Relationship between biological maturation, body composition and psychological functions. Longitudinal study

Doctoral dissertation

Eszter Völgyi

Semmelweis University
Sport Science Doctoral School

Supervisor: Dr. János Mészáros professor

Opponents: Dr. Júlia Pápai Scientific head co-operator, Ph.D.
Dr. Anikó Barabás, associate professor, Ph.D.

Chairman of the examination comittee:
Dr. Gábor Pavlik professor, D.Sc.
Memebers of the examination comittee:
Dr. Róbert Frenkl professor emeritus, D.Sc.
Dr. Márta Szmodis associate professor, Ph.D.
Dr. Tamás Szabó chief director, C.Sc.

Budapest
2008

TABLE OF CONTENTS

List of Tables

List of Figures

Chapter 1

THE PROBLEM

Introduction

As one of the consequences of continuous changes in the environment, the earlier biological maturation (menarche) can be observed in some of the Central European populations. These modifications, however, occur within the physiological range. According to the observation of Bodzsár (1) the menarche median varies between 12.6 and 12.9 years in Hungary. The 0.3 year difference depends first of all on the socio-economic status of the given family. According to the latest publication about 11,600 children (2), the menarche median has changed to 12.83 (12.76-12.91 with the 95% confidence interval).

The hormonal changes of puberty are related to the personal and social effects of physical changes and most importantly the time of changes. Being an early or late maturer (one year earlier or later than average) affects adolescents' satisfaction with their appearance and their body image (3). Earlier maturer girls experience more depression and anxiety (4), have lower self-esteem (5), and are generally less satisfied with their weight and appearance. They tend to be embarrassed by the fact that their bodies are more womanly in shape than those of their female classmates that emphasize a lean look. They are also more likely to have both emotional and behavioral problems.

Since the observed phenomena sources from the changes in socio-economic background, earlier maturation is evaluated as positive by the majority of human biologists (6-8). The advanced biological maturation may have also positive role on the actually measured physical performance scores. To eliminate these effects Demeter (9), Malina and Bouchard (10) suggested the comparison by the same biological maturational level, irrespective of differences between calendar ages.

Marked differences in the speed of sexual maturation may result an extra burden for the given individual. The most important effects were summarized by King (11):

- it is hard to assimilate the consequences of rapid changes in body dimensions, proportions and body composition,
- marked differences can be observed between the evaluation of the various environmental stresses,
- often stressed and increasing claim develops for the individual (personal) independence, however, it is limited by the environment,
- the plans for the future are being changed and the adolescent is preferring firstly that aims which are being realized in shorter time.

By the early observation of Wutscherk (12), Mészáros and Mohácsi (13) the difference between calendar and estimated biological ages can often reach the 5-6 years in relatively small sample of subjects (40-50 adolescents) with a similar chronological age. Since the differences in lifestyle and life standard of the families are sharply divided, it cannot be excluded that the more than 20 years ago observed difference is greater nowadays.

Tatár and associates (14) published significantly closer relationship between the life standard and level of biological maturation, than it was characteristic 15-20 years ago. Nevertheless, the difference between biological maturation and social maturation is increasing (14).

Changes in body fat and regional fat distribution have been described by several investigators (10, 15, 16). The sex difference in fat distribution develops during adolescence. Comparing the two genders in femoral and abdominal depots, adolescent males have more fat deposition in the trunk or abdominal region, while females accumulating their fat on their buttock and femoral areas (10).

Increasing evidence suggests a close association between early sexual maturation (SM) and obesity in girls and female adults. Earlier maturing girls are more likely to be obese than non-early maturers, and are at greater risk of developing overweight in adolescence and also in adulthood (17-20). Those who mature early also tend to have more of their subcutaneous fat on the trunk than others at the same age (20, 21). In previous studies, age at menarche was predominately used as the indicator of SM, and as a result, boys and girls at young ages could not be included. Although age at menarche has been

widely used as an indicator of females' SM and it is easy and cheap to collect (22), there are a few additional limitations when using it to study the relationship between SM and fatness. Studies from the development, psychology, and sociology literature suggest that pubertal development affects adolescents' emotional and social problems such as depression, anxiety, and risky behaviors, and there are gender differences (23, 24). It is possible that the interactions between biological maturation and social environmental factors play a role in the association between SM and obesity.

It is hypothesized that subcutaneous fat tissue acts as a secondary hormonal gland and adipose tissue influences the synthesis and release of hormones (e.g., leptin, estrogen), and thus promotes the onset of menarche (19, 25, 26).

A decline in the age at menarche was recently reported for US girls (27). Although it is possible that this recent drop stems from the concurrent increase in childhood obesity, few longitudinal studies of growth and development have been undertaken to specifically address the temporal relation between growth, adiposity, and the age at menarche. These data suggest that increases in relative weight are a consequence rather than a determinant, of the age at menarche and that secular changes in BMI and in the mean age at menarche could be independent phenomena (27).

Indicators of maturity showed the strongest alterations around menarche. In the majority of the physical characters (e. g. thickness of skinfold) adult values are achieved only a longer period after menarche, whereas others (e.g. dimensions of the head) terminate growth already largely by onset of menarche. It has been found that minimal development of thickness of skinfold at the time of menarche indicates a "second loss of body fat" in girls (28). In the same study authors found that in four different dimensions of personality (health, anxiety, neuroticism, power of concentration) menarche caused an interruption of the psychic development, and that in an adverse sense (28). Patton and colleagues (29) reported that levels of depression and anxiety increased with the secondary school years and girls had significantly higher rates at each school year level. Menarche marked a transition in the risk of depression and anxiety in girls.

Overweight individuals often report that they tend to eat more when they are tense or anxious. Obese persons eat more in a high-anxiety situation than they do in a low-anxiety situation, while normal-weight participants eat more in situations of low anxiety (30). Tóth and Sipos (31) found that girls with normal body weight have lower

level of anxiety than fat and obese counterparts, and they stated that there was a correlation between the state and trait anxiety in both groups.

According to theory and experimental results, self-efficacy makes a difference how people feel, think and act (32). In terms of feeling, a low sense of self-efficacy is associated with depression, anxiety, and helplessness (33). Tóth and Sipos (34) found statistically significant correlation between the trait anxiety and the self-efficacy toward physical exercise (SEPES). General perceived self-efficacy pertains to optimistic beliefs about being able to cope with a large variety of stressors. In contrast to other construct of optimism, perceived self-efficacy explicitly refers to one's competence to deal with challenging encounters. Perceived self-efficacy has continuously become a more widely accepted psychological construct used to explain and predict coping behaviors.

1.1. Significance of the Problem

Adolescence is regarded as a unique phase of human development. Among adolescent girls menarche is an important landmark in the process of growth and maturation (35). The onset of puberty has been viewed as a final marker for entry into adolescence, and thus has received a great attention in research. In general, timing of first menstruation (menarche) has been the subject of most research in this area. Early onset of puberty in girls has been regarded as a stressful event and therefore it is relating to deficits in their functioning. For example, early maturing girls have been found to exhibit significantly more behavior problems than their peers who menstruate on time (23). These early matures are more likely to have social and emotional problems such as depression and anxiety, and experience more intense conflict with parents than do their peers (36). That is, it is generally accepted that early onset of puberty is stressful for girls (37).

Results in experimental psychology have highlighted the significance of the social development and the changes in self-esteem that take place throughout the growth of the young child. In between 7 and 12 years of age, the children are emerging from the dominance of parents to where the peer group influence increases in importance (38). It is also in this period of growth that the children develop a sense of identity and an ability to socialize (39).

The most striking event in the whole process of female puberty is undoubtedly the onset of menstruation. The age at menarche is an important factor in health planning and psychology and is known to be influenced by genetic factors (40), environmental conditions (41), body stature and composition (42-44), socio-economic status (45), and level of education.

It is out of question that the earlier maturation can be evaluated as being positive by the clearly biological aspects; nevertheless it may have negative consequences, if the basis of qualification is psychological or social. Forrai (46) described the time course of different stages of psychological development. Since the psychologists differentiate by mental characteristics, this categorization, however, is significantly different classification as the one used by human biologists (47). The development of personality "only" follows the biological development, but in childhood and early adolescence the attributes never coincide.

The changes of body statures which is a characteristic of this age group is influencing the school-performance and psychological status of students (48). The appearance of psychological problems lead on behavioral and conformity disorders (49).

Patterns of pubertal maturation may have an impact on several risk factors associated with adult morbidity and mortality, such as obesity. And because many adolescents cannot assimilate the discrepancy of early menstruation, it is very important to know more and more from these influential factors.

1.2. Statement of the Problem

The purpose of this dissertation was to analyze and determine relation between biological maturation, physique characteristics, body composition and some psychological functions in girls. The aim of the comparative analysis is to qualify the initial differences and the time course changes in attitude to task solving, state emotion and trait emotion in girls with various sexual maturation (namely: early matures, average and late matures).

We also carried out measurements to determine the age at menarche and its correlation with body composition in different sexual maturation.

According to the above mentioned aims, the following questions were arisen in this dissertation:

1. Are there any statistically or biological differences in growth type, body composition and body dimensions among three various sexual maturation groups (early matures, on-time matures and late matures)?
2. Are there any differences in psychological variables (state- and trait-anxiety, coping) among early-, on-time- and late mature girls?
3. Is there any relationship between anxiety and self efficacy toward physical exercise?
4. Are psychological variables associating with the level of obesity?

1.3. Delimitations of the Study

The following delimitations were recognized in this dissertation:

1. Since the kinanthropometric measurements were carried out in Hungary, and the required body dimensions were taken by the same experienced investigator, according to the suggestions of the International Biological Program (50), the differences in reading accuracy can be excluded.

2. The calipermetric estimation of relative body fat content is a validated method, developed by Pařízková (51). The calculation of growth type (52) is a widely used validated procedure in kinanthropometrics and classic physical anthropologic comparisons. The estimation of these procedures was carried out by the accepted methods of literature.

3. All the psychological questionnaires were standardized and validated by different authors (53, 54). The Hungarian translations of these questionnaires are also standardized (55, 56).

1.4 Limitations of the Study

The present study was subject to the following limitations:

1. Our sample size is medium according to human biological and mathematical statistics definitions. This limit will be revealed in the degree of freedom when we are qualifying the relations and differences and that is why we cannot draw generalize the experimental outcomes to the population. We have to take into account that in the results of the study the statistically small and medium group size modifies the effects of the sampling error.

2. The organization of the data collection was a difficult task because of the teachers' and headmasters' resistance. Regrettably they reject us with reference to the protection of the lessons and rules of the schools, so we assume some unconcern affecting the measurements.

3. Because menarche was monitored at each measurement time by personal interview, in those cases where girls were too shy to report the onset of menarche verbally it was not possible to get the real time of the onset. Therefore, we used a retrospective question in written form to evaluate the first time of menarche, and increase the reliability of age at menarche.

1.5. Definition of Terms

ADAPTATION: It is a positive characteristic of an organism that has been favored by natural selection (57).

ADOLESCENCE: The period of transition from childhood to adulthood (3).

ANXIETY: A state of apprehension, tension, and worry. Synonymous with fear for some theorists, although others view the object of anxiety (such as a vague danger or foreboding) as less specific than the object of a fear (3).

BODY COMPOSITION: The chemical composition of the body (58).

COPING: The process by which a person attempts to manage stressful demands (3).

DEGREES OF FREEDOM: The number of values in a data set that is free to vary when restrictions are imposed on the set (59).

DEPOT FAT: Mathematically the difference between total body fat content and essential fat. Depot fat has two dominant fractions, as well as subcutaneous fat and visceral fat. The depot fat is the part of fat storage which can be easily mobilized during aerobic exercises (60).

ESTIMATION: One of the possible mathematical procedures for the calculation of scientific parameters. It uses the significant biological and statistical relationships (parallelisms, differences, conguerences, correlations etc.) between the dependent and independent variables. The results of this procedure can also be called as estimation (60).

FATNESS: The greater, than the human biologically required amount of depot fat. Relative body fat content ranging between 24-30% for females and 16-24% for males

is often evaluated as fatness. The more accurate qualification depends on physique and also habitual physical activity (60).

MATURATION: An innately determined sequence of growth and change that is relatively independent of external events (3).

MEDIAN: The 50th percentile or the score that falls midway in the range of ordered values (59).

MENARCHE: The first menstrual period (3).

OBESITY: An excessive amount of total body fat for a given body weight; ≥25 %BF for men and ≥ 32 %BF for women (61).

OVERWEIGHT: The state, when the body mass related to stature is greater than the respective reference datum, norm or reference. The overweight not means necessarily fatness or obesity (60).

PUBERTY: The period of sexual maturation that transforms a child into a biologically mature adult capable of sexual reproduction (3).

RELIABILITY: A measure of the consistency of the data when measured more than once under the same conditions (59).

RISK FACTOR: Characteristics that are associated with higher frequency of developing a specific health problem (60).

SKINFOLD (SKF): A measure of the thickness of two layers of skin and the underlying subcutaneous fat (61).

VALIDITY: The soundness or correctness of a test or instrument in measuring what it is designed to measure (i.e., the truthfulness of the test or instrument) (59).

1.6. Hypothesis

H_r: According to the observations of Frenkl and co-workers (6) and Kemper (7) the difference between the anthropometric characteristics of early, on-time and late maturers will be significant. However, the effects of settlement size will not be significant.

The characteristic changes in body dimensions and composition are the consequences of the well known endocrinological differences (62, 63). The results of predictive anthropometric studies show that the girls at the time of menarche reaches the 95% of their final stature (13), that is to say the fast period of statural growth finished.

Faster somatic development may have other significance. Human biologist and psychologist Bodzsár (64) call our attention to the significantly shorter childhood of early maturers. Many of adolescents cannot assimilate this discrepancy. Consequently we suppose lower level (lower, than in average maturers) of task solving functions in early maturers.

H_r: There will be difference in psychological variables among early, average and late maturer girls.

Overweight individuals often report that they tend to eat more when they are tense or anxious, and because early maturer girls are often being overweight, we suppose that there will be a relation between the time of menarche and level of anxiety.

H_r: There will be relation between the time of menarche and level of anxiety.

We suppose also that there will be a correlation between the biological and psychological attributes.

H_r: There will be a relation between the biological and psychological attributes.

Chapter 2.

REVIEW OF RELATED LITERATURE

Introduction

Puberty is one of the most difficult life period for children because of the physiological and therefore psychological changes. Different psychological reactions are the consequences of the changes in hormonal levels and body shape. To live puberty is more stressful for females than for males. Differences among girls in the time of maturation are more emphasized in girls. Experiences of girls are not uniform. Individual differences in girls' experiences became the focus of attention rather than documentation of universal storm and stress. In the case of the young adolescent, the large inter-individual differences in timing of pubertal change could not be ignored (65). A 12-year-old girl whose physical development is within normal ranges may look like a child or a fully developed adult, or may be somewhere in between. The timing of social events such as school changes and dating also exhibit variability. We all know 12-year-olds who date and 16-year-olds who do not. Socrates wrote that adolescents "are ready to contradict their parents, monopolize the conversation in company, eat gluttonously, and tyrannize their teachers" (66). Hall (67), the father of adolescent psychology, described the first part of adolescence as stormy and stressful. After all, every child experiences puberty, has stirrings of sexual arousal, and in Western countries, moves from elementary school to middle school, which places new social and cognitive demands on the individual (68).

Puberty is a period of growth and development between early childhood and adulthood. This is the period when a child transforms into adult. Growth and development of pubertal children have already been studied by many authors, but differences in methods and research philosophy resulted in divergent solutions.

Nevertheless one common finding is that earlier mature girls are more commonly suffering from psychological problems than on-time or late matures. The reason of these findings is the shorter time of preparation to be an adult in shape.

According to the topic of this dissertation the following themes will be summarized in this chapter:

- maturation of girls,
- determinants of obesity,
- psychological changes in childhood.

2.1. Maturation of Girls

"Maturation refers to the tempo and timing of progress toward the mature biological state" (10). People differ in their rates of maturation. The basic difference between growth and maturation is that growth focuses on size and maturation focuses on progress in or rate of attaining size (10). They are closely related to each other, both have a target to reach adult state. Growth and maturation are generally influenced by genes, hormones, nutrients, and by the environment where the human lives. This complex interaction of these factors is regulating the child's growth, neuromuscular maturation, sexual maturation, and general physical metamorphosis during the first 2 decades of life. Genotype and environmental factors together have a product so called phenotype, which is the child's physical or physiological characteristics (10).

The hormones of the endocrine system are important regulatory agents in the processes of growth and maturation. Endocrine secretions are essential for maturation, to reach the optimal genetical potential. The endocrine glands are themselves influenced by genetically determined regulatory mechanism. The nervous system is involved in regulating endocrine secretions. Because the nervous system has interactions with the external environments, the potential variation is numerous. The most important environmental factor which has an influence on growth and maturation is nutrition. It is difficult to specify other environmental factors, but for example it is often said that regular physical activity is also necessary for healthy growth (10).

Farkas (69) wrote that the date of the first menstruation as a signal for the occurrence of puberty is influenced by many factors. A part of these factors are endogenous (with a genetic background or as a result of physiological processes), the rest are

exogenous (natural and social effects), and they usually become manifest in a very complicated interaction.

Many factors are involved and they interact to each other to regulate the processes during puberty. Hence, the regulation of growth and maturation is complex.

2.1.1. Growth and variations of body built

Growth and development of children of the same chronological age often diverge so their biological ages also differ. Growth studies have a relatively long history in Hungary. The first data date back to the 1870s (70). The latest representative sample (55,665 subjects) contained measurements on three dimensions, and referred to various regions of the country with a diversity of territorial representativeness and age distribution (71).

After reviewed the related reports of puberty, Bodzsár found (72) that the ratio between transverse and saggital chest diameter to shoulder width as well as several of other body proportions assume stable value already before puberty and tend to stay unchanged even during the growth spurt of puberty.

With the onset of puberty the somatotype (one of the possible descriptions of physique) undergoes marked changes. Subcutaneous fat is accumulating in the females. The average somatotype moves from ectomorphic-mesomorph region into the ectomorphic-endomorph category. Endomorphy shows monotonous increase in the female except at the age of 10 to 11 years when it does not change significantly (72).

