



# GROWTH AND MATURATION IN HUMAN BIOLOGY AND SPORTS

*FESTSCHRIFT HONORING ROBERT M. MALINA  
BY FELLOWS AND COLLEAGUES*

PETER TODD KATZMARZYK  
MANUEL J COELHO E SILVA  
EDITORS

IMPRESA DA  
UNIVERSIDADE  
DE COIMBRA  
COIMBRA  
UNIVERSITY  
PRESS

# ROBERT M MALINA: CONTRIBUTIONS TO THE STUDY OF PHYSICAL GROWTH, DEVELOPMENT, AND PERFORMANCE IN BRAZIL

*Maria Beatriz Rocha Ferreira*

## INTRODUCTION

It is a great pleasure to contribute to this volume in honor of Professor Robert M. Malina. His knowledge, wisdom and teachings were significant in determining my own professional career. This tribute highlights his professional ethics, systematic thinking in research, organization and accuracy of information, and friendship. These are several of his numerous gifts and the legacy that he has given to his students.

I met Professor Malina in Brazil in 1978 during a sports medicine conference in São Paulo. He made a significant impression on me. After that, I entered the Masters program at the Faculty of Physical Education at the State University of São Paulo (USP) where I conducted research on nutritional status and physical fitness in preschool children under the supervision of Miguel Zucas.

When the opportunity presented itself to pursue doctoral studies overseas, there was no doubt about my choice to study in the Department of Anthropology at the University of Texas, Austin, under Malina's supervision. It was dream come true. I started the PhD in 1982. It was an exciting and challenging experience, and I was always able to count on the support and guidance of Professor Malina.

His courses on Human Physical Growth and Development, Human Adaptability, Introduction to Graduate Physical Anthropology, and Human Adaptation and Evolution were superb and unique. With earned Ph.D. degrees in Physical Education and Anthropology, he was able to combine both fields in his courses and teaching. The subjects were always well structured and extremely well presented. My vision of the world changed with the knowledge that I acquired in his classes and research projects associated with courses taught by other professors at the University of Texas, such as Social Anthropology, Linguistics, Archeology, and Health and Nutrition in Latin America. Upon completing of my Ph.D in 1987, I have had the privilege of remaining in touch with Professor Malina and discussing research projects together.

Professor Malina is a world renowned scholar and researcher. He has many hallmarks. As a professor and research adviser, he taught his students how to focus

research goals clearly, conduct critical and precise literature reviews, select the appropriate variables and measurements to address the question, study and clean the data after collection; select the appropriate statistics, present the data, interpret results in light of the available literature, and write accurately. I have never seen anyone with the same capability to pick out a mistake among thousands of numbers and to know the exact page number of a bibliographical reference. His ability to synthesize is outstanding.

The first experience participating in a research team with him and other students was in a study of menstrual synchrony: "Environmental influences cause menstrual synchrony, not pheromones" (Little et al., 1989). To assess this influence we conducted a longitudinal study of 127 university students living in several houses surrounding a central courtyard. The results suggested that common environmental influences play an important role in the overall pattern of menstrual cyclicity.

### MALNUTRITION, PHYSICAL PERFORMANCE IN CHILDREN AND YOUTH

Professor Malina's knowledge and teachings on human biology and human variation touched me deeply. I have chosen to focus on a subject that Malina has written extensively about and that influenced my own professional life: the study of growth and development, motor development and performance, physical activity, and undernutrition in young children, in addition to socio-cultural and economic circumstances. Subsequently, the role of his research and thoughts in guiding studies and research under my supervision at the State University of Campinas (UNICAMP) is considered.

In the 1980s, protein energy malnutrition (PEM) and its relationships with low socioeconomic status was one of the main public health problems in underdeveloped areas of Brazil. This focus influenced my option to develop research in this area.

Perceptions of malnutrition vary according to cultural circumstances. In Western societies, it is a biomedical entity but with socioeconomic implications, while in the non-western world the focus is more often centered on cultural interpretations and to a lesser extent diet as a primary cause of the condition (Cassidy, 1982). Variability in the timing, severity and duration of dietary deficiencies, different methodologies and ambiguity in terminology, and general unfamiliarity with the etiology of malnutrition make it difficult at times to obtain a consensus among scholars on the specifics of PEM and its effects. However, Professor Malina's ability to synthesize information enabled his students to compare and interpret the findings (Malina, 1986, Malina et al., 1985, 1987).

