	______________	_________
____________	_________	______________	_________

BETWEEN MEALS: TIME OF DAY: _________

NAME OF FOOD	AMOUNT	NAME OF FOOD	AMOUNT
____________	_________	______________	_________
____________	_________	______________	_________

EVENING MEAL: TIME OF DAY: __________

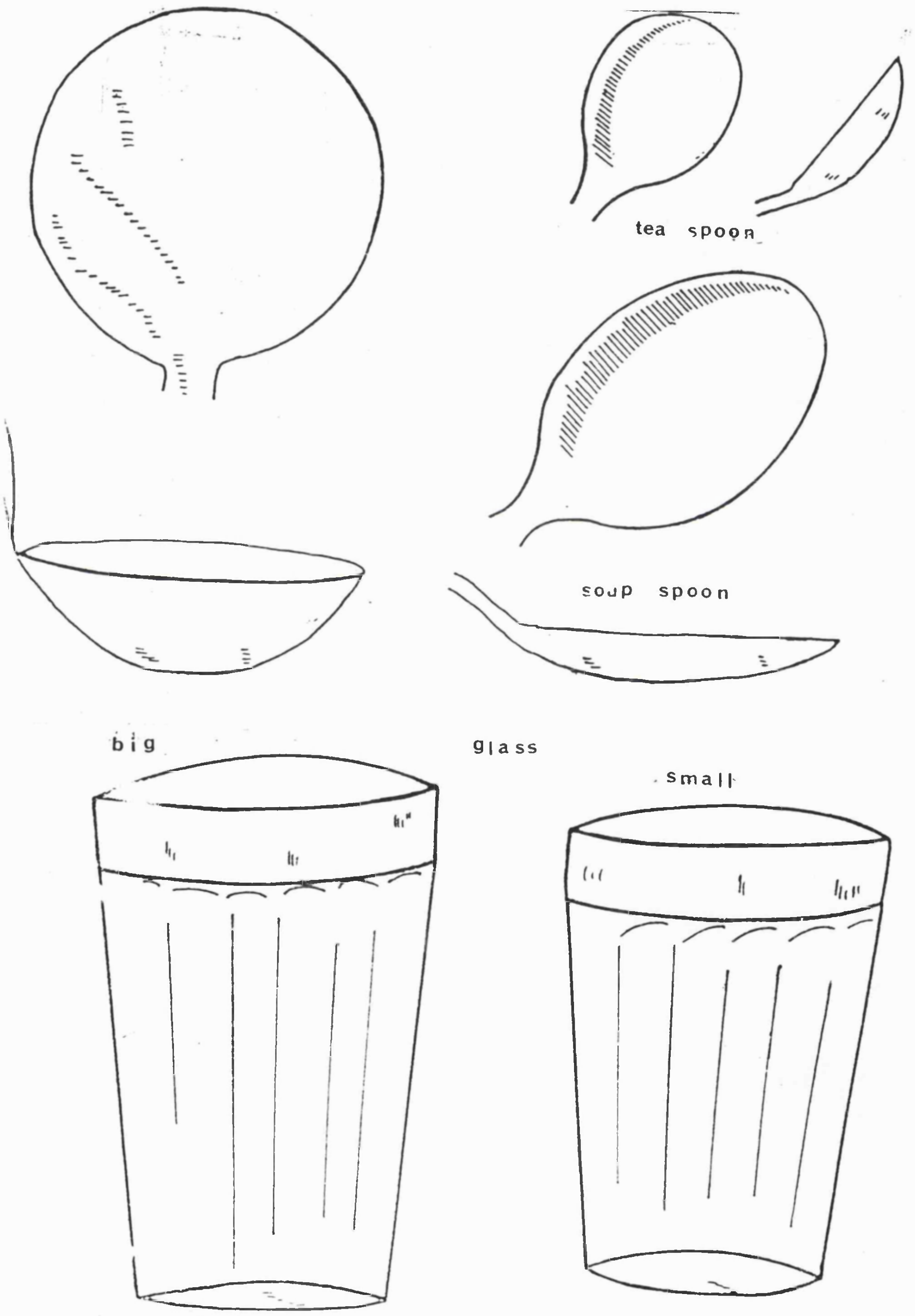
NAME OF FOOD	AMOUNT	NAME OF FOOD	AMOUNT
______________	__________	________________	__________
______________	__________	________________	__________
______________	__________	________________	__________

BETWEEN MEALS: TIME OF DAY: __________

______________	__________	________________	__________

APPENDIX C.2

STANDARD HOUSEHOLD MEASURES
reduced to 65%



APPENDIX D

MENARCHE QUESTIONNAIRE

Question "I am going to ask you a very private question. But, before asking I would like to tell you that the information you are going to give me is very important to this study. Is it all right? Do you know what is menstruation?"

Answer 1 - yes ______ 2 - no ______

Question "Have you had your first menstruation?"

Answer 1 - yes _____ 2 - no ________

If **yes**,

Question "When did you have your first menstruation? Can you remember?"

Answer 1 - do not remember _____ 2 - remember a. year ______

b. month and year ______

c. age ______

If **2.a or 2.c**,

Question "Let me help you... Can you remember whether it was near":

"new year" (january) ______ "carnival" (february) _______

easter" (april) _______ "Sao Joao party" (june) ______

"independence day" (september) _____ "Republic day" (november) _____

"christmas" (december) _______

APPENDIX E

REPORTED MORBIDITY QUESTIONNAIRE

Question "How is your health?"