Data on body height and body mass from other Hungarian authors were reviewed by Pápai and associates (73), and they found that post-menarcheal girls were taller and heavier in all age groups. Pápai and Bodzsár (74) found in their study that body mass was rapidly increased between age 10 to 14 in Hungarian girls. Before menarche, the gain of lean body mass was intense, and body fat percentage was found to slightly decrease, however, after the onset it is markedly raised. Their findings indicate that around menarche the pattern of fat deposition becomes rearranged: subcutaneous fat on the limbs grows comparatively less while on the trunk a greater proportion of fat is deposited. These studies suggest that the body built of those girls who experience the onset of menarche earlier is more robust while late matures are more linear in body shape.

2.1.2. Timing of maturation and its influence

Being an early-maturing contains some risk. Early matures weigh more and are slightly taller than are their peers when pubertal growth is complete, and this persists throughout life. Early developers may not be as prepared for pubertal change as are late matures, because they have no time to prepare for it. Early matures seem to have a poorer body image and more eating problem scores than on-time or late matures (65). The reason to be an early maturer is still not clear. There is a disagreement among the researchers that sexual maturation has an effect on fatness or level of fatness has on the timing of sexual maturation.

Early-maturing children of both sexes are taller and heavier than their average- and late-maturing age and sex peers from about age 6 onward (10). Early maturers are closer to the adult stature in all ages. They also have more weight for stature at each age and these children stop growing in height first, and children in the other two maturity categories continue to grow for longer periods of time. In body weights, early-maturing children have greater average as young adults and have greater weight for stature than others. These trends suggest differences in physique and body composition among children who vary in maturity status (10).

The different maturing children also differ in relative body proportions during growth. Early-maturing girls tend to have relatively broad hips (relative to their bi-acromial widths) and, conversely, relatively narrow shoulders (10). Early-maturing girls have on the average larger measurements of muscle, bone, and fat in the left arm and calf (10).

Early matures, both boys and girls, may engage in “adult behaviors” at a younger age than later developers. By late adolescence, differences between early and late mature in social and sexual behavior disappear. Magnusson and his colleagues (75) attempted to understand why early maturing girls are likely to engage in smoking and drinking sooner than later maturing girls. They found that the effect was due to many early matures being older.

Those early-maturing girls who experience negative events are more likely to exhibit depressive affect than later maturing girls who experience the same events. Additionally, girls seem to be more negatively affected than are boys by being early developers (65, 76, 77). Brooks-Gunn found (78) that rises in estradiol, an estrogen

hormone, is associated with depressive symptoms and aggressive affect in 5th to 7th graders, however, the hormone levels account for only about 1% of the variance in depressive symptoms, with negative life events. While hormonal levels play an important role in adolescent behavior, they are not as important as changes in body shape, menarche, breast growth, and regional body fat.

Also, other non-biological events occur during the first years of adolescence, events that have great impact on girls. Stress is said to occur when an individual is confronted with an event that is perceived as threatening, requires a novel response, and for which an individual does not have an appropriate coping response available (79-81). In a 4-year longitudinal study of about 125 girls seen yearly, investigators discovered that depressive symptoms are increasing from 11- to 15-years of age (82). However, early maturation did influence the likelihood of an increase in depressive symptoms, although not as much as did life events. Some research report that early maturing girls have more difficulty moving to middle school in sixth grade than do their peers who are on-time or late matures and who therefore are not in the middle of puberty during this school transition (83, 84).

Timing of maturation is associated also with body image and eating behavior. Late maturing dancers have been found to be more satisfied with their bodies than their earlier maturing counterparts. Timing of maturation has less dramatic effects in girls who, although influenced by the cultural norms stressing thinness, do not have a professional requirement for thinness (85). Eating problem scores were higher for on-time than late maturing dancers; such differences were not found for non-dancers (86).

2.1.3. Relation between sexual maturation and obesity

The positive relationship between greater body fat content and earlier biological (sexual) maturation seems to be a well evidenced fact (6, 10, 16). Obese children have approximately an average biological advance between 1.0-0.5 years. This level of acceleration is remarkable.

Increasing evidence suggests a close association between early sexual maturation (SM) and obesity in girls and female adults. Wang (19) found that earlier maturing girls are more likely to be obese than non-early matures. He reported also that fatness (BMI and skinfold thickness) was associated with SM stages with early maturation in both

boys and girls, but the associations were in opposite directions. Compared with their peers, early maturing boys were thinner, whereas early maturing girls were fatter (19).

In the Amsterdam Growth and Health Study van Lenthe found that early maturing girls had higher sum in skinfold thicknesses than on-time maturers during the whole study. In conclusion, individuals who developed earlier in adolescence were, in general, more obese than those who were late-maturing. Rapid maturation seems to have long-term consequences for obesity and should therefore be considered a risk indicator for the development of obesity (87).

Adair wrote in her publication that the overweight prevalence rates were significantly higher in early maturing adolescents in all ethnic groups. The highest ratio (57.5%) was found among early maturing Afro-Americans girls (17). To be an early maturer means nearly double probability of being overweight (body mass index at or above the 85th percentile) (17, 88).

Garn and colleagues found out from two major studies with more than 16,000 white participants, that menarcheal timing is a major determinant of weight and fatness in early adulthood. Early-maturing women were slightly shorter than late-maturing females with about 1 cm in all age groups, but weigh 4 kg more. Early maturers had 30% more fat at age 30 than late maturers. The data suggest that maturational timing has a greater long-term effect on the level of fatness than the level of fatness had on maturational timing (88).

Early sexual maturation is one determinant in increased body weight in adolescents. Several studies have shown that, those female young adults who experienced menarche before 12 years of age are heavier and have more fat in proportion than late-maturing girls (88, 89). It has been shown that the size differences attributed to early menarche persist into later life. Longitudinal studies organized in the United States and the Netherlands (21, 90) also show a strong relation between early maturation and increased body mass index (BMI) and body fat, but the causal relationship of this association is controversial (25, 91).

Two major studies (91, 92) provided a strong evidence that Afro-American girls are earlier maturers. The data from the National Growth and Health Study show that this result reports for Black–White BMI differences among girls at age 10. From a different study it has been shown that BMI values were significantly higher in post-menarcheal

girls than in pre-menarche girls in similar age. However, at partial regression analysis BMI values were influenced by pubertal stage and by age, but not by menarcheal status (93).

Malina and Bouchard (10) found that early-maturing children of both sexes have more subcutaneous fat all ages from 7 to 17 years, but the differences are most marked during adolescence. Average- and late-maturing girls have similar fat thickness throughout, but the differences among the three maturity groups are not very large during the preadolescent years. There are some researcher for example Laron (94), who found that obese girls were taller than the controls up to age 14, with a statistically significant difference between 11 and 13 ($p<0.001$), and the bone age was significantly advanced between 9 and 11 years ($p<0.01$), but there were no significant differences in the age of appearance and development of the breasts (Tanner scales), pubic hair, genitalia, or age at menarche.

The critical weight or fat hypothesis has an interest as a mechanism for the onset of menarche in human females. It means that menarche is caused by a critical percentage fat or weight and the maintenance of the menstrual cycles requires a certain level to persist throughout. But based on available evidence, the critical weight (fat) hypothesis cannot be accepted. The significance of critical body composition (not only the fat and muscle ratios within the body) is more important. Hypotheses based on normal maturational processes, especially of the central nervous system, currently provide better explanations (95).

Frisch supports the critical weight hypothesis. He thinks that puberty occurs in the human female at a certain weight or with a particular body composition (96). In the rat, for example, puberty is reached at a set body size rather than at a specific age. Compelling support derives from the clinical observation that patients with anorexia nervosa and amenorrhea have a prepubertal or early pubertal pattern of gonadotropin secretion, which is reversed to the adult pattern in response to a weight gain. Among young ballet dancers, there is a high incidence of primary amenorrhea (failure to initiate the first menstrual cycle), secondary amenorrhea (loss of previously established menstrual cycle), and irregular cycles, which are clearly correlated with excessive thinness (96). A change in the fat/lean ratio may affect metabolism and hormone levels, which may delay menarche and menstrual cycles (97).

2.2. Determinants of Obesity

Data from almost all the countries of the industrialized (developed) world, and even those from the third world, relevant that a continuously growing proportion of children, adolescents and adults is overweight, fat or frankly obese (98). The prevalence of frank obesity in childhood and adolescence has more than doubled since the early 1960s (99).

In the weight maintenance, the simple energy balance equation (Energy intake = Energy expenditure) is quite valid because only limited changes are possible without changing body weight (100). This form of energy balance equation is quite useful because of the light it has shed on the nature of reported energy intake. When the energy stores are changing, the energy balance equation is most often used:

change in energy stores = energy intake – energy expenditure

Significant weight gain is a result of an imbalance between energy intake and energy expenditure; however, this simple statement belies the complex, multi-factorial nature of obesity and the numerous biological and behavioral factors that can affect both sides of the equation (100). Correlates of overweight and obesity or of body weight and body fat gain over time was summarized by Bouchard (16) in Table 1.

Table 1. Correlates of obesity or of body weight and body fat gain over time.

Variable	**Comment**
Age	• Childhood obesity is a risk factor for adulthood obesity • Body fat content increases during adulthood • Maximal rates of overweight and obesity are attained from 55 to 65 yr.
Gender	• Women have more body fat • Sex differences in prevalence of obesity vary in populations or among ethnic groups
Socio-economic status	• More obese in high-SES classes in poor countries • More obese in low-SES classes in rich countries
Energy intake	• Overfeeding causes weight gain and leads to obesity

Dietary fat intake	• Dietary fat is related to prevalence of overweight in ecological studies • High-fat diet causes fat gain • Low fat diet reduces body weight
Resting metabiloc rate	• A low body mass and composition adjusted RMR is a risk factor for weight gain, but contradictory data have been found • Overweight and obese people have a higher absolute RMR • Overweight and obese people have a lower relative RMR
Thermic response to food	• Obese have a depressed response in some studies, but contradictory results are abundant
Physical activity level	• A low level of PA is a risk factor for weight gain • Level of sedentarism is higher in obese people • Regular PA changes body composition • High level of PA increase sympathetic nervous system activity and also RMR • Regular PA contributes to weight loss and weight maintenance
Lipid oxidation rate	• Body fat gains decrease RQ • A high RQ is a risk factor for weight gain, but there are contradictory results • Ex-obese have a higher RQ than never obese
Blood leptin level	• Low leptin levels are weakly related for weight gain • Most obese have high leptin levels
SNS activity	• Low SNS activity could be a risk for weight gain • SNS activity increases with overfeeding and body weight gain
Growth hormone level	• Low GH is risk factor for weight gain • Most obese have low GH levels
Insulin sensitivity	• Obese are often insulin resistant and hyperinsulinemic • Insulin resistance protects against weight gain, but there are contradictory results
HPA axis and cortisol levels	• Obese have generally a hyper-responsive and hyperactive hypothalamic-pituitary-adrenal axis • Obese have elevated cortisol production rates, but also accelerated degradation

Sex-steroid levels	• Obese men have often low androgen levels • Obese women often have high androgen levels with further elevation upon ACTH stimulation
Adipose tissue metabolism	• Catecholamine-induced lipolysis is reduced in obesity • Lipogenesis from glucose is increased in human fat cells from obese people • Adipose tissue LPL is increased in obesity • Elevated adipose LPL activity remains high in reduced obese • High adipose tissue LPL is a risk factor for weight gain
Skeletal muscle metabolism	• SM type I fibber is not affected by obesity • SM type IIb fibber proportion is often elevated in obesity • SM oxidative enzyme markers are inversely related to obesity • SM LPL activity is low in obesity
Energy and nutrient patterning	• Under positive energy balance conditions, some people channel more food carbons into proteins • High rates of lipid accretion could be risk for further weight gain
Smoking	• Smoking is associated with lower body weight • Cessation increases body weight in most people.

Note. From Physical activity and obesity (p. 10), by C. Bouchard, 2000, Champaign, Illinois: Human Kinetics, Copyright 2000 by Human Kinetics Publishers, Inc. Reprinted with Permission.
(SES = Socioeconomic status; RMR = Resting metabolic rate; PA = Physical activity; SNS = Sympathetic nervous system; RQ = Respiratory quotient; GH = Growth hormone; HPA = Hypothalamic-pituitary-adrenal; ACTH = Adrenocorticotropic hormone; LPL = Lipoprotein lipase; SM = Skeletal muscle.)

2.2.1. Metabolic predictors of the development of obesity

Ravussin and Swinburn (101) have found that obesity is generally associated with high absolute energy expenditure, low respiratory quotient (RQ), low insulin resistance, high sympathetic nervous system activity, and elevated plasma leptin concentrations. Since the effects of leptin are a very young physiological observation, a short summary is given.

"Leptin is a 16 kilodalton protein secreted by adipocytes, is believed to regulate food intake through negative feedback signal between adipose tissue stores and the satiety centers in the hypothalamus, possibly mediated by decreased neuropeptide Y acti-

vity and increased corticotrophin releasing hormone activity. Although plasma leptin concentrations are significantly correlated to body weight and relative body fat content in many diverse groups of subjects, leptin concentrations in the central nervous system remains fairly constant when plasma concentrations are greater than 25mg $\times$ ml^{-1}, suggesting that most obesity is leptin resistant. Leptin resistance may be due to defects in leptin transport across the blood-brain barrier, or to defects in the leptin-signaling sites and action within the central nervous system" (16).

The relatively low plasma leptin concentrations are a risk factors for fatness and obesity (102). In response to weight gain, plasma leptin concentrations become "normal" for the new body size and body composition. However, baseline leptin concentrations do not appear to predict success at weight loss or weight loss maintenance (16).

In contrast, longitudinal studies indicate that relative to body size, a low metabolic rate, a high respiratory quotient, insulin sensitivity, low sympathetic nervous system activity, and low plasma leptin concentration predict weight gain (100). Upon gaining weight, the original abnormal metabolic state becomes normalized. Weight gain causes an increase in metabolic rate, a decrease in RQ, a decrease in insulin sensitivity, an increase in sympathetic nervous system activity, and an increase in plasma leptin concentrations (103, 104).

2.2.2. Resting metabolic rate

It is evident that there is a close correlation between resting metabolic rate (RMR) and body size. In earlier years, researchers thought that RMR was constant for a given body size, therefore different equations were developed for different body size (105). Nowadays it is clear that RMR can be quite different by individuals (106) and scientists' still try to assess the underlying mechanism determining the variance (16). In a study where investigators reported that sleeping metabolic rate was correlated best with fat free body mass, which explains 66% of its variance, they concluded also that RMR is at least partially genetically determined (107). Cross-sectional studies indicate significant decline of RMR with age (108, 109). Racial differences were observed also between Afro-American and Caucasian adults and children (110-114). Griffiths and his colleges (115) published that the sex differences were consistent with the earlier maturation of girls, and the growth differences with the hypothesis that a low RMR/kg body

weight is associated with an early pattern of growth and development in children predisposed to obesity.

2.2.3. Insulin sensitivity

It appears that, at least in adults, insulin resistance seems to be a mechanism influencing further weight gain (116). In 5- to 10-year-old children a high fasting plasma insulin concentration seemed to predict overweight and definite overfat 7-8 years later, especially in boys (117). These results indicate that hyperinsulinemia assists excess weight increase during growth in childhood and that long-lasting insulin resistance than protects adults against further weight or fat gain.

2.3. Psychological Changes in Childhood

The preadolescence (8-12-year of age), is one of the determining age period in psychological changes also. It has a special character in the development of the personality. At this time of life the secondary growth spurt happens, which means that the number of fat cells are increasing and the body shape is changing due to hormonal action (118, 119).

The complex developmental processes in this life cycle of the children are: changes in the body shape, differentiation of physiological functions, and expression with high intensity of the motor-, cognitive-, affective-, and psychomotor skills/abilities (3). Adolescents have increased interests in their appearances because it is greatly influenced by the media and peer groups. It has been reported that many adolescents have fear for obesity regardless of their body weights, and excessive concerns for obesity can induce underweight and be harmful to health (120).

The development of the psychic functions could be measured in different ways. The differentiation and integration of the personality are generally accepted parameters. The relatively unstructured and changeable characteristics and processes of the earlier age periods gradually get structured feature, show differentiation, and they reach a higher level of organization. Special individual psychological patterns, habits result in more and more organized and purposeful human existence (activity). The psychological processes develop in close connection with each other. The phases of the development follow each other in a strict order (3).

The personality, as a self-regulating system, tries to serve the psychological well being of the person, which is permanently influenced by the changes of the internal and external conditions. In the adolescence, playing activities (alone) cannot decrease the tension of internal conflicts. In case of lack of appropriate habits, potentially self-destructive behaviors (smoking, alcohol consumption, drug use, etc.) could be start in this age. The physical activity requires physiological, psychological and educational conditions with equal importance (3).

Stress is defined like the potentially stressful social and biological life event that characterize the passage from childhood to adolescence. Storminess refers to rapid shifts in moods, and outbursts of often short-lived negative behavior (78). The first mentioned cause of the storminess of pubertal changes is the change in hormonal levels.

Pápai (121) found among 10-14 year old Hungarian girls that early maturers had significantly better results in intelligence and creativity tests. Her data confirm that differences are more pronounced in early and middle puberty, than in late puberty where differences are not exist anymore. She found also that early developers were less satisfied with their body than late developer counterparts. This result presumably comes from the differences in body shape between early- and late maturers. Those who experience the onset of menarche earlier, have more fat in femoral and hip part, while late matuters body shape is more linear, they have broad shoulder and narrow hip. They did not find differences in the measures factors of personality among different maturer girls.

2.3.1. Depression

The more negative life events experienced the more likely that depressive symptoms will increase from year to year. Depressed individuals tend to have low self-esteem, feel lethargic, sad, and inadequate, and they blame themselves for their failures. These persons also tend to be passive and they have difficulties to initiate activities.