PEM can seriously damage health of the individual. The most common consequences are stunted physical growth, reduced muscle mass, delayed maturation of the nervous system and motor development, decreased physical performance, decreased maximal oxygen consumption, delayed or perhaps impaired learning ability, increased susceptibility to infectious diseases, and elevated mortality (Spurr, 1993, Malina, 1981, Malina et al., 1981, 1990).

His paper (Malina, 1990), "Growth of Latin American children: Socioeconomic, urban-rural and secular comparisons," showed that trends in the growth status of low-income children in Latin America were consistent with those observed in other areas of the world. Children from low socioeconomic classes tended to be shorter, weigh less, and have reduced estimated muscle mass.

The relationship between undernutrition and physical performance has been another topic of his studies. Body size and proportions, physique, and body composition are related to physical performance. In particular, height and weight, together with age and sex, have been used to classify children and adolescents in various kinds of physical capacities (Malina, 1983, 1984, 1985, 1986, Malina et al., 1985, 1991, 2011, Peña Reyes et al., 2003a).

Changes in body composition, especially reduced lean body mass and muscle mass, may significantly affect performance. Reduced muscle mass in an undernourished individual is probably related to reduction in static and dynamic muscle strength, which may subsequently influence performance of other motor tasks (Malina, 1984, Malina et al. 1985, 1991). However, data showing this phenomenon are inconsistent among samples. For example, the correlation between grip strength and estimated body composition was low in mild to moderately undernourished Zapotec children in rural Mexico (Malina and Little, 1984), but was higher in undernourished Manus children in Pere village, Papua New Guinea (Malina, 1986, Malina et al 1987).

My doctoral thesis under his supervision, "Growth, Physical Performance and Psychological Characteristics of Eight Year Old Brazilian School Children from Lower and Upper Socioeconomic Background," was a significant contribution to the area due to the diverse set of variables (Rocha Ferreira, 1987). The results pointed to the same pattern identified in Malina's studies (1994, 1995), i.e., children from lower SES tend to be shorter and leaner, and to have poor physical performance and psychological characteristics. The exception of better results for the 9-minute-run can be explained by the lifestyle of low socioeconomic children. They walked to school and played in the street, and some of them lived on steep hills and therefore exerted greater physical effort to go to school, in contrast to the upper SES children, who tend to go everywhere by car (Rocha Ferreira, 1987, Rocha Ferreira, et al. 1991). Indeed, in his Oaxaca studies, stunted children did not differ from normal weight children in a distance run of either 8 or 12 minutes (Malina et al., 2011).

The logistics and structure of the research carried out under Malina's supervision laid the groundwork for my future field research in Brazil. I became a Professor in the Faculty of Physical Education at UNICAMP and created the Laboratory of Biocultural Anthropology (1988-2012).

In the 1980s, 1990s and 2000s, Malina visited Brazil on several occasions and had an unbelievable influence upon teaching and advising students. He presented short courses on Growth and Development at the Faculty of Physical Education and the Faculty of Medical Sciences of UNICAMP and also at the School of Physical Education and Sports of the State University of São Paulo (USP), and conferences at several international sports science symposia hosted by the Center for the Study of the Physical Fitness Research Laboratory of São Caetano do Sul (CELAFISCS). The logic of his thinking, knowledge, and interpretation of the research influenced students and faculty and subsequent theses, dissertations and other publications in Brazil. During one of his visits, the Department of Adapted Physical Education at UNICAMP asked him to make a contribution in the area of adapted physical education. Although this was not his major focus of study, he lectured on the subject, and his teachings and writings are still important references.

## LABORATORY OF BIOCULTURAL ANTHROPOLOGY

Over the past twenty years, the Laboratory has conducted studies focusing on child growth and development from a biocultural view. The research developed in this Lab is associated with the Graduate Program of the Faculty of Physical Education and the Faculty of Medical Sciences – Child and Adolescent Health, at UNICAMP. Dr. Malina's influences can be observed in the projects, theses and dissertations developed in the Laboratory, several of which are subsequently summarized.

### Malnutrition and growth

The research conducted with preschool children from 4 to 6 years of age in different regions followed the same research design and produced similar findings as studies referenced by Malina. Research conducted with low-income children aged 4 to 6 years old in the cities of São Paulo (Rocha Ferreira and Zucas, 1981), São José dos Campos (Rocha Ferreira and Rocha, 1993, 1988), Limeira (Kube, 1995), Holambra (Eilert, 1997), Itapira (Arruda, 1997), and Ilhabela – 1989-1995 (Prado, 2000). Similar methods were used in the studies: anthropometry, motor tests and parent interviews or questionnaires dealing with socioeconomic status of the family, physical activity and infant feeding. Overall, the findings indicated similarities in patterns of growth and motor performance in the context of local social structure.