1 - Good _______ 2 - more or less _____ 3 - not good _______

If **2 or 3**,

Question "What are you feeling?"

1 - cold/cough ______ 2 - diarrhoea ________ 3 - others _____

Question "For how long have you been with this symptom?"

1 - one day ______ 2 - more than one day _______

APPENDIX F

TIMETABLE

ACTIVITY	M O N T H S SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SE
contacts	——
pil.stu.	—
survey	————————————————————————

APPENDIX G1

Mean and standard deviation of attained values at specific skinfold sites of Alagoan girls without menarche by social class (A and B) and age range in the months of October/90 and September/91

Social class	Age	No.	Mth	Triceps Mean	Triceps SD	Biceps Mean	Biceps SD	Subscapular Mean	Subscapular SD	Suprailiac Mean	Suprailiac SD
	9.5	15	Oct	12.3	5.5	8.3	3.8	12.1	7.8	12.9	7.4
			Sep	12.1	5.0	8.1	3.9	11.8	6.8	13.1	7.9
	10.5	33	Oct	14.1	4.5	9.6	4.0	12.0	5.7	15.2	7.6
			Sep	13.3	4.5	8.9	4.1	11.7	5.9	13.5	6.5
A	11.5	33	Oct	13.6	5.3	9.3	4.4	12.2	6.9	15.4	7.8
			Sep	12.6	4.9	8.3	3.7	12.3	6.4	13.5	6.0
	12.5	12	Oct	13.9	6.6	8.3	3.2	11.3	5.8	12.6	7.3
			Sep	13.6	4.8	8.1	3.3	12.4	5.4	13.6	6.6
	13.5	2	Oct	12.3	2.2	8.2	1.1	8.8	0.1	12.0	2.8
			Sep	13.1	0.5	7.9	1.8	9.9	2.2	9.5	1.2
	9.5	20	Oct	11.1	3.3	7.6	2.7	9.0	3.9	10.9	5.9
			Sep	10.6	3.7	7.5	2.9	9.3	3.8	10.8	4.4
	10.5	56	Oct	9.9	3.2	6.9	2.7	9.5	5.3	9.5	6.0
			Sep	9.9	3.0	6.3	2.0	9.3	4.0	9.3	5.1
B	11.5	33	Oct	10.8	3.5	7.0	2.5	9.6	4.0	9.7	5.0
			Sep	11.1	4.8	7.0	3.7	10.6	6.3	11.2	6.8
	12.5	20	Oct	9.7	3.1	6.9	2.7	9.6	4.1	9.7	4.9
			Sep	10.1	2.9	5.9	1.5	9.9	3.2	10.5	4.8
	13.5	10	Oct	11.8	5.5	7.9	4.4	11.0	7.0	10.5	7.7
			Sep	12.1	5.6	7.1	4.0	12.3	7.5	12.2	7.5

APPENDIX G2

Mean and standard deviation of attained values at specific skinfold sites of Alagoan girls with menarche by social class (A and B) and age range in the months of October/90 and September/91

Social class	Age	No.	Mth	Triceps Mean	Triceps SD	Biceps Mean	Biceps SD	Subscapular Mean	Subscapular SD	Suprailiac Mean	Suprailiac SD
	9.5	3	Oct	18.5	6.7	11.5	4.8	20.5	9.2	19.2	5.2
			Sep	18.3	7.5	10.4	5.8	21.0	9.9	22.1	9.6
	10.5	3	Oct	17.2	7.3	11.8	5.2	19.0	10.3	24.8	13.1
			Sep	15.7	4.7	10.3	4.3	19.3	9.3	20.7	3.0
A	11.5	16	Oct	14.4	5.1	10.2	5.0	14.2	6.6	16.1	7.9
			Sep	14.8	5.0	9.7	3.6	14.4	7.2	16.8	5.8
	12.5	14	Oct	15.6	6.4	9.5	3.9	13.6	6.2	17.5	8.7
			Sep	15.8	6.9	10.2	5.0	14.8	6.8	17.6	8.8
	13.5	14	Oct	17.2	4.9	10.5	4.1	13.3	5.4	17.4	6.3
			Sep	16.7	5.4	10.0	3.5	13.6	5.3	19.2	6.0
	9.5	1	Oct	11.9	-	10.9	-	10.1	-	14.7	-
			Sep	8.3	-	6.1	-	10.0	-	9.9	-
	10.5	2	Oct	12.9	2.6	7.7	0.3	9.4	0.7	12.4	2.2
			Sep	11.1	0.8	7.7	0.2	8.4	0.1	10.0	2.1
B	11.5	15	Oct	13.6	5.0	8.0	2.1	13.5	6.3	15.3	9.4
			Sep	14.2	5.5	7.8	2.7	14.5	8.0	16.6	7.5
	12.5	25	Oct	13.0	5.0	7.7	3.2	13.3	6.4	13.3	6.3
			Sep	13.5	5.6	7.7	3.6	14.1	7.0	15.6	6.8
	13.5	25	Oct	12.7	4.3	7.9	2.6	11.5	4.1	12.6	5.7
			Sep	12.9	3.7	7.9	2.7	12.6	4.6	14.9	6.2

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