Because in puberty body image is important, therefore its relationship with depression is weighty for early adolescent girls. In the early adolescent years the rates of depression increase significantly (122). The body change dramatically with puberty because of hormonal changes for both girls and boys (123), but for girls it is changing not into the cultural ideal of thinness (124), because girls' pubertal development involves a significant increase in fat around hip and upper thighs, and thus weight (96, 125). Em-

pirical findings have showed a relationship between body dissatisfaction and depression among early adolescent girls (126-131). Kaplan and associates (132) found also relation between self-perceived classification of weight and depressive symptoms in 11-18-year olds. Weight and dissatisfaction with weight are in central attempts to account for the increase in depressive symptoms among early adolescent girls. Rearden and Koff (133) reported that, adolescent girls may have relatively great body dissatisfaction and high depression in the absence of atypical body weight.

It may be that observed relationships between body image and depression can be explained by the girls self-concept in large part on their perception of the social response to the body (134), and since overweight individuals are relatively devalued at any age, the social response to the objective weight may provide a basis for a stance of self-rejection which is characteristic of depression.

Muris and associates (135) revealed that almost 70% of the normal children reported that they worried every now and then. The content of these worries predominantly pertained to school performance, dying and health, and social contacts. They found also that worry, anxiety, and depression seemed to be strongly related.

2.3.2. Self-efficacy

According to theory and research (32), self-efficacy makes a difference how people feel, think, and act. Bandura defined it also as our belief in our ability to succeed in specific situations. In terms of feeling, a low sense of self-efficacy is associated with depression, anxiety, and helpless (33), but in everyday life it can be useful to approach our goals, aims, and challenge.

According to the social cognitive theory human motivation is well influenced by previous conception. To wait for a result of an action is different by individuals, because it depends from the person's mental constitution, how to react. We can define self-efficacy as the idea of a human that he or she can reach that level of achievement in all area of life what he or she previously defined for him- or herself (32). The setup of a goal is dependent from the individual's self-estimation. Those who have stronger self-efficacy can setup higher goals for themselves. Low level of self-confidence makes the human's successful performance more difficult. Basically, there are four factors, which have influence on the strength of self-efficacy:

High level of working capability

Capability for substitution

Capability for oral persuasion

Psycho physiological status

Analysis of the self-efficacy promote to explain more dependable the different strategies in the psychological practice. It seems that those who have higher self-esteem are more capable to solve problems, and are more successful to be up and doing. The self-efficacy questionnaire of Albert Bandura (136) contained state-specific resolutions. Schwarzer and Jerusalem (137) developed their questionnaire on college students in Germany. The observations of the authors shows that this 10 items scale's reliability is high (Cronbach alpha varies between 0.75 and 0.90), and meet the criteria for discriminant and convergent validity. According to their analysis self-efficacy has a positive correlation with optimistic approach, and has negative relation with anxiety, depression, and with their physical symptoms.

Weinberg tried to use Bandura's theory on athletes. He found that motivating people to do regular physical exercise depends on several factors. Perceived self-efficacy was a major instigating force in forming intentions to exercise and in maintaining the practice for an extended time. Endurance in physical performance was found to depend on efficacy beliefs that were created in a series of experiments on competitive efficacy by (138).

Perceived self-efficacy has become a widely accepted psychological method to explain coping behaviors. Measurement of self-efficacy (139) in Hungarians (140) has a new perspective in consequence of the revision of the original Generalized Self-Efficacy Scale (GSES). Tóth and Sipos (34) published that there was no significant difference in self-efficacy towards P.E. between girls and boys. They found also that there was a statistically significant correlation between trait anxiety and self-efficacy towards P.E. in boys.

2.3.3. Anxiety

The most common response to a stressor is anxiety (3). Anxiety usually means the unpleasant emotion characterized by worry, apprehension, tension, and fear. Anxiety is a part of life like eating and sleeping and under certain circumferences it can be be-

neficial. Anxiety is also defined as feeling of apprehension accompanied by sympathetic nervous system arousal, which results in increase in sweating, heart rate, and breathing rate (141).

It elevates alertness and readies the body for action. Faced with an unfamiliar challenge or situation, a person is often spurred by anxiety to prepare for the upcoming event. That is why anxiety is often a reason of external or internal stressors, which are different individual by individual, and therefore it is dissimilar how to act.

Children have fears what adults often don't understand. At certain ages children seem to have more fears than at others. Puberty is an accentuated period, because maturation occurs during this time. Nearly all children develop fears of correspondence to their parents, friends, and peers. Because the development is different child by child significant differences can be observed in body shape and therefore in psychological functions among different maturers. Over time, these fears normally fade. But when they persist with a normal daily routine, he or she may need the attention of a mental health professional.

Anxiety disorders refer to a group of illnesses. These often mentioned disorders are phobias, panic disorders, post-traumatic stress disorder and obsessive-compulsive disorders. When suffering from anxiety people often say that they perceive worryness, fears, sleep disturbances, sweating, dizziness, diarrhea, and high heart rate. In addition, people suffering from anxiety disorders are often apprehensive and worry that something bad may happen to themselves or loved ones. They often feel impatient, irritable and easily distracted (142).

Anxiety disorders are the most prevalent psychiatric problems among adolescents. 15–20% of the general youth population has an anxiety disorder (143). Children and adolescents with this psychological problem typically experience intense fear, worry, or uneasiness that can last for long periods of time and significantly affect their lives. If not treated early these disorders are strongly associated with risk for later developing mood disorders, low self-esteem, other anxiety disorders, academic failure, and substance abuse problems (144-146).

Several studies have showed that those children whose suffering from anxiety disorders are at increased risk of developing anxiety problems compared to those children whose parents have no psychiatric disorders (147-151). Biedeman and co-wor-

kers (148) also reported the same phenomenon with depression. McClure and associates (149) reported that maternal lifetime history of anxiety disorder more than doubled children's risk of anxiety disorder. Merikangas and colleagues (151) showed that children with one parent with an anxiety disorder were three times more likely to have overanxious disorder and an additional threefold risk when both parents had an anxiety disorder. All these studies demonstrated that anxious parents having anxious children (147, 150).

Spielberger and associates (152) found that children with high trait anxiety are more prone to respond to situations perceived as threatening with elevations in state anxiety intensity than low trait children. Elevations in A-State are normally evoked in children exposed to stressful situations. In general, children who are higher in trait experience state elevations more frequently and with greater intensity than low A-Trait children because they perceive a wider range of circumstances as dangerous or threatening. Situations in which failure is experienced, or in which personal adequacy is evaluated are more likely to be perceived as threatening by a high trait child, but whether children who differ in trait will show corresponding differences in A-State depends upon the extent to which a specific situation is perceived as dangerous or threatening by a particular child, and this is greatly influenced by the child's past experience.

Summary

Summarizing the observations of related literature we can state.

Growth and development of pubertal children have already been studied by many researchers, but differences in methods resulted in divergent solutions. Most of them state that early sexual maturation is one factor consistently related to increased body weight in adolescents and young adults.

Growth and maturation are generally influenced by genes, hormones, nutrients, and by the environment where the human lives (16). Therefore the date of the first menstruation is also determined by many factors (69). Pápai and Bodzsár (74) reported that body mass was rapidly increased between age 10 to 14 in Hungarian girls. Before menarche, the gain of lean body mass was more or less intense, and body fat percentage was found to slightly decrease, however, after the onset of menarche it is markedly

raised. Their findings indicate that around menarche the pattern of fat deposition becomes rearranged.

The reason to be an early maturer is still not clear. There is a disagreement among the researchers that sexual maturation has an effect on fatness or level of fatness has on the timing of sexual maturation. Early-maturing children of both sexes are taller and heavier than their average- and late-maturing age and sex peers from about age 6 onward (10). Pápai and associates (73), reported also that post-menarcheal girls were taller and heavier. Wang (19) found that earlier maturing girls are more likely to be obese than non-early matures. The body change dramatically with puberty because of hormonal changes for both girls and boys (123), but for girls it is changing not into the cultural ideal of thinness (124), because girls' pubertal development involves a significant increase in fat around hip and upper thighs, and thus weight (96, 125).

Relationship between body image, anxiety and depression seems important for early adolescents, particularly for girls. It is in the early adolescent years that rates of depression increase significantly, with this increase greater for girls than for boys. Anxiety disorders are the most prevalent psychiatric problems among adolescents. 15–20% of the general youth population has an anxiety disorder (143).

Chapter 3

SUBJECTS AND METHODS

Introduction

To complete the aims and find answers for the questions described in Chapter 1, a detailed functional and anthropometric program was carried out in western part of Hungary. Altogether 254 girls were investigated, and the final sample was selected after the end of the last measurement based on the number of subjects participating in the longitudinal study. According to the respective paragraphs of the Helsinki Declaration (153) all the participant were volunteer, and the written consents of their parents (or one of the parents only) were also collected before the first measurement. The school teachers and headmasters were informed before the first measurements about the aims of study and were asked if they would allow their pupils to participate in this study. Psychological questionnaires were administered anonymous.

Girls have suffered of neither neurological or metabolic nor neuro-endocrine disorders during the past 10 years, and no other long-lasting disorders were preliminary reported. Children were informed about the aims of the investigation as well as about the tasks to execute.

3.1. Subjects

Sample selection was randomly stratified and sample (N=207 at the end of 10^{th} measurement) consists of Hungarian girls exclusively. Anthropologically all of them were of Europid origin. Children of other ethnicity were tested naturally, but their results were excluded from the statistical analysis. A three years longitudinal data collection was completed initially from 5^{th} grade (10-11-year-old) from 10 elementary schools. The available measurement places were Keszthely with 4 schools (n=92), Hé-

víz with 1 school (n=22), Tapolca with 3 schools (n=72), Gyenesdiás with 1 school (n=15) and Vonyarcvashegy (n=6) with also 1 school. The first three of them are cities and last two are villages.

As shown in chapter 2, menarcheal timing is a major determinant of weight and fatness in early adulthood. Menarche has a significant value judgments associated with its attainment in many cultures, and the psychological importance of menarche in girls' development has no counterpart in the sexual maturation process of boys. To answer the questions described earlier, we formed 3 groups by the timing of menarche in our sample. The classification of cases was based on tertiles of menarche age

G1; Early-maturers (first 33% of the sample),

G2; On-time maturers (middle 33% of the sample),

G3; Late-maturers (last 33% of the sample).

Numbers of children by groups and settlements are demonstrating in Table 2. The final sample is smaller than the starting sample because of the subject loss.

Table 2. Distribution of girls by groups and settlements.

	Early maturers	**On-time maturers**	**Late maturers**	**SUMMARY**
Keszthely	37	26	29	**92**
Hévíz	3	11	8	**22**
Tapolca	22	27	23	**72**
Gyenesdiás	4	4	7	**15**
Vonyarcvashegy	3	1	2	**6**
SUMMARY	**69**	**69**	**69**	**207**

Data collection was carried out only on those individuals who had organized physical activity in curricular PE classes, exclusively. No illnesses were reported under the data collections and subjects did not take any medications regularly.

3.2. Methods

To complete the aims detailed anthropometric and psychological measurements were carried out.

3.2.1. Anthropometric methods

Anthropometric measurements for the estimation of physique and body build can be evaluated as relatively new methods. Some of their significant advantages (comparing to somatoscopic techniques) are the clear objectivity (a well practiced investigator can record the body dimensions reproducibly), and their speed using computer programs during data evaluation. Participants were weighed with light clothes and without shoes. Height was determined using an antropometer device to the nearest 0.1cm. Weight was determined within 0.1kg for each subject using an electronic scale.

3.2.1.1. The estimation of Conrad growth type

Conrad (52) has suggested the characterization of two developmental directions. The various physique patterns were described by two indices based on different body dimensions. Beyond the constitutional characteristics Conrad has analyzed also the bone-muscle development of the physique. Both of the indices can be expressed in decimal numbers.

The metric index

This index relates the chest width to the chest depth and is corrected by the actually measured stature. In first view the metric index is one of the characters of the roundness of the chest, however, following its validation the calculated parameter was characteristic for the roundness or linearity of the whole body (154). The metric index for girls and females can be calculated as follows:

$$MIX = 0.185CHD + 0.17CHW - 0.0365BH - 2.71 \qquad R = 0.999$$

where: MIX = metric index, CHD = chest depth (cm), BH = height (cm), CHW = chest width (cm), R = multiplied correlation coefficient indicating the congruence between the nomographic and calculated values.

The strongly negative values refer to the leptomorphic body build, the slightly negative ones to the athletic physique, and the positive ones to the picnomorph constitution. For the evaluation of growth type in children and adolescence the respective nation-wide representative data are suggested to use.

The plastic index

This index is the arithmetic sum of three body dimensions that are characteristic for bone-muscle development.

Plastic index (cm) = shoulder width (cm) + lower arm girth + hand circumference (cm)

By the numeric values of these two indices a right-angle co-ordinate system can be created, where the vertical axis is scaled by the metric index and the horizontal one refers to the plastic index. The metromorph-normoplastic body build is located at the centre of the coordinated system. The upper-left quarter contains the leptomorph but hypoplastic individuals; the right-upper quarter refers to the leptomorph-hyperplastic body build. The lower-left area is characteristic for the picnomorph-hypoplastic, and the lower-right quarter contains the picnomorph-hyperplastic physique variants. In children the vertical axis is suggested to position at the level of respective plastic index averages.

3.2.1.2. The estimation of relative body fat content

The expression body composition indicates the ratio of various body substances (for instance: water, protein, fat, muscles bone, different minerals etc.) within the whole body. By the more often used techniques estimate the ratio of depot fat and lean body mass or fat free mass (body mass – depot fat and essential fat mass).

Variability among the results of different body fat estimates gives the reason to use such skinfold techniques by which representative references are available, and the technique was validated by densitometric procedure. The calipermetric estimation of relative body fat content, developed by Pařízková (51), meets both conditions mentioned.

This procedure requires the measurement of 5 skinfold thicknesses: over biceps and triceps, subscapular, suprailiac and medial calf.

Procedure: the sum of the 5 skinfold values multiplied by 2, and then entered into the table, where the crossing of the multiplied sum and gender indicates the estimated relative body fat content. The originally published table of Pařízková (51) can be found in Table Appendix No. 2.

As one of the estimates of fatness or obesity the Body Mass Index (BMI) was also calculated.

$$\text{Body Mass Index} = \text{body mass (kg)} \times \text{height (m)}^{-2}$$

In taking the necessary body dimensions the IBP (International Biological Program) suggestions were observed (50).

3.2.2. Psychological questionnaires

3.2.2.1. STAIC-H (155)

The State-Trait Anxiety Inventory for Children (STAIC) (53, 55, 152) was initially developed as one of the research tools for the study of anxiety in elementary schoolchildren (see Appendices 4 and 5). It is comprised of separate, self-report scales for measureing two distinct anxiety concepts: state anxiety (A-State) and trait anxiety (A-Trait). The STAIC is similar in conception and structure to the State-Trait Anxiety Inventory (STAI) which provides measures of anxiety for adolescents and adults (152). While especially constructed to measure anxiety in nine- to twelve-year-old children, the STAIC may also be used with younger children with average or above reading ability and with older children who are below average in ability.

The STAIC A-State scale consists of 20 statements that ask children how they feel at a *particular moment in time.* The STAIC A-Trait scale also consists of 20 item statements, but subjects respond to these items by indicating how they *generally* feel. Individual STAIC items are similar in content to those included in the STAI, but the format for responding to the STAIC has been simplified to facilitate its use with young children. The STAIC A-State and A-Trait scales are printed on opposite sides of a single-page Test Form. The A-State scale is designated C-l; the A-Trait scale is designated C-2.

The A-State scale is designed to measure transitory anxiety states, that is, subjective, consciously perceived feelings of apprehension, tension, and worry that vary in intensity and fluctuate over time. The A-Trait scale measures relatively stable individual differences in anxiety proneness, that is, differences between children in the tendency to experience anxiety states. Investigators may use the STAIC A-State scale to determine the actual levels of A-State intensity induced by stressful experimental procedures, or as an index of drive level (D) as this concept is defined by Hull (156) and Spence (157). The A-State scale should also prove useful as an indicator of the level of transitory anxiety experienced by children in counseling and psychotherapy situations, and, especially, as a measure of the effectiveness of desensitization and counter conditioning procedures in behavior therapy.

The STAIC A-Trait scale may be used for research purposes to select children who vary in anxiety proneness or as an experimental screening device for detecting ne-

urotic behavioral tendencies in elementary school children. The A-Trait scale should also prove useful as a measure of the effectiveness of clinical treatment procedures designed to reduce neurotic anxiety in children.

Administration

The STAIC was designed to be self-administering and has no time limits. It may be given either individually or in groups. Complete instructions are printed on the Test Form for both the A-State and A-Trait scales. Fourth, fifth, and sixth-grade children generally require only 8 to 12 minutes to complete either the A-State or the A-Trait scale, and less than 20 minutes to complete both. Repeated administrations of the A-State scale typically require 5 to 7 minutes or less.

Many of the STAIC items have face validity as measures of "anxiety," but the examiner should not use this term in administering the inventory. In talking about the STAIC, the examiner should consistently refer to the inventory and its sub-scales as the "How-I-Feel-Questionnaire," the title that is printed on the test form.

Since the validity of the STAIC rests upon the assumption that a child has a clear understanding of the *state* and *trait* instructions the child's attention should be directed to the fact that the instructions are different for the two parts of the inventory. It should be emphasized that the child must report how he feels *at a particular moment in time* when he responds to the A-State scale (C-l), and how *he generally* feels when he responds to the A-Trait scale (C-2).

The standard procedure for administering the STAIC, especially in group administrations, is for the examiner to read the directions aloud while the child reads them silently. In group administrations, the group should not be too large since children in such situations tend to be less attentive and occasionally become unruly. It is interesting to note, however, that in groups ranging from 15 to 35 children, the size of the group did not seem to affect A-State scores in any systematic direction (158). In administering the STAIC, the examiner should emphasize that one of the three phrases that follow the item stem should be circled, not the stem itself. With younger children, children with marginal reading ability, and those who come from lower socio-economic backgrounds, it is especially important to ensure that the instructions are understood.