Although the cities varied with respect to population and geographical location, the conditions of diet, health, lifestyle and socioeconomic class were similar. For the preschool children, anthropometric dimensions depended largely on family social and cultural circumstances of the family interacting with susceptibility to infectious diseases and malnutrition among others factors.

The results were similar among studies. Boys performed better in motor tests than girls. Lack of physical (movement) activity among girls partially explained the poorer motor

performances. Low-to-moderate correlations suggested that motor performance was not highly dependent on body weight and stature. The low correlations and differences in direction were likely explained by the different backgrounds of the children (Rocha Ferreira et al, 1998). To better understand the relationship between body dimensions and performance, second order correlations, controlling for age and either stature or weight were used. Movements in which the body was projected (standing long jump and dashes) tended to have low negative correlations with body weight. Stature, when age and weight are controlled, had a positive correlation with jumping, agility, sit-ups, and speed. Stature as a proxy of overall body size and to some extent biological maturation suggests that the more mature children had better motor performances.

From the perspective of family structure, physical activity of children was associated with the habits of parents or other adults with whom they lived or interacted regularly. Lack of physical activity in and out of school, and sedentary lifestyle due to lack of opportunities and/or safe environments interfered with the full development of movement skills, i.e., coordination, agility, speed, strength, motor learning, and so on. The young child is essentially active and requires appropriate conditions of health and education to optimize growth and development (Rocha Ferreira and Rocha 1993, 1988).

In the academic year 1997-1998, I was Visiting Professor at the Catholic University of Leuven and had the good fortune to interact with Gaston Beunen and Roland Renson. Malina made a short visit to Leuven, and we exchanged various ideas about my research topics. One of the high points of my time at Leuven was the ceremony of Honoris Causa for Claude Bourcard, a former student of Professor Malina.

The interdisciplinary research of Professors Renson and Beunen over several years Belgium was extremely important for the continuity of my career and research pursuits. It was a turning point that encouraged me to develop research focusing on cultural studies with indigenous peoples relative to biological factors. This results in the development of another research sub-area in the Laboratory of Biocultural Anthropology at UNICAMP.

In studies of indigenous children in Oaxaca, Malina, colleagues and former students (Malina et al., 1981, Malina and Little, 1984, Malina and Buschang, 1985, Peña Reyes et al., 2003a, 2003b, among others) made significant contributions in the development of the laboratory and were fundamental to the doctoral dissertation of Tagliari (2006), "Growth, Physical Activity, Performance and Food Intake in 8 and 9 year old School Children in Rural, Urban and Indigenous Land in Paraná." Moreover, the opportunity to exchange ideas with Malina during his stay in São Paulo was important to the analysis of the data. Children living in rural and urban areas were heavier, taller, and had greater bone diameters, circumferences and skinfolds than those living on indigenous lands. These data were similar to observations of Oaxaca children (Peña Reyes et al., 2003a, 2003b).

Physical activities, games and entertainment were similar among the urban, rural and indigenous groups, while work activities were more frequent among indigenous youth.

Indigenous children tend to have higher scores on accelerometer measurements of physical activity. Rural and urban children, on the other hand, had better scores on performance tests, except for the sit and reach flexibility test, even when controlling for age, weight and height (Tagliari, 2006).

Indigenous children were also grouped on the basis of stature related to age, group 1 ( $< - 2$  z score) and group 2 ( $> - 2$  z scores). Children in Group 1 were, as expected, shorter, but were also leaner and had lower performance results and physical activity levels than children in Group 2. Children of both sexes in Group 1 also tended to come from households with lower income and with mothers having fewer years of schooling compared with Group 2. The results showed a social gradient in the indigenous land and its impact on growth, motor performance and physical activity of children. The characteristics of the indigenous socio-cultural context studied appeared to be less favorable for children with a possible growth deficit, thus contributing to less favorable development compared to other children in the same indigenous area and in rural and urban areas. The possible influence of genetic factors to variation in growth status between indigenous and non-indigenous children should be noted.

### Nutritional transition

The decrease in the prevalence of child stunting and wasting and the rapid increase in overweight and obesity is a current public health problem in the world. This nutritional transition, which is associated with the growing prevalence of chronic diseases in the adult population, is evident in different areas in Brazil, particularly among in the low-income population (Monteiro, 1995, Batista Filho and Rissin, 2003). Children are showing lower rates of physical activity, increasingly sedentary lifestyles, poor quality of diet, and increased prevalence of obesity, especially in urban centers.