After presenting the instructions, the child should be given the opportunity to raise questions. If specific questions arise in the testing session, the examiner should

respond in a non-committal manner. Responses such as "Just answer according to how you *generally* feel," or "Answer the way you *feel right now"* will usually suffice. If a child asks the pronunciation or meaning of a particular word, the examiner should read the word to him but should not define it. Most children respond to all the items without being prompted, but if this question arises, they should be told not to omit any items. In research applications, the experimenter may wish to instruct subjects to respond to all of the items.

Research on the STAI with adolescents and adults has consistently demonstrated that scores on the A-Trait scale are relatively impervious to the conditions under which this scale is given (152, 159, 160), but A-State scores are (by design) influenced by the immediate environment. Therefore, in the standardization of the STAIC, the A-State subscale was given first, followed by the A-Trait scale, and this order is recommended when both scales are given together.

The standard administration of the STAIC requires the child to respond to each item by circling the word or phrase printed on the Test Form to the right of the item-statement. For large samples, the STAIC may be administered with a machine scorable answer sheet. If this is necessary, care must be taken to insure that the child understands that he must blacken the space on the answer sheet that corresponds to the alternative choice on the Test Form which best describes his feelings. Children should also be cautioned to make sure that the number on the answer sheet corresponds with the number of the question on the Test Form. The use of multiple-choice answer sheets is not recommended for younger children nor for children with limited ability who are likely to have difficulty understanding what they are supposed to do.

In research, the experimenter may give the scale with standard instructions or alter the instructions to focus upon a particular time period. A child may be instructed to respond, for example, according to how he felt while performing on an experimental task that he has just completed. It may be useful on lengthy tasks to instruct the child to respond according to how he felt earlier in the task, or how he felt while working on the final portion of the task. Most children have no difficulty in responding to the STAIC A-State items according to how they felt in a specific situation, or at a particular moment in time, provided the feelings were recently experienced and the child is motivated to cooperate with the experimenter.

Children respond to the STAIC by selecting one of the three alternative choices for each item which describes them best. In essence, each STAIC item is a 3-point rating scale for which values of 1, 2, or 3 are assigned for each of the three alternative choices. Thus, scores on both the STAIC A-State and A-Trait subscales can range from a minimum of 20 to a maximum score of 60.

The stem for all 20 STAIC A-State items is "I feel." For each of the 20 different key adjective terms, the child responds by circling one of the three alternatives that describes him best. The key terms in half the items are indicative of the presence of anxiety (e.g., nervous, worried), while the key terms reflect the absence of anxiety in the other half (e.g., calm, pleasant).

For items in which the key term indicates the presence of anxiety, *very* and *not* are assigned values of 3 and 1, respectively. The order of weighting is reversed for items in which the key terms indicate the absence of anxiety, i.e., *very* = 1; *not* = 3. A value of 2 is assigned to all responses where the child circles only the adjective. For example, *very nervous* = 3; *nervous* = 2; and *not nervous* = 1; and *very calm* = 1, *calm* = 2, and *not calm* = 3. Items indicative of the absence of anxiety, which are scored 1, 2, and 3 are: 1, 3, 6, 8, 10, 12, 13, 14, 17 and 20. For the remaining items, *very* is scored 3, and *not,* 1.

The STAIC A-Trait scale requires the child to respond to each item by indicating the frequency of occurrence of the behavior described by that item. For example, for Item 6 ("I worry too much"), the child responds by circling *hardly ever, sometimes,* or *often.* The scoring weights assigned to *hardly ever, sometimes,* and *often* are 1, 2, and 3, respectively, for all of the STAIC A-Trait items.

Children generally give responses for all of the STAIC items without special instructions or prompting. If a subject does omit one or two items on either the STAIC A-State or A-Trait scales, his prorated full-scale score can be obtained by the following procedure: 1) determine the mean score for the items to which the subject responded; 2) multiply this value by 20; and 3) round the product to the next higher whole number. If three or more items are omitted, however, the validity of the scale must be questioned.

Templates are available for scoring the STAIC A-State and A-Trait subscales by hand. To score each scale, place the appropriate template on the Test Form and simply

add the response values printed on the scoring key for each item. This is more conveniently done with a simple hand counter, but one may also use an adding machine, a desk calculator, or do the adding in his head. Make certain that the correct template is used for scoring the A-State and the A-Trait scales. The scores for each scale may be recorded at any convenient place on the Test Form.

For studies employing a large number of subjects, the use of IBM 1230 or Digitek answer sheets is generally feasible with fifth or sixth graders. From these answer sheets, a card deck containing weighted item responses can be produced with an IBM Test Scoring Machine, and individual scores can then be obtained with computer programs. The TESTAT program described by Veldman (161) may be adapted for this purpose.

The Hungarian translation of the STAIC test was made by Spielberger and Sipos in 1978 and called STAIC-H.

3.2.2.2. Self-efficacy towards physical exercise (33, 56)

The original scale was created to assess a general sense of perceived self-efficacy with the aim in mind to predict coping with daily hassles as well as adaptation after experiencing all kinds of stressful life events. The scale is designed for the general adult population, including adolescents. As a general measure, it does not tap specific behavior change. Therefore, in most applications it is necessary to add a few items to cover the particular content of the survey or intervention (such as smoking cessation self-efficacy, or physical exercise self-efficacy). The physical exercise version of the scale is also designed to be self-administering and has no time limits. It may be given either individually or in groups. Complete instructions are printed on the Test Form. It requires 5 minutes on average to fill. The questionnaire contains 12 items and responses are made on a 7-point Likert scale (see appendix 3). Sum up the responses to all 12 items to yield the final composite score with a range from 12 to 84.

In samples from 23 nations, Cronbach's alphas ranged from 0.76 to 0.90, with the majority in the high 0.80s. The scale is unidimensional.

The measure has been used internationally with success for two decades. It is suitable for a broad range of applications. It can be taken to predict adaptation after life changes, but it is also suitable as an indicator of quality of life at any point in time.

3.2.3. Statistical procedures

Descriptive statistics (means, medians and standard deviations) were calculated for all the measured and calculated variables in samples.

Distribution of the data was checked by Shapiro-Wilk's W test, and to test homogeneity Levene test of homogeneity has been used.

Differences in anthropometric and psychological variables among three groups (early maturers, average maturers and late maturers) were analyzed by Kruskal-Wallis ANOVA or one-way ANOVA at 5% level of random error.

Changes of body composition and biological maturation under the 10 measurements were analyzed by repeated measures of ANOVA or Friedman ANOVA at 5% level of random error.

Relations between anthropometric and psychological variables by groups were analyzed by Pearson, Spearman or Kendall-τ correlation at 5% level of random error.

Chapter 4

ANALYSIS AND INTERPRETATION OF RESULTS

Introduction

The purposes of this dissertation were, namely:

1. To identify statistically or biological differences in growth type, body composition and body dimensions between three various sexual maturation groups (early maturers, on-time maturers and late maturers).
2. To investigate differences in psychological functions (state- and trait-anxiety, coping) between early-, normal- and late matured girls.
3. To analyze the associations among fatness, BMI, psychological functions and sexual maturation in girls.
4. To investigate the relations between anxiety and self-efficacy toward physical exercise.

For the purpose of answering these questions the following hypothesis were tested:

1. H_0 There will not be significant difference in anthropometric characteristics among early, average and late matured girls.
2. H_0 There will not be difference in psychological variables among early, average and late matured girls.
3. H_0 There will not be a relation between the biological and psychological attributes.
4. H_0 There will not be a relation between anxiety and self-efficacy toward physical exercise.

This chapter consists of the following sub-headings:

1. Physical characteristics, growth type and body composition of early, on-time, and late matured girls.
2. Results of psychological questionnaires.
3. Correlations between anthropometric and psychological variables.

4.1. Physical Characteristics, Growth Type and Body Composition of Early-, On-time-, and Late Matured Girls

Descriptive statistics

The characteristics of the sample are presented in Table 3. Because of body mass related body fat content, BMI, plastic and metric indexes are calculated scores, parametric procedures cannot be used to evaluate the results. According to the assumptions of applying parametric procedures, first we performed Shapiro-Wilk's W test of normality to check whether our variables are normally distributed or not. Levene's homogeneity test was used to check preassumed equal variances.

As expected, girls developed significantly in all variables. They grew an average of 15 cm, weight more with 14kg at the end of measurement. Their body mass index increased with an approximate $2kg \times m^{-2}$, while their body mass related body fat percentage was higher an average 2%. The growth type has changed according to the development of the muscles and skeletal system, metric index decreased with 0.20 cm and plastic index increased with 6cm, respectively.

Table 3. Physical characteristics of the subjects at baseline and at last measurement

	1st measurement		10th measurement	
	Mean (SD)	**Min-Max**	**Mean (SD)**	**Min-Max**
DCK (yr)	11.04 (0.39)	10.20-12.43	14.05 (0.39)*	13.23-15.42
BH (cm)	147.71 (7.18)	130.20-167.60	162.70 (6.21)*	147.60-177.40
BW (kg)	41.68 (9.72)	23.90-70.00	55.34 (11.00)*	33.00-98.60
BMI ($kg \times m^{-2}$)	18.96 (3.50)	13.41-30.42	20.86 (3.75)*	14.44-35.13
BF%	22.89 (5.50)	9.57-38.52	25.05 (5.25)*	13.47-38.76
MIX (cm)	-2.05 (0.42)	-2.62-0.66	-1.86 (0.45)*	-2.57--0.02
PLX (cm)	67.95 (4.51)	56.90-83.20	74.19 (4.04)*	63.30-88.00

DCK = calendar age (yr); BH = body height (cm); BW = body weight; BMI = body mass index ($kg \times m^{-2}$); BF% = body mass related body fat percentage; MIX = metric index (cm); PLX = plastic index (cm); * = significant difference at $p<0.05$.

According to the categorization of the subjects, there were significant difference in age at menarche among the three groups ($p<0.001$). The mean at age of menarche for the early matured girls was 11.53 ± 0.61 years, for on-time maturers 12.63 ± 0.23 years, and for late maturers, where only 47 girls experienced the onset, the mean age at menarche was 13.47 ± 0.36 years.

4.1.1. Test of normality

Before any statistical evaluations were performed, body height and body weight have been evaluated to determine their distribution using a Shapiro-Wilk's W test of normality (see Table 4). Based on the results body height showed normal, while body weight showed non normal distribution at all time points (see Table 4).

Since all W statistics were significant for body weight, in this case the hypothesis that the respective distribution is normal has been rejected. Therefore, according to the results of the normality test, a non-parametric technique of Kruskal-Wallis ANOVA was chosen to test differences in body weight among the three groups. The W statistics were not significant for body height, so the hypothesis that the respective distribution is normal has been accepted. Therefore a parametric technique one-way ANOVA was used to test differences among the three groups if the variability of the groups will be equal.

Table 4. Result of Shapiro-Wilk's W test for body height, and body weight variables.

Variables	N	W	p	Variables	N	W	p
BH 1	207	0.99371	0.53148	**BW 1**	207	0.94407	.00000*
BH 2	207	0.99370	0.52941	**BW 2**	207	0.94797	.00000*
BH 3	207	0.99270	0.39478	**BW 3**	207	0.95646	.00001*
BH 4	207	0.99280	0.40795	**BW 4**	207	0.95695	.00001*
BH 5	207	0.99270	0.39493	**BW 5**	207	0.95696	.00001*
BH 6	207	0.99309	0.44492	**BW 6**	207	0.95662	.00001*
BH 7	207	0.99149	0.26784	**BW 7**	207	0.92974	.00000*
BH 8	207	0.99354	0.50676	**BW 8**	207	0.92711	.00000*
BH 9	207	0.99392	0.56142	**BW 9**	207	0.92027	.00000*
BH 10	207	0.99120	0.24278	**BW 10**	207	0.90306	.00000*

* Distribution significantly different from normal distribution

4.1.2. Test of homogeneity

Homogenity of variance among all groups had also been checked with Levene's Test of homogenity. (see Table 5).

Table 5. Levene Test of homogeneity of variances for body height

Variables	F	p	Variables	F	p
BH 1	0.16	0.85	**BH 6**	2.05	0.13
BH 2	0.42	0.66	**BH 7**	1.97	0.14
BH 3	0.95	0.39	**BH 8**	1.75	0.18
BH 4	1.50	0.23	**BH 9**	1.69	0.19
BH 5	1.66	0.19	**BH 10**	1.62	0.20

* Not homogeneous sample

As the result of Levene Test indicates no significant differences were found in body height at any measurement time, so the hypothesis that the samples come from the same population has been accepted, therefore in this case the sample is considered to homogeneous.

As the result of the test of normality and homogeneity, one-way ANOVA has been used to describe differences in body height among the groups. A non-parametric technique of Kruskal-Wallis ANOVA test has been used to describe differences in body weight, body mass index, fat content relative to body mass, metric and plastic indices among the three groups.

Descriptive data and results of one-way ANOVA followed by Tukey test and Kruskal-Wallis ANOVA followed by Mann-Whitney U test for the 10 measurements of body heights, and body weights are presented in Table 6.

As Table 6 reveals significant differences ($p<0.01$) were found in body height means between early and late maturer girls until the 9th measurement, respectively. At baseline early maturers were significantly taller with an average of 5cm than on-time and with an average of 7cm than late maturers ($p<0.001$, respectively), but no statistical differences were found between on-time and late maturer girls. However, all three maturation groups differed from each other from the 2nd until the 6th measurement ($p<0.05$).

On-time maturers reached the body height of early maturer girls, because significant difference were found only between early- and late- ($p<0.001$), and on-time- and late maturers ($p<0.05$) at the 7th measurement. Later statistical differences existed only between early- and late maturer girls ($p<0.01$). The statistical differences in body height have disappeared among the groups at the last measurement. Late maturer girls reached also their peers stature.

Table 6. Descriptive statistics containing mean, maximum, minimum and standard deviation and results of ANOVA and Kruskal-Wallis ANOVA for body height and body weight by groups.

	Early maturers (n=69)		On-time maturers (n=69)		Late maturers (n=69)	
	Mean (SD)	**Min-Max**	**Mean (SD)**	**Min-Max**	**Mean (SD)**	**Min-Max**
			Body Height (cm)			
1	151.80(6.31)[bc]	135.4-167.6	146.7(6.80)[a]	130.8-162.5	144.57(6.49)[a]	130.2-164.4
2	154.40(6.26)[bc]	137.0-169.0	149.41(6.88)[ac]	132.8-165.1	146.63(6.79)[ab]	132.8-166.1
3	156.47(6.01)[bc]	140.5-170.9	151.73(6.95)[ac]	134.9-167.0	148.64(6.91)[ab]	135.4-166.8
4	158.34(5.78)[bc]	143.2-174.0	154.32(6.75)[ac]	137.9-169.5	150.83(6.98)[ab]	137.0-169.0
5	159.59(5.64)[bc]	144.4-174.1	156.07(6.86)[ac]	139.5-171.9	152.46(6.97)[ab]	138.2-169.2
6	160.90(5.55)[bc]	146.1-175.0	157.99(6.71)[ac]	142.5-173.3	154.53(7.07)[ab]	139.8-171.3
7	162.09(5.52)[c]	147.1-175.1	159.57(6.56)[c]	143.2-175.2	156.67(6.95)[ab]	141.8-171.3
8	162.81(5.46)[c]	148.2-176.3	160.89(6.56)	145.4-175.6	158.61(6.66)[a]	144.2-171.6
9	163.36(5.43)[c]	149.0-176.6	161.81(6.56)	147.8-176.6	159.98(6.41)[a]	146.5-174.2
10	163.95(5.47)	149.3-177.3	162.69(6.66)	147.6-177.4	161.45(6.28)	147.8-175.6
			Body Weight (kg)			
1	47.97(9.57)[bc]	30.9-70.0	39.59(7.64)[a]	26.4-63.0	37.46(8.58)[a]	23.9-64.9
2	50.72(9.82)[bc]	33.1-70.8	41.82(7.78)[a]	28.5-64.8	39.16(9.02)[a]	25.4-67.6
3	51.40(9.72)[bc]	32.1-74.4	42.42(7.82)[a]	29.1-65.9	39.73(9.13)[a]	25.0-68.1
4	53.95(9.71)[bc]	34.4-79.5	45.02(7.73)[ac]	31.8-71.9	41.79(10.04)[ab]	26.4-76.6
5	54.99(9.58)[bc]	35.9-79.8	46.73(8.01)[ac]	32.6-73.6	43.30(10.43)[ab]	27.6-80.3
6	56.07(9.61)[bc]	38.4-86.3	47.90(7.72)[ac]	33.5-75.6	44.34(10.24)[ab]	29.6-83.9
7	57.76(10.02)[bc]	41.8-91.3	49.56(7.97)[a]	36.9-79.9	47.25(11.63)[a]	30.6-90.6
8	58.56(10.24)[bc]	44.1-93.9	51.25(8.05)[a]	36.1-80.3	48.97(11.79)[a]	31.6-91.5
9	59.45(10.54)[bc]	44.8-98.0	52.23(7.99)[a]	36.9-81.0	50.05(11.85)[a]	32.4-93.9
10	60.18(10.68)[bc]	45.4-98.6	53.70(7.90)[a]	37.7-83.8	52.15(12.39)[a]	33.0-96.5

[a] significantly differ from early maturers ($p<0.05$), [b] significantly differ from on-time maturers ($p<0.05$), [c] significantly differ from late maturers ($p<0.05$)

As it shown also in Table 6 early maturer girls' body weight were significantly different from on-time-, and late maturers' weight ($p<0.001$, respectively) at all measurement times. Differences between on-time and late maturer girls appeared only during the 6th grade ($p<0.05$).

Descriptive data and results of Kruskal-Wallis ANOVA for the 10 obseravtions of BMI, body mass related body fat percentage are presented in Table 7. As the result of Kruskal-Wallis ANOVA indicate significant differences were found in BMI ($p<0.001$) and body mass related body fat percentage ($p<0.05$) among the groups at all measurement times. Early maturer girls had higher values in BMI ($p<0.001$) and had higher amount of fat in proportion ($p<0.05$) than on-time or late developers during the whole

study. There were no significant differences in BMI and body fat percentage between on-time and late maturers.

Table 7. Descriptive statistics containing mean, maximum, minimum and standard deviation and results of Kruskal-Wallis ANOVA for body mass related body fat percentage and BMI variables by groups.

	Early maturers (n=69)		**On-time maturers (n=69)**		**Late maturers (n=69)**	
	Mean(SD)	**Min-Max**	**Mean(SD)**	**Min-Max**	**Mean(SD)**	**Min-Max**
			Body Mass Index ($kg \times m^{-2}$)			
1	20.74(3.57)[bc]	14.9-30.4	18.31(2.87)[a]	14.3-25.9	17.82(3.33)[a]	13.4-29
2	21.21(3.62)[bc]	15.1-30.1	18.67(2.82)[a]	14.7-26.7	18.10(3.36)[a]	13.8-29.3
3	20.94(3.56)[bc]	15.0-29.9	18.37(2.82)[a]	14.5-26.3	17.88(3.37)[a]	13.5-29.3
4	21.49(3.60)[bc]	15.4-31.4	18.87(2.75)[a]	15.2-28.0	18.26(3.60)[a]	13.9-30.2
5	21.57(3.57)[bc]	15.5-31.5	19.16(2.86)[a]	15.0-28.1	18.52(3.71)[a]	14.1-30.9
6	21.65(3.55)[bc]	16.0-31.6	19.16(2.65)[a]	15.8-28.2	18.51(3.75)[a]	11.4-31.4
7	21.98(3.69)[bc]	17.1-33.1	19.44(2.70)[a]	16.1-29.4	19.16(3.99)[a]	14.2-32.8
8	22.10(3.81)[bc]	16.8-34.1	19.77(2.67)[a]	15.9-29.4	19.38(4.02)[a]	14.2-32.9
9	22.29(3.91)[bc]	17.0-35.1	19.93(2.66)[a]	16.1-29.4	19.48(3.99)[a]	14.2-32.1
10	22.39(3.89)[bc]	17.2-35.0	20.26(2.51)[a]	16.4-30.3	19.94(4.19)[a]	14.4-35.1
			Body mass related body fat percentage (%)			
1	25.14(5.50)[bc]	12.1-38.5	22.43(5.06)[a]	13.9-35.5	21.10(5.20)[a]	9.6-33.9
2	26.33(5.67)[bc]	13.0-38.5	23.02(5.26)[a]	14.1-37.1	21.45(6.00)[a]	10.1-37.8
3	26.11(5.41)[bc]	13.9-36.5	22.85(5.07)[a]	13.3-37.4	21.46(5.91)[a]	10.1-37.1
4	25.74(5.00)[bc]	13.5-35.9	22.79(4.93)[a]	13.2-34.4	21.81(5.82)[a]	12.1-36.4
5	25.31(4.80)[bc]	15.8-34.7	22.60(4.45)[a]	13.5-33.4	21.35(5.61)[a]	13.0-35.1
6	25.07(4.97)[bc]	15.4-36.4	22.40(4.45)[a]	13.0-34.3	21.51(5.86)[a]	11.2-36.7
7	25.95(4.64)[bc]	18.6-38.3	23.02(4.34)[a]	13.5-33.4	22.46(5.69)[a]	13.9-38.2
8	25.87(4.78)[bc]	15.4-38.9	22.95(4.17)[a]	15.1-35.3	22.00(5.83)[a]	13.5-39.0
9	26.39(4.77)[bc]	18.0-39.5	23.22(4.39)[a]	13.7-36.4	22.32(5.69)[a]	12.8-37.7
10	27.22(4.95)[bc]	17.1-38.7	24.62(4.18)[a]	14.8-37.5	23.31(5.78)[a]	13.5-38.8

[a] significantly differ from early maturers ($p<0.05$), [b] significantly differ from on-time maturers ($p<0.05$), [c] significantly differ from late maturers ($p<0.05$)

Descriptive statistics and results of Kruskal-Wallis ANOVA for metric-, and plastic indexes are presented in Table 8. As it shown in Table 8 early maturer girls were significantly different in metric index from on-time- ($p<0.05$), and late maturers ($p<0.01$) at all measurement times except at baseline, where they were different only from late maturers ($p<0.05$). There were no significant differences between on-time-, and late maturers. Early developers had significantly higher values in plastic index than on-time-($p<0.01$), or late developers ($p<0.001$) at all measurement times. On-time ma-

turers were statistically more robust than late maturers only at the 2nd measurement. No differences were found between these groups at other measurement times.

Table 8. Descriptive statistics containing mean, maximum, minimum and standard deviation and results of Kruskal-Wallis ANOVA for metric- and plastic index

	Early maturers (n=69)		On-time maturers (n=69)		Late maturers (n=69)	
	Mean(SD)	**Min-Max**	**Mean (SD)**	**Min-Max**	**Mean(SD)**	**Min-Max**
			Metric Index (cm)			
1	-1.94(0.45)[c]	-2.6-0.7	-2.10(0.35)	-2.6--1.2	-2.12(0.43)[a]	-2.6--0.7
2	-1.92(0.41)[bc]	-2.7-0.9	-2.12(0.39)[a]	-2.6--1.2	-2.13(0.45)[a]	-2.8--0.9
3	-1.79(0.49)[bc]	-2.8-0.5	-2.02(0.38)[a]	-2.7--0.9	-2.08(0.46)[a]	-2.7--0.4
4	-1.69(0.47)[bc]	-2.5-0.0	-1.96(0.32)[a]	-2.5--1.0	-1.94(0.50)[a]	-2.6--0.3
			Plastic index (cm)			
1	70.66(3.89)[bc]	60.1-79.7	67.21(3.67)[a]	59.1-80.2	65.99(4.60)[a]	56.9-83.2
2	73.50(3.69)[bc]	62.6-82.8	70.30(3.64)[ac]	63.3-82.0	68.26(4.34)[ab]	58.3-81.5
3	74.92(3.49)[bc]	66.4-84.7	72.27(3.55)[a]	65.7-83.2	70.61(4.21)[a]	62.1-83.4
4	75.66(3.62)[bc]	69.5-88.0	73.87(3.72)[a]	66.8-85.0	73.04(4.33)[a]	63.3-85.2

[a] significantly differ from early maturers ($p<0.05$), [b] significantly differ from on-time maturers ($p<0.05$), [c] significantly differ from late maturers ($p<0.05$)

Results of repeated measures of ANOVA and Friedman ANOVA of the anthropometric variables are presented in Table 9.

Table 9. Results of repeated measures of ANOVA and Friedman ANOVA for the biological variables by groups

	Early maturers (n=69)		On-time maturers (n=69)		Late maturers (n=69)	
	F	**p**	**F**	**p**	**F**	**p**
BH (cm)	5550.40	0.00*	4070.63	0.00*	4747.44	0.00*
	ANOVA χ^2	**p**	**ANOVA χ^2**	**p**	**ANOVA χ^2**	**p**
BW (kg)	493.94	0.00*	538.21	0.00*	567.41	0.00*
BMI ($kg \times m^{-2}$)	156.97	0.00*	245.08	0.00*	256.31	0.00*
BF (%)	80.34	0.00*	69.00	0.00*	73.80	0.00*
MIX (cm)	56.72	0.00*	22.57	0.00*	32.91	0.00*
PLX (cm)	139.22	0.00*	172.31	0.00*	191.77	0.00*

* Significant difference at $p<0.05$

As it shown in Table 9 there were significant changes in all anthropometric variables ($p<0.001$), but this is of course evident, because these girls were in the growing period.

As it shown in Figure 1, the speed of growing had slow down, but the differences in body height between the last two measurements were still significant ($p<0.05$) in all groups. Early maturer girls were still in the linear phase of the growing curve, while the shape of the curve for on-time and late maturers were resemble to logarithmic curve. The speed of their height already has started to slow down.

In body weight the significant difference of early maturer girls existed through the 3 years (Fig. 2). The speed of gaining body mass was nearly the same in all groups, and it was significant between each measurement time ($p<0.05$). A seasonal oscillation could be observed in late maturer girls, their body mass was increasing more during each summer. This phenomenon appeared only at the first summer in on-time, and late developers.

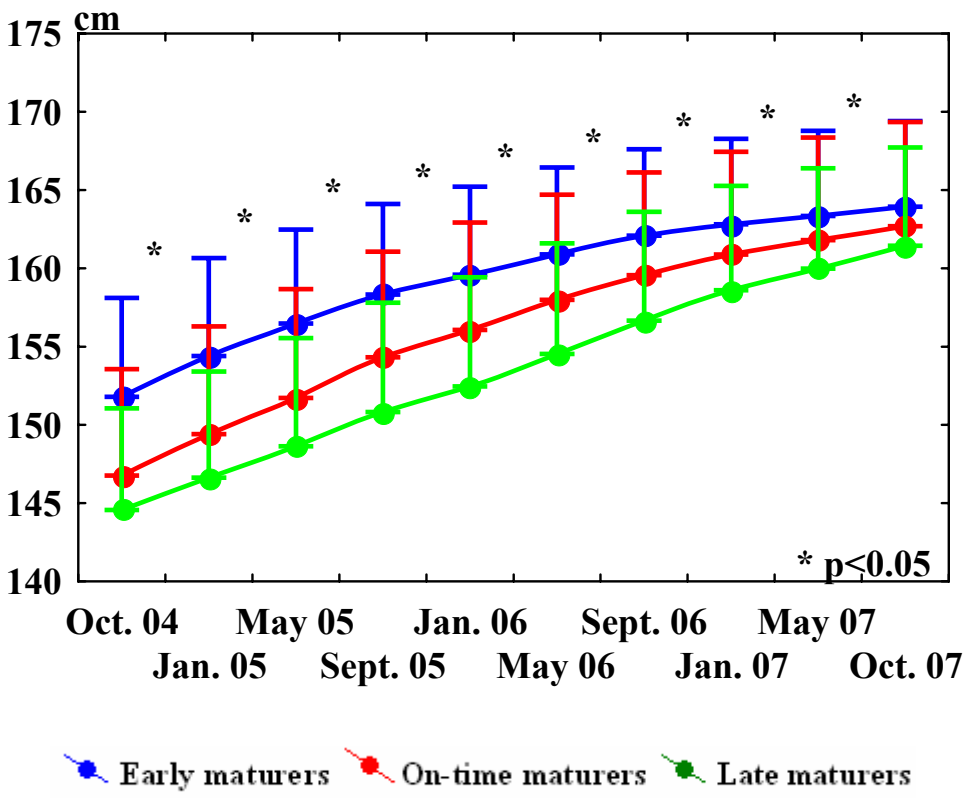

Figure 1. Means, standard deviations and results of repeated ANOVA for body height in girls.

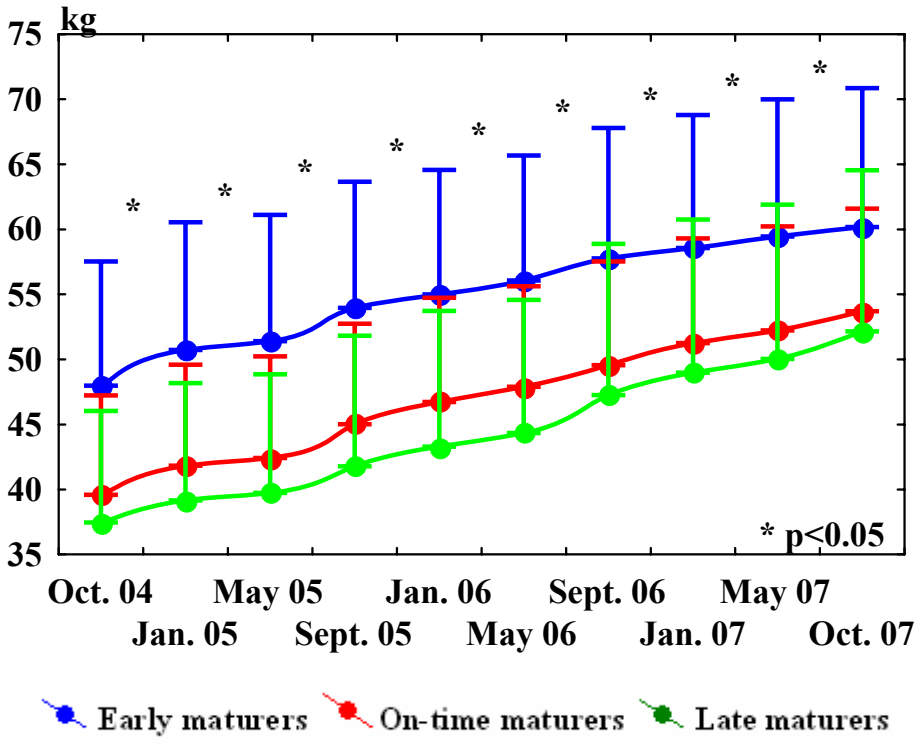

Figure 2. Means, standard deviations and results of Friedman ANOVA test for body weight in girls.

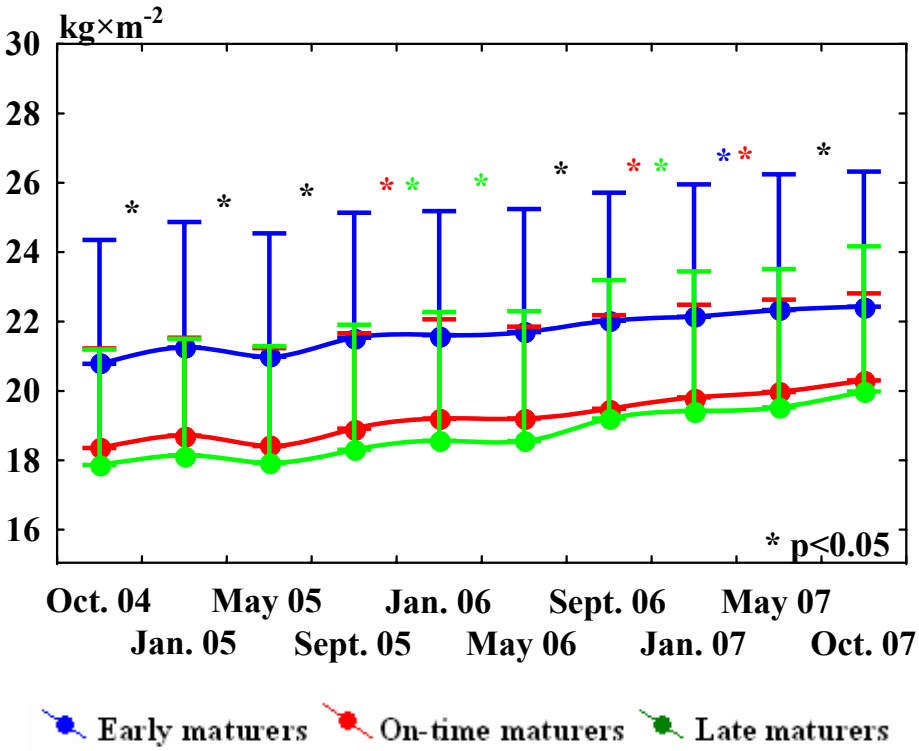

Figure 3. Means, standard deviations and results of Friedman ANOVA test for Body Mass Index in girls.

Overall, changes in body mass index during the 3 year period were significant in all groups, however, group differences were also observed. Seasonal variations were noticed in all groups, namely that each group increased their BMI mostly during summers ($p<0.05$). Remarkable increase was observed also in body mass related body fat percentage during summer in each group (Fig.4).

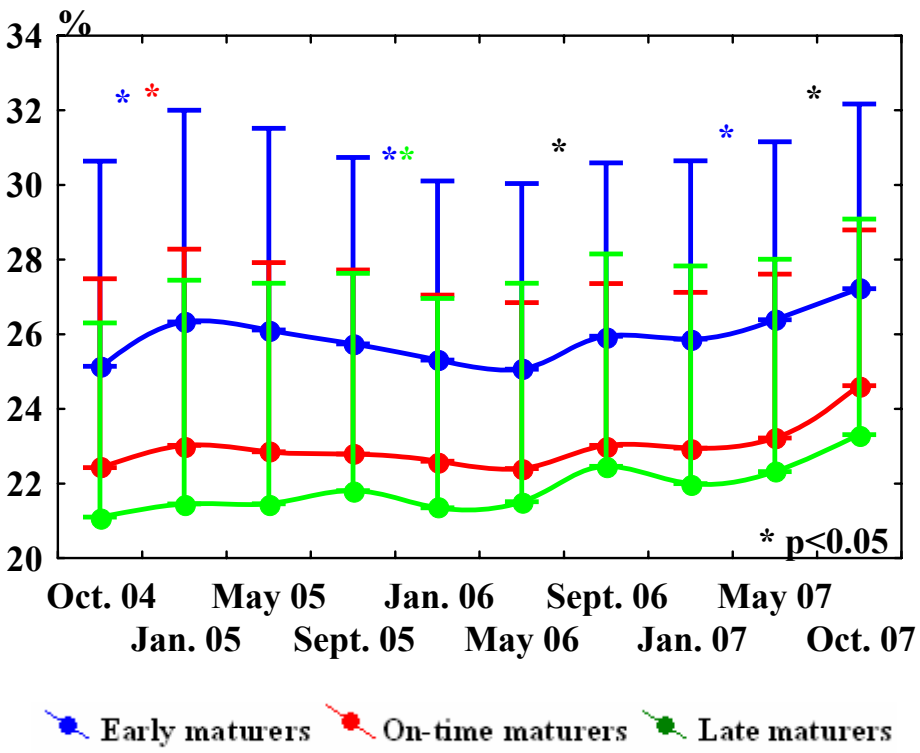

Figure 4. Means, standard deviations and results of Friedman ANOVA test for body mass related body fat percentage in girls.

Metric index has changed into more picnomorphic shape in all groups (Fig. 5), however, these values still describe the leptomorphic and athletic physique. The changes through the study were significant between the 2nd and 3rd measurement in early- and on-time maturers, and between 3rd and 4th measurement in early- and late developers ($p<0.05$, respectively). Plastic index has significantly changed among all measurements in all groups (Fig. 6). The curves of early- and on-time maturer girls were showed logarithmic shape, while late maturers had linear increase in plastic index values. As it shown in body height, plastic index differences were also going closer apart for the last measurement, but early developers statistically different from others.