Research conducted by Bracco (2001) and Bracco et al (2002) was influenced by discussions with Malina during another visit to São Paulo. The aim of the study was to compare the physical activity profile, energy expenditure from physical activity, and energy intake of children of both sexes in a low socioeconomic school population in the city of São Paulo. The results showed that even in a low socioeconomic population, obesity was more prevalent among children than stunting and wasting, pointing to the nutritional transition process. Higher energy expenditure from physical activity (reflecting their larger body sizes) but less time in physical activity was noted in obese children. Moreover, the obese also presented higher total energy intake and carbohydrate ingestion than non-obese children.

Longitudinal research by Figueira Junior (2009) compared physical activity level, physical fitness, and socio-cultural factors in adolescents in Santo André (metropolitan city) and São Bento do Sapucaí (rural town) in 1997 and 2007. The number of active adolescents increased in 2007 compared to 1997 in both regions and sexes. Muscular strength also increased for both groups between periods. The same trend was observed

for agility and trunk strength. Walking as health-related locomotion, positively contributed to total physical activity. Barriers to physical activity were greater in Santo André than in Sao Bento do Sapucaí in both years (2007 and 1997). The most common barriers to the practice physical activity in both years were shame of feeling overweight, lack of parent stimulus and lack of appropriate space (Figueira Junior, 2000, 2009). Multivariate regression showed that participation in physical education classes and siblings walking or riding a bike to or from school were variables that may favor physical activity in both regions.

In summary, Malina's contributions to studies on growth, development, maturation and physical activity in children and adolescents were immense and influenced many others in the field. I was also impressed by his dedication to youth as a baseball and soccer coach for his children and their friends. After his work at the University of Texas, I often noticed him spending afternoons coaching. I had the opportunity to enjoy some of these moments with him and his family. Moreover, I thank him, Eva, and the children for the Easter holiday gatherings, which I remember with great fondness.

## REFERENCES

- Arruda, M. (1997). Crescimento e desempenho motor: variação bio-sócio-cultural em pré-escolares de Itapira. *Doctoral dissertation*. Faculty of Physical Education at the State University of Campinas.
- Batista Filho, M. and Rissin, A. (2003). A transição nutricional no Brasil: tendências regionais e temporais. *Caderno Saúde Pública*, Rio de Janeiro, 19(Sup. 1):181-191.
- Bracco, M.M. (2001). Estudo da Atividade Física, Gasto Energético e Ingestão Calórica em Crianças de Escola Pública na Cidade de São Paulo. 120 f. *Master Thesis*. Faculty of Medical Sciences at the State University of Campinas.
- Bracco, M.M., Rocha Ferreira, M.B., Morcillo, A.M., Colugnati F., Jenovesi, J. (2002). Gasto energético entre crianças de escola pública obesa e não obesas. *Revista Brasileira de Ciências & Movimento*, 10(3), 29-35.
- Cassidy, C.M. (1982). Protein-energy malnutrition as a culture-bound syndrome. *Culture, Medicine, and Psychiatry* 6:325-345.
- Eilert, C.A. (1997). Crescimento físico e performance motora: um estudo em descendentes de Holandeses – Holambra. *Master Thesis*. Faculty of Physical Education at the State University of Campinas.
- Figueira Junior, A. (2000). A família, o adolescente e suas relações com a prática de atividades físicas em região metropolitana e interiorana do Estado de São Paulo. *Master Thesis*. Faculty of Physical Education at the State University of Campinas.
- Figueira Junior, A. (2009). Atividade física e aptidão física de adolescentes: similaridades e contrastes em uma década. *Doctoral Dissertation*. Faculty of Physical Education at the State University of Campinas.
- Kube, L.C. (1995). Crescimento e desempenho motor: alimentação e atividade motora em escolares de Limeira. *Master Thesis*, Faculty of Physical Education at the State University of São Paulo.

- Little, B. B., Guzik, D.S., Malina, R.M., Rocha Ferreira, M.B. (1989). Environmental influences cause menstrual synchrony, not pheromones. *American Journal of Human Biology* 1:53-58.
- Malina, R.M. (1983). Socio-cultural influences on physical activity and performance. *Bulletin Société Royale Belge d' Anthropologie et de Préhistoire* 94:155-176.
- Malina, R.M. (1984). Physical activity and motor development/performance in populations nutritionally at risk. In E. Pollitt and P. Amante (eds.): *Energy intake and activity*. (Alan R. Liss, New York), pp. 285-302.
- Malina, R.M. (1985). Growth and physical performance of Latin American children and youth: socioeconomic and nutritional contrasts. *Collegium Anthropologicum* 9:9-31.
- Malina R. M. (1986). Motor development and performance of children and youth in undernourished populations. In F.L. Katch (ed.): *Sport Health and Nutrition*. (Human Kinetics Publishers, Champaign, Illinois), p. 213-226.
- Malina, R.M., (1990). Growth of Latin American children: Socioeconomic, urban-rural and secular comparisons. *Revista Brasileira de Ciencia e Movimento* 4:46-75.
- Malina R. M., P.H. Buschang. (1985). Growth, strength and motor performance of Zapotec children, Oaxaca, Mexico. *Human Biology* 57:709-716.
- Malina R. M., Himes, J. H., Stepick, C. D., Lopez, F. G., Buschang, P. H. (1981). Growth of rural and urban children in the Valley of Oaxaca, México. *American Journal of Physical Anthropology* 54:327-336.
- Malina, R.M. Little, B.B., Shoup, R.F. and Buschang, P.H. (1987). Adaptive significance of small body size: strength and motor performance of school children in Mexico and Papua New Guinea. *American Journal of Physical Anthropology* 73:489-499.
- Malina, R.M., Little B.B. (1990), *Estimated body composition of boys 9-14 years of age from a rural Zapotec-speaking community in the Valley of Oaxaca*. In Para Conocer al Hombre: Homenaje a Santiago Genovés as los 33 Años como Investigador en la UNAM, edited by Tapia, L.L., (Mexico, DF: Universidad Nacional Autónoma de México), pp. 553-559.
- Malina, R.M., Bouchard, C. (1991). *Growth, Maturation and Physical Activity*. (Human Kinetics, Champaign, Illinois).
- Malina, R.M., Little, B.B., Buschang, P.H. (1991). Estimated body composition and strength of chronically mild-to-moderately undernourished rural boys in southern Mexico. Shephard Rj. Parizková J. (eds) *Human growth, physical fitness and nutrition*. (Basel, Karger), pp. 109-118.
- Malina, R.M., Peña Reyes, M.E., Tan, S.K., Little, B.B. (2011). Physical fitness of normal, stunted and overweight children 6-13 years in Oaxaca, Mexico. *European Journal of Clinical Nutrition* 65:826-834.
- Prado, J. M.S. (2000). A criança pré-escolar em Ilhabela: crescimento e atividade motora. *Master Thesis*. Faculty of Physical Education at the State University of Campinas.
- Peña Reyes, M. E., Tan, S.K., Malina, R. M., (2003a). Urban-rural contrasts in the physical fitness of school children in Oaxaca, Mexico. *American Journal of Human Biology* 15:800-813.
- Peña Reyes, M. E., Tan, S.K., Malina, R. M., (2003b). Urban-rural contrasts in the growth status of school children in Oaxaca, Mexico. *Annals of Human Biology* 30:693-713.

- Rocha Ferreira, M.B. (1987). Growth, physical performance and psychological characteristics of eight year old Brazilian school children from low socioeconomic background. *Doctoral Dissertation*. University of Texas at Austin, Department of Anthropology.
- Rocha Ferreira M.B.; Malina, M. R. & Rocha, L.L. (1991). Anthropometric, functional and psychological characteristics of eight-year-old Brazilian children from low socioeconomic status. Shephard R.J., Parizková J. (eds) *Human growth, physical fitness and nutrition*. (Basel, Karger), pp. 109-118.
- Rocha Ferreira, M. B., Rocha, L. L. (1993). Growth, physical performance and psychological characteristics of disadvantaged Brazilian preschool children. In: Duquet, W., Day, J. P. (org.). *Kinanthropometry IV*. (London: E & FN Spon), pp. 256-267.
- Rocha Ferreira, M.B., Rocha, L.L. (1998). Growth, Development and Socio-cultural Characteristics of Brazilian Preschool Children. In: Parizkova, J.; Hills AP (eds): *Physical Fitness and Nutrition during Growth*. (Basel, Karger), pp. 1-12.
- Rocha Ferreira, M.B, Zucas, S.M. (1981). *Estado nutricional e aptidão física em pré-escolares*. SEED-MED – Ministério de Educação e Cultura. Fundação Nacional de Material Escolar. Premio Liselott Diem.
- Spurr G.B. (1993). Nutritional status and physical work capacity. *Yearbook of Physical Anthropology* 26:1-34.
- Tagliari, I.A. (2006). Crescimento, atividade física, performance e ingestão alimentar em crianças indígenas, urbanas e rurais. *Doctoral Dissertation*. Faculty of Medical Sciences at the State University of Campinas.