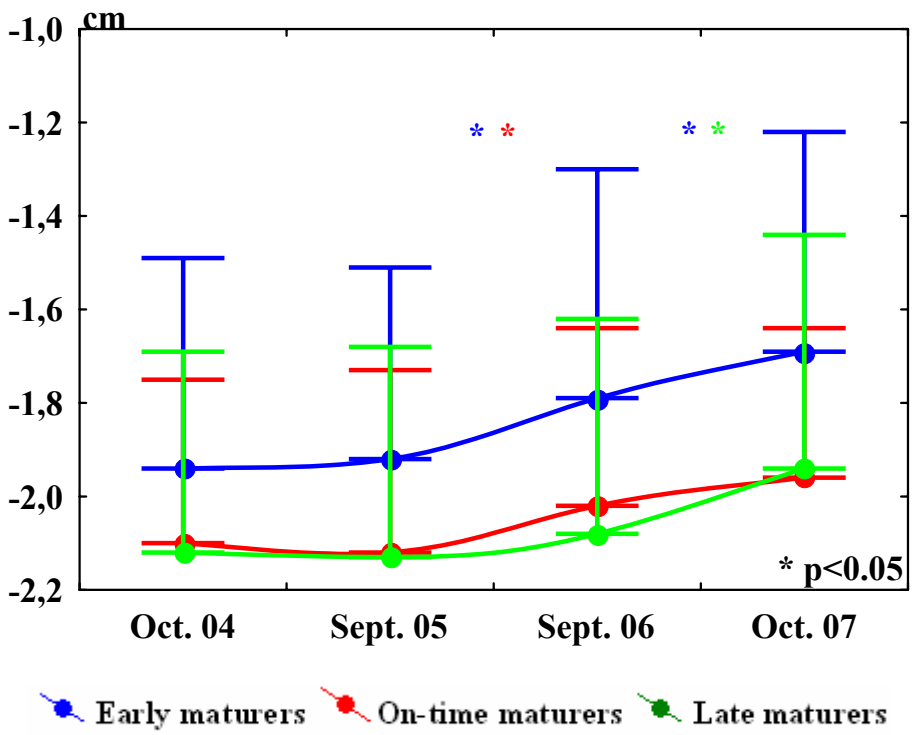

Figure 5. Means, standard deviations and results of Friedman ANOVA test for metric index in girls.

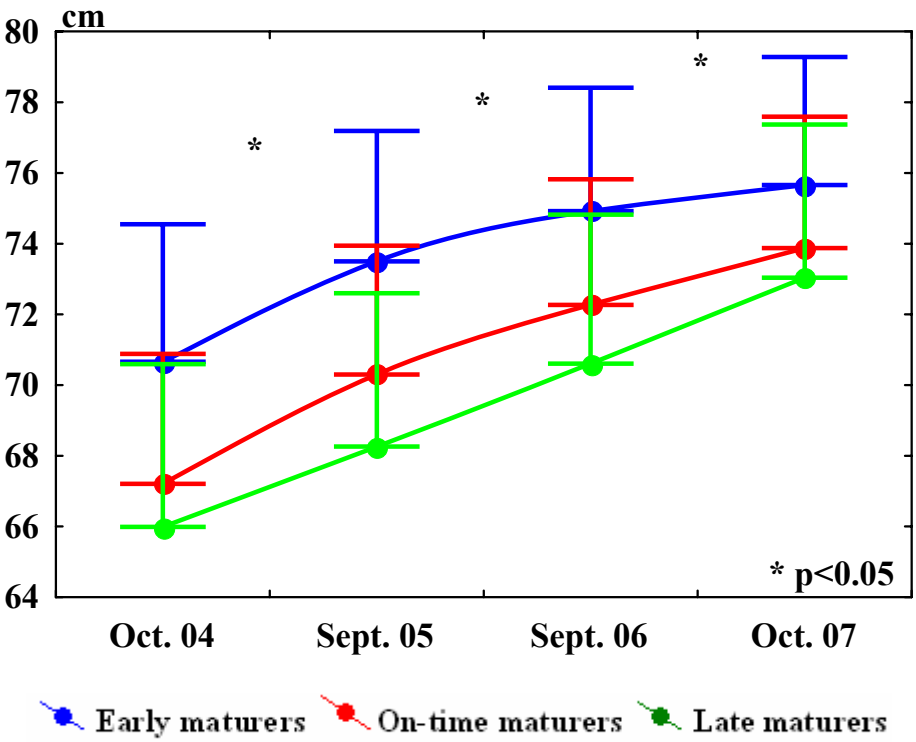

Figure 6. Means, standard deviations and results of Friedman ANOVA test for plastic index in girls.

4.2. Results of Psychological Questionnaires

Questionnaire data are measured in an ordinal scale, therefore we cannot use parametric procedures to analyze the psychological variables. The results of Kruskal-Wallis ANOVA of state-, trait anxiety and self-efficacy toward physical exercise scores are shown in Table 10.

Table 10. Descriptive statistics containing median, minimum, and maximum and results of Kruskal-Wallis ANOVA for state-, trait anxiety, and self efficacy toward physical exercise by groups

	Early maturers (n=69)		**On-time maturers (n=69)**		**Late maturers (n=69)**	
	Median	**Min-Max**	**Median**	**Min-Max**	**Median**	**Min-Max**
			State Anxiety			
1	32	20-58	34	22-53	32	20-55
2	33	20-58	34[c]	24-53	31[b]	20-44
3	33	12-46	32	13-43	32	21-48
4	32	20-52	32	15-47	30	12-51
			Trait Anxiety			
1	37	20-50	34	23-51	33	20-46
2	36	20-53	34	25-50	34	21-47
3	33	22-50	32	22-46	31	20-51
4	33	23-53	33	11-54	34	20-49
			Self-efficacy toward physical exercise			
1	47	20-84	48	23-82	53	13-80
2	43	17-83	47	19-81	49	17-80
3	41	15-83	48	17-76	44	16-79
4	46	20-76	50	20-82	48	15-83

[a] significantly differ from early maturers ($p<0.05$), [b] significantly differ from on-time maturers ($p<0.05$), [c] significantly differ from late maturers ($p<0.05$)

As it shown in Table 10, significant difference was found only in state anxiety score between on-time and late maturers at the 2nd measurement.

No statistical differ-ences were found in trait anxiety and in self efficacy toward physical exercise among the groups at any measurement time (Table 10).

The results of Friedman ANOVA test for the psychological variables are shown in Table 11.

Table 11. Results of Friedman ANOVA for the psychological variables by groups

	Early maturers (n=69)		On-time maturers (n=69)		Late maturers (n=69)	
	ANOVA χ^2	p	ANOVA χ^2	p	ANOVA χ^2	p
State-Anxiety	3.51	0.32	2.15	0.54	4.79	0.19
Trait-Anxiety	10.58	0.01*	7.31	0.06	3.59	0.31
SEPES	10.03	0.02*	1.42	0.70	4.28	0.23

* Significant difference at $p<0.05$

The differences in state anxiety scores were not significant among the measurement times, except in early maturers between the 1st and 2nd time point and in late maturers between the 3rd and 4th time point (Fig. 7.). Friedman ANOVA test showed statistical differences in trait anxiety scores, but the differences existed only in on-time maturers among the 2nd, 3rd and 4th time point, and in early maturers between the 2nd and 3rd measurements (Fig. 8.).

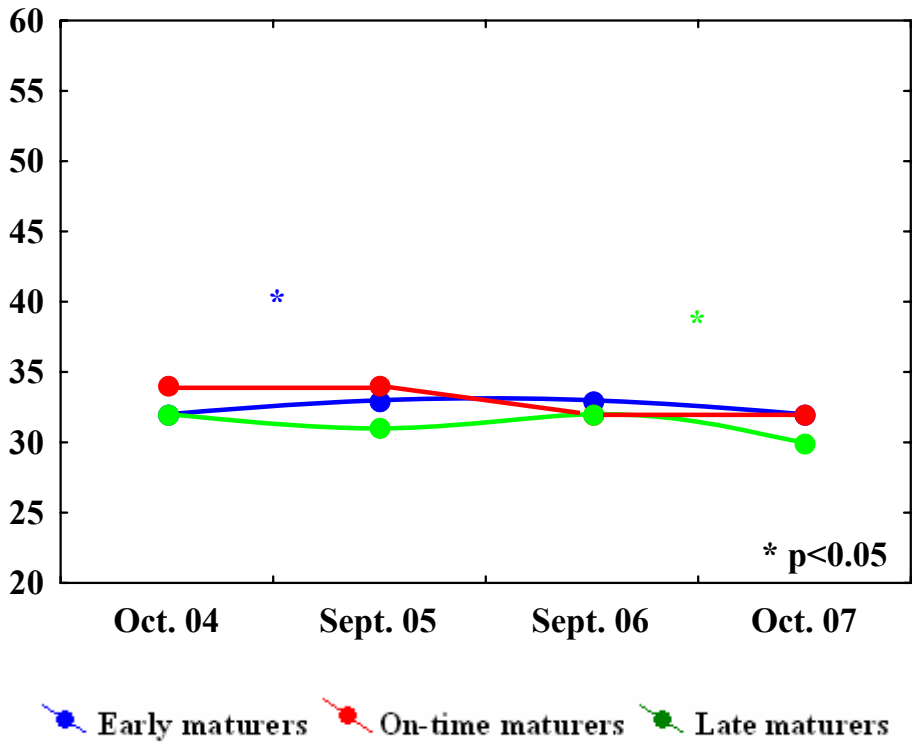

Figure 7. Results of Friedman ANOVA test for state anxiety scores.

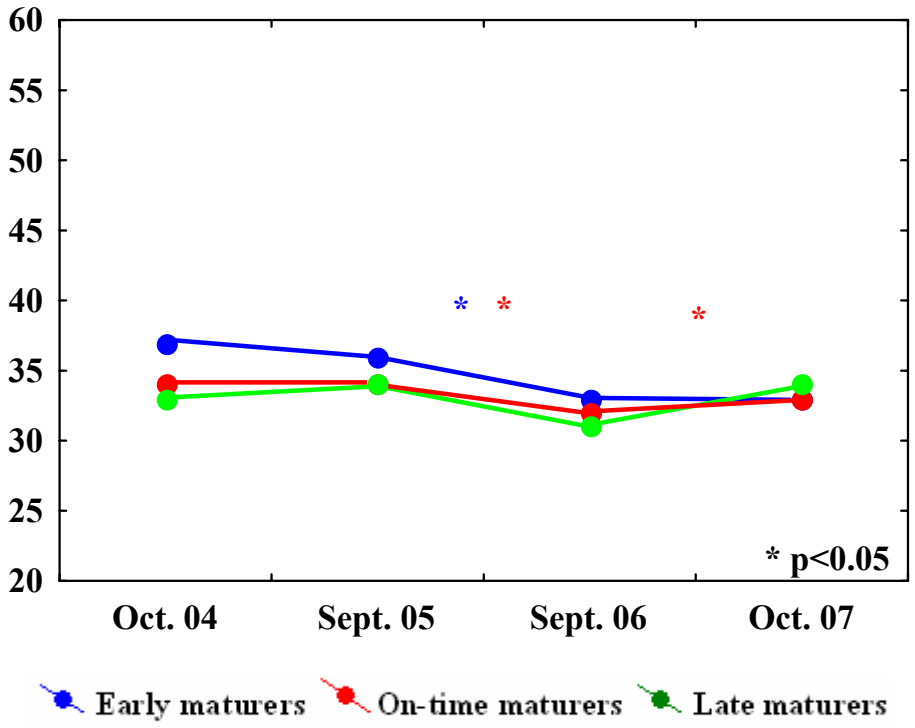

Figure 8. Results of Friedman ANOVA test trait anxiety scores.

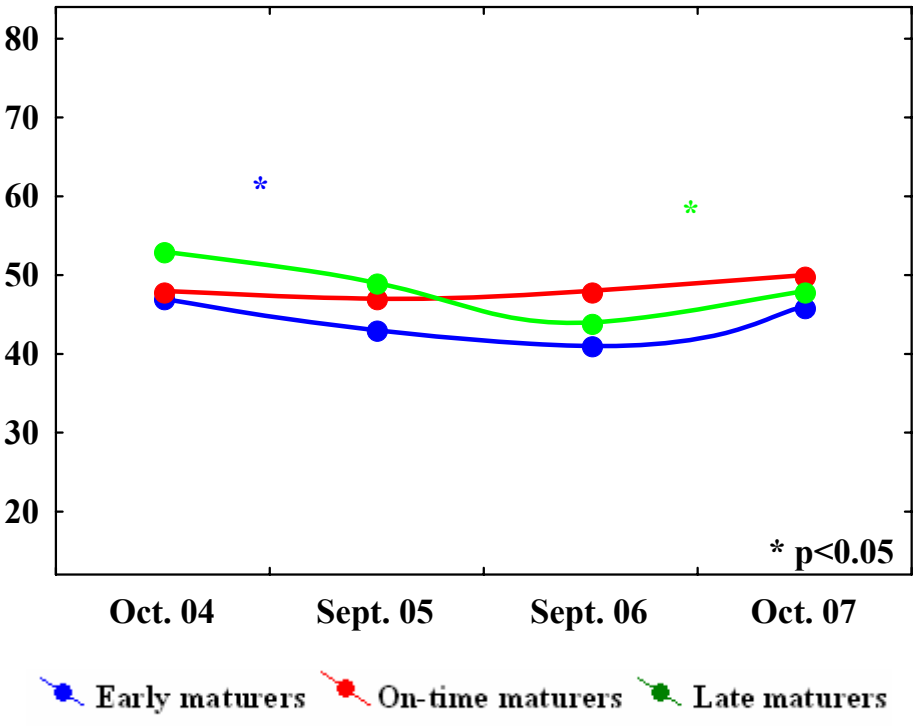

Figure 9. Results of Friedman ANOVA test for self-efficacy toward physical exercise scores.

Differences in self-efficacy toward physical exercise scores among the measurement times existed only between the 1st and 2nd measurement in case of early maturers, and between the 3rd and 4th measurement in late maturers (Fig. 9.). Therefore only state anxiety scores were quite stable during this 3 years longitudinal study.

Spearman rank correlations among the three psychological questionnaires are presented in Table 12.

Table 12. Spearman rank correlations among state-, trait anxiety, and self efficacy toward physical exercise scores

	SEPES			Trait Anxiety			State Anxiety		
	G1	**G2**	**G3**	**G1**	**G2**	**G3**	**G1**	**G2**	**G3**
				October 2004					
SEPES	1.00	1.00	1.00						
Trait Anxiety	-0.01	0.13	-0.00	1.00	1.00	1.00			
State Anxiety	-0.08	0.03	-0.12	0.46*	0.08	0.31*	1.00	1.00	1.00
				September 2005					
SEPES	1.00	1.00	1.00						
Trait Anxiety	0.18	0.04	0.04	1.00	1.00	1.00			
State Anxiety	0.17	-0.10	-0.10	0.60*	0.37*	0.37*	1.00	1.00	1.00
				September 2006					
SEPES	1.00	1.00	1.00						
Trait Anxiety	0.22	-0.20	-0.05	1.00	1.00	1.00			
State Anxiety	0.25*	-0.04	-0.18	0.48*	0.36*	0.56*	1.00	1.00	1.00
				October 2007					
SEPES	1.00	1.00	1.00						
Trait Anxiety	0.24	0.02	-0.14	1.00	1.00	1.00			
State Anxiety	0.03	-0.05	-0.25*	0.54*	0.46*	0.51*	1.00	1.00	1.00

* Significant correlation $p<0.05$

Significant correlations were found between state- and trait anxiety scores in all groups and at all measurement times except in G_2 at baseline. Statistical relations were found between state anxiety and self-efficacy toward physical exercise only in early maturers at 3rd and 4th measurement, but correlations were inverse. The relation between state- and trait anxiety was significant for the whole sample at each measurement time ($p<0.001$, respectively).

4.3. Relations Between Anthropometric and Psychological Variables

Questionnaire data are measured on ordinal scale, and anthropometric variables are continuous variables, therefore we cannot use parametric procedures to analyze the re-

lations between biological and psychological variables. The correlation coefficients of Kendall Tau correlations among the anthropometric and psychological variables are shown in Table 13.

As it is shown in Table 13 there were significant correlations between state anxiety and body height, and state anxiety and plastic index but only at baseline. Body mass related body fat percentage was positively related to state anxiety at last measurement.

Table 13. Kendall Tau correlations among anthropometric and psychological variables

	BH	**BW**	**BMI**	**BF%**	**MIX**	**PLX**
			October 2004			
SEPES	-0.04	-0.04	-0.03	-0.03	-0.04	-0.04
Trait Anxiety	0.01	0.04	0.04	0.06	0.02	0.04
State Anxiety	0.11*	0.08	0.04	-0.01	0.09	0.09*
			September 2005			
SEPES	-0.08	-0.06	-0.03	-0.04	-0.02	-0.07
Trait Anxiety	-0.01	0.05	0.08	0.08	0.02	0.05
State Anxiety	0.02	0.04	0.03	0.05	-0.02	0.06
			September 2006			
SEPES	-0.09	-0.06	-0.03	-0.05	-0.01	-0.05
Trait Anxiety	-0.06	0.05	0.09	0.08	0.08	0.04
State Anxiety	-0.02	0.05	0.07	0.07	0.04	0.07
			October 2007			
SEPES	0.04	-0.03	-0.04	-0.04	-0.03	0.03
Trait Anxiety	-0.03	-0.02	-0.02	0.05	-0.03	-0.05
State Anxiety	-0.02	0.04	0.06	0.09*	0.05	0.02

* Significant correlation $p<0.05$

4.4. Interpretation of Results

In summary the most important results of the research were that the growth type of children has changed according to the biological development of the muscles and skeletal system, but the differences in anthropometric characteristics among early-, on-time, and late maturer girls were mostly significant. Early maturer girls were significantly heavier, they had higher value in BMI, in body mass related body fat percentage, and in plastic index, and had lower value in metric index than on-time and late maturer girls.

We did not find significant difference in psychological variables among early-, on-time and late developer girls except in state anxiety score between on-time and late

maturers at the 2nd measurement, nevertheless there were no correlation between the biological and psychological variables, except between body height and state anxiety at the 1st measurement and between body mass related body fat percentage and state anxiety at the last measurement.

The relation between state- and trait anxiety was significant for the whole sample at each measurement time, but between state anxiety and self-efficacy toward physical exercise statistical correlations showed up in early maturers at 3rd and 4th measurement, but correlations were inverse.

Chapter 5

DISCUSSION

Introduction

The pattern of healthy growth is quite similar from one individual to another, but there are individual variabilities in rate and speed of growth at different ages, and maturation groups.

The reviewed literatures were avaiable to analyse our results separately in biological and psychological variables, but there were only few cross-sectional studies available to interpret the relations between anxiety and self efficacy toward physical exercise. The longitudinal investigations are generally the psychological variables, however, cross-sectional results showed the high prevalence of childhood depression, anxiety and lower self-esteem especially in girls.

In our study, cross-sectional comparisons were applied to describe the differences in anthropometric and psychological variables by age groups, and to analyze the relations between the biological and psychological attributes.

However, it was not a purpose of the dissertation to describe the prevalence of overweight and obese girls, which varies according to age, gender, race, and socio-economic status from our data we could draw a conclusion for that special western part of the country.

5.1. Physical Characteristics, Growth Type and Body Composition of Early-, On-time, and Late Matured Girls

Girls developed significantly in case of all anthropometric variables. The research question was whether there was a difference in growing among the three maturation group of girls. According to Frenkl and co-workers (6) and Kemper (7) the dif-

ference between the anthropometric characteristics of early, average and late maturer girls were significant. The same phenomenon was observed in our study. Their growth type has changed according to the development of the muscles and skeletal system.

The body height and body mass are the most often analyzed variables in anthropometric studies. Mean height values revealed increasing trends in all maturation groups, however, the slope of the curves were different. The early maturer girls have grown an average of 12cm, on time maturers 16cm and late maturers have grown about 17cm during the study. Because all girls had the onset of menstruation in both early- and on-time maturer groups, the speed of growing in their body height already slowed down. Therefore the shape of the curves for these two groups is resembled to the logarithmic curves. Most of the girls had no menstruation in late maturers group, so therefore their growth trend was still linear. As it has shown in chapter 2, several studies described that early maturer girls were taller (10, 16, 73). Because early maturers were significantly taller with an average of 5cm than on-time and with an average of 7cm than late maturers at baseline, but these differences disappeared for the last measurement. Early maturers were taller than late maturers until the 9^{th} measurement. The explanation for this is the peak height velocity. Because our measurements were carried out during the fast growth period, the time of menarche has an influence on stature. This influence had no effect at the end of the study, because 75% of the girls were in postmenarche. Early-maturing children of both sexes are taller and heavier than their average- and late-maturing age and sex peers from about age of 6 onward (10). Early maturers are closer to the adult stature in all ages. They also have more weight for stature at each age and these children stop growing in stature first, and children in the other two maturity categories continue to grow for longer period of time.

In body weight, early-maturing children have greater average as compared to young adults and have greater weight relative to stature than others. In our study we found the same incident, but early maturer girls were still significantly heavier, after the differences in height were equalized. Early maturer girls have increased their weight with 12kg, on-time maturers with 14kg, and late maturers with an average of 15kg during the study. The speed of gaining body mass was nearly the same in all groups, and it was significant between each measurement time. A seasonal oscillation could observe in late maturer girls, namely that their body mass was increasing more during each sum-

mer. This phenomenon appeared only at the first summer in on-time, and late developers.

Differences between on-time and late maturer girls appeared only during the 6th grade, but early maturers were heavier than the other two groups at all measurement times, respectively. It is an alarming finding of our study that while the differences in body height has disappeared by the end of the study, in body weight it still exist with an average of 8kg difference between early- and late developers. Pápai and Bodzsár (74) found that body mass rapidly increased between age 10 to 14 in Hungarian girls. Before menarche, the gain of lean body mass was intense, and body fat percentage was found to decrease (74). In our study, most of the late matured girls were premenarcheal, but we did not find any decrease in body mass related body fat percentage other than seasonal differences. It seemed that each group increased their BMI mostly during the summers and a remarkable increase was observed also in body mass related body fat percentage during this period of the year in each group. This can be due to the changes in diet and due to the absence of curricular physical exercise. Carrel and co-workers (2007) reported that after an intervention program in school time, the benefits of it has disappeared during the summer holiday. They observed also a rapid increase in body mass related body fat percentage in summer (162). Sohmiya and colleagues found decrease in body fat content during summer and increase during winter (163), while others found no seasonal changes in body composition (164). Von Hippel and colleagues' objective was to compare school and nonschool influences on children's BMI (165). They found rapid increase in BMI during summer. The variation in our data showed the same phenomena. Faster increase in BMI was found in each maturation group during all three summers. The increase was more intense in late matured girls. The slowest gain in BMI values was observed between January and May in each year. Body mass index has grown with an average 2kg $\times$ m^{-2} during the three years, which is consistent with the 2% increase in body mass related body fat percentage. When compared the maturation groups of girls, we found significant differences in BMI and body mass related body fat percentage among the groups at all measurement times. Early maturer girls had higher values in BMI and had higher amount of fat in proportion than on-time or late developers during the whole study. The observed differences are the results of the significantly different body weight. There were no significant differences in BMI and body fat

percentage between on-time and late maturers. BMI is not sensitive whether it is the amount of muscle mass or fat mass that has an influence on the results. Because we found the same incident in the body mass related body fat percentage, we assume that in our case the differences in BMI are coming from the higher amount of fat in proportion. Because of the differences between the results of body mass related body fat percentage estimation techniques, the interpretation of findings between different working groups should be taken with certain limitations (166-168).

The observed annual changes in growth type were also according to the biological maturation; development of the muscles and skeletal system. Conrad's (1963) method was used to describe the constitution in this study. We found that metric index decreased with 0.20cm and plastic index increased with an average of 6cm about. We observed that early maturer girls were significantly different in metric index from on-time-, and late maturers at all measurement times except at baseline, where they were differ only from late maturers. We did not find any significant differences between on-time-, and late maturers. The lowest values were found in on-time developers (-1.96cm at the end of the study), but late developers were also close to -2cm (-1.94cm at the end of the study) therefore, their body shape were the most linear. Early developers had the highest values in metric index (-1.69 at the end of the study), therefore their body constitution is metromorphic at this age. The body built of these girls has not changed during the three years, early maturers were mezomorphic, on-time and late maturers were leptomorphic at baseline measurements also. As Szmodis and colleagues presented (1976), metric index is one of the characters of the roundness of the chest, however, following its validation the calculated parameter was characteristic for the roundness or linearity of the whole body (154). The strongly negative values refer to the leptomorphic body build, the slightly negative ones to the athletic physique, and the positive ones to the picnomorph constitution. Metric index is based on the bone parameters, and therefore more and more Hungarian studies showed that this index describes that what, when and how materialized from genotype. In our study the mean was -2.05cm for the whole sample, therefore these girls generally referred to athletic leptomorphic body structure.

Because shoulder width is included in the equation of plastic index, and acromions are covered by subcutaneous fat, and it is also influencing the lower arm girth,

the amount of adipose tissue has minor effect on the results. Early maturer girls plastic index was 70.66cm at baseline which is hyperplastic, because this is a parameter for age 13 not for age 11. On-time maturers were also hyperplastic (67.21cm) but with less degree. These two groups were significantly different from late maturers result (65.99cm) who were normoplastic, because the mean value for age 11 is 65.6cm. These categories appeared also at the end of the study, the mean value for age 14 is 72.8cm, therefore early- and on-time maturers were again hyperplastic (75.66cm, 73.87cm), and on-time maturers were normoplastic (73.04cm). Early maturers were again significantly more robust than late maturers. As we mentioned subcutaneous fat has an effect on the results, therefore we think that the absolute higher value of PLX in early maturers was the straight consequence of the higher body mass related body fat percentage. Pápai and associates found the same phenomenon in their study, they revealed that the body built of those girls who experience the onset earlier is more robust while late matures are more linear in body shape (73, 74). As it is shown in body height, plastic index differences were also going closer except the last measurement, but early developers were statistically different from others.

The prevalence of overweight and obese girls in our sample was according to the international results. 19.3% (n=40) of the girls were overweight and 6.8% (n=14) were obese at baseline, which means all together 26.1%. The situation was much better by the end of the study, because we found only 35 (16.9%) girls, who were above the suggested cut offs by Cole (169). 11.1% of the girls were overweight and 5.8% obese according to the age specific standards at the end of the study. According to the WHO classification (22) for thinness Cole published the reference cut offs for children and adolescents (170). We found all together 17 girls, who were under the age reference, 2 of them were already in the 2nd grade of underweight at baseline. The number of underweight girls has decreased into 12 by the end of the study. One girl was in grade 3, five in grade 2.

The pubertal transition, and especially its timing, may have a disruptive influence on the emotional well-being of girls. The influence of peers can be great at this phase of life, therefore when they are reporting something according to the onset of puberty, the result can be misleading. The investigator has the opportunity to control the answers during a longitudinal study, but no differences were observed among the re-

peated indications in our study. Because menarche was monitored at each measurement time by personal interview, in those cases where girls were too shy to report the onset of menarche verbally it was not possible to get the real time of the onset. Therefore, a retrospective question was used in written form to evaluate the first time of menarche. Most of the written answers followed the previously reported dates, but there were differences in some cases, where finally the previously reported time was used for the analysis.

The social judgement on the onset of puberty has been changed during the last decades; therefore girls do not perceive the situation as stressful as earlier. Because of this fact it is assumed that girls can not report the onset of menarche accurately. Those who develop early are at risk for psychological disorders such as depression, anxiety, poor body image (171). Tests of reliability are required to measure the age at menarche, because unreliable measures may lead to misunderstand the possible relationship between the time of puberty and psychological disorders. Smolak and colleagues (172) focused in their study whether adolescents' self-reported grade at menarche is reliable to use to categorize pubertal timing. They found that self-reports of grade at menarche was statistically reliable, but the categories of relative maturational status on the basis of reports showed some change. At least 10% of the girls changed category. To check the reliability in our sample, we compared the answers from the personal interview and the retrospective question. We found that they were significantly correlated to each other ($r=0.76$, $p<0.00$).

5.2. Results of Psychological Questionnaires

According to the referenced literature earlier in Chapter 2 (126-131), we expected differences in psychological variables among the different maturation groups, but our results showed significant difference only in state anxiety scores between on-time and late maturer girls at the 2nd measurement. No statistical differences were found in trait anxiety and in self efficacy toward physical exercise among the groups in any measurement time.

This result could be due to the change of psychological judgment on the biological maturation or it is just a sample specific outcome. Differences in state anxiety scores were not significant among the different measurement times. However, Friedman

ANOVA test showed statistical differences in trait anxiety and in self-efficacy toward physical exercise scores, but only in early maturer girls. Therefore state anxiety scores were quite stable during this 3 years longitudinal study. To compare our results with other studies we found that as Tóth and Sipos (34) reported, we experience also higher values in trait anxiety than is state anxiety. The medians of our sample in STAIC questionnaires were also close to the national standards.

Story and colleagues (173) showed that there were no significant difference in self-efficacy between overweight/obese and normal children. Tóth and Sipos (34) reported the preliminary result of self efficacy toward physical exercise. The mean score for 115 girls was 57.7, which is higher than the medians what we found in our groups. For early maturers the medians of SEPES scores varied between 41 and 47, for on-time maturers between 47 and 50, and for late maturers between 44 and 53. Because Tóth and Sipos (34) did not give information about the anthropometric characteristics of the subjects, therefore we cannot compare the results. The age range was quite similar, but the sample size was half of ours. There is also a demographic difference (about 210km) between the two areas, where the measurements were performed.

Significant correlations were found between state- and trait anxiety scores in all groups, at all measurement times except in on-time maturers at baseline in our study. The relations between these two questionnaires were significant for the whole sample at each measurement time, respectively. Tóth and Sipos (34) found the same phenomena in their sample, but the level of significance was $p<0.1$. Therefore we think that this is a contradictory result. Houston and colleagues (174) found also a correlation between state and trait anxiety in fourth grade children, so it supports our findings. Further research is needed to clarify this relationship. We found significantcorrelation also between state anxiety and self-efficacy toward physical exercise only in early maturers at 3rd and 4th measurement, but correlations were inverse. Tóth and Sipos (34) found correlation between trait anxiety and self-efficacy toward physical exercise, but only for the total sample, and for boys, not in girls.

5.3. Correlations between anthropometric and psychological variables

Wadden and associates (175) did not find an association between weight and trait-anxiety in his mixed ethnic and gender sample, however, in a later study Young-

Hayman and her associates (176) reported a relation between body weight and body mass index in their study. As it shown there is a disagreement among the studies, whether there is a relation between body weight, body mass index and anxiety. Overweight girls were only slightly differing from normal weight girls in state anxiety (177). In our study we found significant correlations between state anxiety and body height, and state anxiety and plastic index but only at baseline. Body mass related body fat percentage was positively related to state anxiety at last measurement. The outcomes of our study cannot support any of the above mentionedthe previous findings; this can be due to changes among pu-bertal girls that the onset of menarche is not as stressful event for girls as it was earlier. There is a clear difference between the social and biological maturation of these girls. Thus, from both psychological and social perspectives, maturing either early or late than peers, may cause stress may not. A possible explanation for the non significant relation is that weight perception rather than the weight status per se is related to depressive symptoms. Weight misperceptions may explain why there is an inconsistency in the obesity-psychological disorders literature. Pubertal development involves biological, psychological and social changes that all may contribute to mental health problems. If one of these factors change it may influences the outcome. Because of the judgement of the society the social development of the children is more accelerated than their biological development. Therefore, it is easier for them to process the onset itself hence early maturers who has less time to prepare for the menstruation are not anxious about this.

On the other hand our findings can be sample specific results. We have to take into account that early maturer girls were not overweight or obese in our sample; therefore this can explain also why we did not find relations between the anthropometric and psychological variables. Further research is needed to clarify the assumptions between anthropometric and psychological variables.

Chapter 6

CONCLUSION

The aim of this longitudinal study was to analyze the differences in anthropometric and psychological variables among early-, on-time, and late maturer girls (N=207).

The following research questions were investigated in this dissertation:

1. Are there any statistically or biological differences in growth type, body composition and body dimensions among three various sexual maturation groups (early matures, on-time matures and late matures)?
2. Are there any differences in psychological variables (state- and trait-anxiety, coping) among early-, on-time- and late mature girls?
3. Are there any relation between anxiety and self efficacy toward physical exercise?
4. Are psychological variables associating with the level of obesity?

Based on the Shapiro-Wilk's W test and Levene's test of homogeneity we analyzed our data with both parametric and nonparametric statistical procedures.

We found out:

1. Early maturer girls were significantly taller than on-time and late maturer girls until age 13.7 year. The difference was 5cm between early- and on-time developers and 7cm between on-time- and late maturers. No significant difference was found in body height among the groups at the last measurement.

   Early maturer girls' body weight was significantly different from on-time and late maturers' weight at all measurement times. Differences between on-time and late maturer girls appeared only during the 6^{th} grade.

Significant differences were found in BMI and body mass related body fat percentage among the groups at all measurement times. Early maturers had significantly higher values in BMI and had higher amount of fat in proportion than on-time or late maturers during the whole study. There were no significant differences between on-time and late maturers.

Early developer girls were significantly different in metric index from on-time and late developers at all measurement times, except at baseline, where they were different only from late developers. There were no significant differences between on-time and late maturer girls at any measurement time. Early developers had significantly higher values in plastic index than on-time- or late developers at all measurement times. On-time maturers were statistically more robust than late maturers only at the 2nd measurement. No differences were found between these groups at other measurement times.

Our research hypotheses that there will be significant difference in anthropometric characteristics among early-, on-time and late maturer girls were accepted.

2. In the psychological questionnaires, significant difference was found only in state anxiety score between on-time and late maturers at the 2nd measurement. No statistical differences were found in trait anxiety and in self efficacy toward physical exercise among the groups at any measurement time.

   There were differences in trait anxiety and self-efficacy toward physical exercise scores among the measurement times, but no difference was found in state anxiety.

   Our research hypothesis that there will be significant difference in psychological variables among early-, average- and late maturers based on our results cannot be accepted.

3. Significant correlations were found between state- and trait anxiety scores in all groups and at all measurement times except in G_2 at baseline. Statistical relations were found between state anxiety and self-efficacy toward physical exercise only in early maturers at 3rd and 4th measurement, but correlations were inverse. The relation between state- and trait anxiety was significant for the whole sample at each measurement time ($p<0.001$, respectively).

Our research hypothesis that there will be relation between anxiety and self-efficacy toward physical exercise was accepted at all measurement times, except in G_1 at baseline.

4. There were significant correlations between state anxiety and body height, and state anxiety and plastic index but only at baseline. Body mass related body fat percentage was positively related to state anxiety only at the last measurement.

   Our research hypothesis that there will be relation between the biological and psychological attributes was rejected.

Our main finding that was that, as body height differences were equalized among the different maturation groups, differences in body weight, BMI, body mass-related body fat percentage, in metric and plastic indexes still existed. Therefore those girls, who experience the onset earlier than the average, are in danger for obesity in adulthood also. Our study is not able to clarify whether the observed differences were because of the earlier onset, or the first bleeding is the influence of the already experienced fat accumulation. Further research, starting at earlier age, is needed to reliably answer this biological question.

It was difficult to draw trend lines in the case of psychological variables because the changes were so minor, and they were not consistent. This means that between age 11 to 14 the level of anxiety and self-efficacy toward physical exercise were quite unstable. Therefore it is hard to make conclusions, because we cannot handle the extraneous factors such as the happenings in the child's life on the measurement day. We also assumed from experience that the filling of these questionnaires were difficult to these girls. They were not able to clearly differentiate between trait- and state anxiety. Hence we suggest to use the STAIC questionnaire in later life. It was also difficult to use the self-efficacy toward physical exercise questionnaire in those cases where girls had no extracurricular physical activity.

Because we did not find consequent relations between the biological and psychological attributes as others reports, further research is also needed to clarify if this result can be due to the change of psychological judgment on the biological maturation or it is just a sample specific outcome.

ABSTRACT

Eszter Völgyi. RELATIONSHIP BETWEEN BIOLOGICAL MATURATION, BODY COMPOSITION AND PSYCHOLOGICAL FUNCTIONS. LONGITUDINAL STUDY

This dissertation investigated differences in anthropometric and psychological variables according to the onset of menarche among Hungarian teenage girls.

All together 207 girls were included in the analysis (mean age was 11.04±0.39 at baseline). The subjects were divided into three groups by tertiles according to the onset of menarche (G1; n=69 early matured, G2; n=69 on-time matured, G3; n=69 late matured).

Anthropometric measurements were carried out 10 times during the 3 years observation period, every 4th month. Body mass related body fat was estimated by the caliper metric method of Pařízková (51). The physique patterns were described by plastic and metric indices (52). Self-administered questionnaires were used to describe state and trait anxiety (53) and self-efficacy towards physical activity (33). Differences between the groups were analyzed by one-way ANOVA or Kruskal-Wallis ANOVA depending on respective distributions and measurement scales. Changing during the three years was tested by repeated measures of ANOVA or Friedman ANOVA according to the distributions and measurement scales. Relations between anthropometric variables and psychological variables by groups were analyzed by Kendall-τ correlation.

In summary the principal results of the research were that early maturer girls were significantly heavier, they had higher value in BMI, in body mass related body fat percentage, in plastic index, and in metric index than on-time and late maturer girls. We did not find significant difference in psychological variables among early-, on-time and late developers. Nevertheless there were no correlations between the biological and psychological variables.

The conclusion is that the differences among anthropometric characteristics are the consequences of the process of biological maturation, but the pace of their social maturation is not the same. Other factors (family background, type of the settlement where they live) may influence the social behavior.

ÖSSZEFOGLALÓ

Völgyi Eszter. A PSZICHIKUS FUNKCIÓK, A TESTÖSSZETÉTEL ÉS A BIOLÓGIAI ÉRÉS KAPCSOLATÁNAK HOSSZMETSZETI VIZSGÁLATA

A disszertáció célja az volt, hogy elemezzék a különböző érési típusú magyar tinédzser leányok testösszetételében és pszichológiai jellemzőiben tapasztalható különbségeket.

A vizsgálatban összesen 207 lány vett részt naptári életkoruk 11,04±0,39 év volt az első vizsgálat időpontjában. A mintát három csoportra osztották, az első menstruáció időpontja szerint (G1; n=69 korán érők, G2; n=69 időben érők, G3; n=69 későn érők).

Az antropometriai vizsgálatokat a 3 év alatt összesen 10 alkalommal végezték minden negyedik hónapban. A testtömeghez viszonyított relatív testzsírtartalmat Parízková (51) kalipermetriás módszerével becsülték. A növekedési típust a metrikus és plasztikus indexekkel jellemezték (52). Önkitöltős kérdőívet használtak, hogy elemezzék a pillanatnyi és általános szorongást (53) és a sporttevékenységre (fizikai aktivitásra) való készenlétet (33). A csoportok közötti különbség vizsgálatára az adatok típusától és eloszlásától függően variancia analízist vagy Kruskal-Wallis próbát alkalmaztak. A három év alatt történt változást az adatok eloszlásától és típusától függően az ismételt mérések variancia analízisével vagy Friedman ANOVA teszttel elemezték. Az antropometriai és pszichológiai változók közötti kapcsolatot Kendall- τ teszttel elemezték.

Összességében megállapíthatják, hogy a korán érő lányok jelentősen nehezebbek voltak és magasabb értéket mutattak mind a testtömeg indexben, testtömeghez viszonyított relatív testzsírtartalomban, mind pedig a metrikus és plasztikus index értékekben. A pillanatnyi és általános szorongásban, továbbá a sporttevékenységre (fizikai aktivitásra) való készenlétben nem találtak különbséget egyik vizsgálati időpontban sem. Továbbá nem találtak korrelációt a biológiai és a pszichológiai változók között.

Az antropometriai jellemzők közötti különbségek alapvetően a biológiai érettség következményei, de a szociális fejlődés ezzel nem egyezik meg. Más faktorok (családi háttér, település nagysága, ahol élnek) befolyásolhatják a szociális szokásokat.

BIBLIOGRAPHY

1. Bodzsár É. *Életkorok biológiája. A pubertáskor.* Budapest: ELTE: Eötvös Kiadó, 2003.
2. Bodzsar EB, Zsakai A. Present State of Secular Trend in Hungary. In: Bodzsar EB, Zsakai A, eds. *New Perspectives and Challanges in Anthropology.* Newcastle, UK: Cambridge Scholars Publishing, 2007:217-227.
3. Atkinson RL, Atkinson RC, Smith EE, Bem DJ, Nolen-Hoeksema S. Hilgard's *Introduction to Psychology.* USA: Harcourt, Inc., 2000.
4. Brooks-Gunn J, Rubble DN. The experience of menarche from a developmental perspective. In: Brooks-Gunn J, Petersen AC, eds. *Girls at puberty: Biological and psychological perspectives.* New York: Plenum, 1983.
5. Simmons RG, Blyth DA. *Moving into adolescence: The impact of pubertal change and school context.* Hawthorne, NY: Aldine, 1988.
6. Frenkl R, Mészáros J, Mohácsi J, Bukta M. Biological maturation and motor performance in 12 to 14-year-old girls. In: Malina RM, ed. *Young athletes; biological, physiological, and educational perspectives.* Champaign, Illinois: Human Kinetics, 1988:93-97.
7. Kemper HCG, ed. *The Amsterdam growth study: A longitudinal analysis of health, fitness, and lifestyle.* Champaign, Illinois: Human Kinetics Sport Science Monograph Series, 1995.
8. Bodzsár ÉB, Susanne C. eds. *Secular growth changes in Europe.* Budapest: Eötvös University Press, 1998.
9. Demeter A. *Sport im Wachstums- und Entwicklungalter. Anatomische, physiologische und psychologische Aspekte.* Leipzig: Johann Ambrosius Barth, 1981.
10. Malina RM, Bouchard C. *Growth, maturation, and physical activity.* Champaign, Illinois: Human Kinetics Books, 1991.
11. King AC. Community intervention for promotion of physical activity and fitness. Exerc Sport Sci Rev 1991;19:211-59.
12. Wutscherk H. *Grundlagen der Sportanthropometrie.* Leipzig: DHfK, 1981.
13. Mészáros J, Mohácsi J. A biológiai fejlettség meghatározása és a felnőtt termet előrejelzése a városi fiatalok fejlődésmenete alapján. MTA. Budapest, 1983:1-151.

14. Tatár A, Zsidegh M, Mészáros Z, et al. Physique body composition and motor performance in Hungarian and Roma boys. Revista Portuguesa de Ciencias do Desporto 2003;3:122-124.
15. Lohman T. *Advances in Body Composition Assessment.* Champaign, Illinois: Human Kinetics Publishers, 1992.
16. Bouchard C. *Physical Activity and Obesity.* Champaign, Illinois: Human Kinetics, 2000.
17. Adair LS, Gordon-Larsen P. Maturational timing and overweight prevalence in US adolescent girls. Am J Public Health 2001;91:642-4.
18. Biro FM, McMahon RP, Striegel-Moore R, et al. Impact of timing of pubertal maturation on growth in black and white female adolescents: The National Heart, Lung, and Blood Institute Growth and Health Study. J Pediatr 2001;138:636-43.
19. Wang Y. Is obesity associated with early sexual maturation? A comparison of the association in American boys versus girls. Pediatrics 2002;110:903-10.
20. Beunen G, Malina RM, Lefevre J, et al. Size, fatness and relative fat distribution of males of contrasting maturity status during adolescence and as adults. Int J Obes Relat Metab Disord 1994;18:670-8.
21. van Lenthe FJ, Kemper HC, van Mechelen W, et al. Biological maturation and the distribution of subcutaneous fat from adolescence into adulthood: the Amsterdam Growth and Health Study. Int J Obes Relat Metab Disord 1996;20:121-9.
22. World Health Organization Expert Committee (1995). Physical Status, the Use and Interpretation of Anthropometry. Geneva, Switzerland: WHO, 263–311.
23. Caspi A, Moffitt TE. Individual differences are accentuated during periods of social change: the sample case of girls at puberty. J Pers Soc Psychol 1991;61:157-68.
24. Laitinen-Krispijn S, Van der Ende J, Hazebroek-Kampschreur AA, Verhulst FC. Pubertal maturation and the development of behavioural and emotional problems in early adolescence. Acta Psychiatr Scand 1999;99:16-25.
25. Frisch RE, Revelle R. Height and weight at menarche and a hypothesis of critical body weights and adolescent events. Science 1970;169:397-9.

26. Frisch RE, McArthur JW. Menstrual cycles: fatness as a determinant of minimum weight for height necessary for their maintenance or onset. Science 1974; 185:949-51.
27. Demerath EW, Li J, Sun SS, et al. Fifty-year trends in serial body mass index during adolescence in girls: the Fels Longitudinal Study. Am J Clin Nutr 2004; 80:441-6.
28. Welpe I, Bernhard W. Physical and psychological changes in relation to the period before and after onset of the menarche. Anthropol Anz 1986;44:1-12.
29. Patton GC, Hibbert ME, Carlin J, et al. Menarche and the onset of depression and anxiety in Victoria, Australia. J Epidemiol Com Health 1996;50:661-66.
30. McKenna RJ. Some effects of anxiety level and food cues on the eating behavior of obese and normal subjects: a comparison of the Schachterian and psychosomatic conceptions. J Pers Soc Psychol 1972;22:311-9.
31. Tóth L, Sipos K. Tizenkét-tizennégy éves túlsúlyos és normál testsúlyú tanulók pszichológiai jellemzőinek, motoros és iskolai teljesítményének vizsgálata. Kalokagathia 1995;33.
32. Bandura A. *Self-Efficacy: The exercise of control.* New York: Freeman, 1994.
33. Schwarzer R. *Measurement of Perceived Self-efficacy - Psychometric Scales for Cross-Cultural Research*. Berlin: Forschung an der Freien Universität, 1993.
34. Tóth L, Sipos K. Generalized self-efficacy, and self-efficacy towards physical exercise results on 10-15-year-old school-children. Kalokagathia 2003; 1:104-110.
35. Minimol G. Preparing girls for menarche. Nursing Journal of India 2003;94(3):54-6.
36. Susman EJ, Nottleman ED, Inoff-Germain GE, Loriaux DL, Chrousos GP. The relation of relative hormonal levels and physical development and social-emotional behavior in young adolescents. J. Youth and Adolesc. 1985;14:245-64.
37. Kornfield S. *Impact of parental marital status, gender, and pubertal development on adolescent functioning.* University of Georgia, Georgia, 1990.
38. Spink KS. Group cohesion and collective efficacy in volleyball teams. Journal Of Sport & Exercise Psychology 1990;12:301-11.

39. Harter S. Effective motivation reconsidered: Toward a developmental model. Human Development 1978;21:36-64.
40. Eveleth PB, Tanner JM. Worldwide variation in human growth 1976. Cambridge: Cambridge University Press, 1976.
41. Saar E, Shalev C, Dalal I, Sod-Moriah UA. Age at menarche: the influence of environmental conditions. Int J Biometeorol 1988;32:33-5.
42. Sharma K, Talwar I, Sharma N. Age at menarche in relation to adult body size and physique. Ann Hum Biol 1988;15:431-4.
43. Georgiadis E, Mantzoros CS, Evagelopoulou C, Spentzos D. Adult height and menarcheal age of young women in Greece. Ann Hum Biol 1997;24:55-9.
44. Fakeye O. The interrelationships between age, physical measurements and body composition at menarche in schoolgirls at Ilorin, Nigeria. Int J Gynaecol Obstet 1985;23:55-8.
45. Roberts DF, Danskin MJ, Chinn S. Menarcheal age in Northumberland. Acta Paediatr Scand 1975;64:845-52.
46. Forrai J. *A magánélet és az egészség kultúrája I.* Budapest-Pécs: Dialógus Campus Kiadó, 2002.
47. Mészáros J. ed. *A gyermeksport biológiai alapjai.* Budapest: Sport, 1990.
48. Farmosi I. Mozgásfejlődés. Budapest: TF jegyzet, 1992.
49. Banis HT, Varni JW, Wallander JL, et al. Psychological and social adjustment of obese children and their families. Child Care Health Dev 1988;14:157-73.
50. Weiner JES, Lourie JA, eds. *Human Biology. A Guide to Field Methods.* IBP Handbook (No. 9.). Oxford: Blackwell Scientific Publisher, 1969.
51. Parízková J. Total body fat and skinfold thickness in children. Metabolism 1961; 10:794-807.
52. Conrad K. *Der Konstitutionstypus.* Berlin: Springer-Verlag, 1963.
53. Spielberger CD. *STAIC Preliminary Manual for the State-trait Anxiety Inventory for Children.* Palo Alto, California: Consulting Psychologist Press, 1973.
54. Fuchs R, Wegner M, Schwarzer R. Self-efficacy towards physical exercise. In: Schwarzer R, ed. *Measurement of perceived self-efficacy - Psychometric Scales for Cross-Cultural Research.* Berlin: Forschung an der Freien Universität Berlin, 1993.

55. Spielberger CD, Sipos K. H.STAIC F.C-1 és F.C-2. (Hungarian translation K. Sipos, 1978). Budapest: MTA Pszichol. Int., 1978.
56. Sipos K, Fuchs R, Wegner M, Schwarzer R. *The Hungarian version of Self-Efficacy Towards Physical Exercise.* (Sporttevékenységre való készenlét). Budapest Hungarian University of Physical Education, 1993.
57. Sterelny K, Grifiths PE. *Sex and Death: An Introduction to Philosophy of Biology:* University of Chicago Press, 1999.
58. Wilmore JH, Costill DL. *Physiology of Sport and Exercise.* Champaign, Illinois: Human Kinetics, 1994.
59. Vincent WJ. *Statistics in kinesiology.* Champaign, Illinois: Human Kinetics, 2005.
60. Anshel MH, ed. *Dictionary of the Sport and Exercise Sciences.* Champaign, Illinois: Human Kinetics, 1991.
61. Heyward VH, Stolarczyk LM. *Applied body composition assessment.* Champaign, Illinois: Human Kinetics, 1996.
62. Sizonenko PC. Endocrinology in preadolescents and adolescents. I. Hormonal changes during normal puberty. Am J Dis Child 1978;132:704-12.
63. Rowland TW. Developmental exercise physiology. Champaign, Illinois: Human Kinetics, 1996.
64. Bodzsár É. *Humánbiológia. Fejlődés: növekedés és érés.* Budapest: ELTE Eötvös Kiadó, 1999.
65. Brooks-Gunn J, Petersen AC, Eichorn D. The study of maturational timing effects in adolescence. Journal of Youth and Adolescence 1985;14:149-61.
66. Anthony J. The reactions of adults to adolescents and their behavior. In: Caplan G, Lebovici S, eds. *Adolescence: Psychosocial perspectives.* New York: Basic Books, 1969:77.
67. Hall GS. Adolescence: Its Psychology and its Relation to Physiology, Anthropology, Sociology, Sex, Crime, Religion and Education. American Journal of Insanity 1904;61:375-81.
68. Brooks-Gunn J. How stressful is the transition to adolescence for girls? In: Colten ME, Gore S, eds. *Adolescent Stress: Causes and consequences.* New York, NY: Aldine de Gruyter, 1991:131-50.

69. Farkas G. Relationship between the age at menarche and the socioeconomic factors in Hungary. Anthrop. Közl. 1986;30:117-23.
70. Kézmárszky T. Über die Gewichtsveränderungen reifer Neugeborenen. Archiv für Gynaekologie (Berlin) 1873;5:547-61.
71. Farkas G. *Délalföldi 10-18 évesek testi fejlettsége és a leányok menarche-kora.* Szeged: JATE, 1986.
72. Bodzsár ÉB. A rewiev of Hungarian studies on growth and physique of children. Acta Biologica Szegediensis 2000;44:139-53.
73. Pápai J, Szmodis I, Bodzsár É. Growth, maturation and performance. Anthrop. Közl. 1992;34:75-82.
74. Pápai J, Bodzsár É. Menarcheal age and growth in Jászberény girls. Anthrop. Közl. 1989/90;32:151-58.
75. Magnusson D, Strattin H, Allen VL. Biological maturation and social development: A longitudinal study of some adjustment processes from mid-adolescence to adulthood. Journal of Youth and Adolescence 1985;14:267-83.
76. Brooks-Gunn J. The psychological significance of different pubertal events to young girls. Journal of Early Adolescence 1984;4:315-27.
77. Petersen AC. Adolescent development. Annu Rev Psychol 1988;39:583-607.
78. Brooks-Gunn J. Growing up female: How stormy and stressful is the transition to adolescence? 13th Annual Konopka Lecture. Princeton, NJ: Educational Testing Service, 1990.
79. Cohen S, Wills TA. Stress, social support, and the buffering hypothesis. Psychol Bull 1985;98:310-57.
80. Lazarus RS. *Psychological stress and the coping process.* New York: McGraw-Hill, 1966.
81. Lazarus RS, Launier R. Stress-related transactions between person and environment. In: Pervin LA, Lewis M, eds. *Perspectives in interactional psychology.* New York: Plenum Press, 1978.
82. Baydar N, Hyle P, Brooks-Gunn J. A Longitudinal Study of the Effects of the Birth of a Sibling during Preschool and Early Grade School Years. Journal of Marriage and the Family 1997;59:957-65.

83. Blyth DA, Simmons RG, Zakin DF. Satisfaction with body image for early adolescent females: The impact of pubertal timing within different school environments. Journal of Youth and Adolescence 1985;14:207-25.

84. Simmons RG, Blyth DA, McKinney KL. The social and psychological effects of puberty on white females. In: Brooks-Gunn J, Petersen AC, eds. *Girls at puberty: Biological and psychosocial perspectives.* New York: Plenum Press, 1983:229-72.

85. Attie I, Brooks-Gunn J. Weight concerns as chronic stressors in women. In: R. C. Barnett, Biener L, Baruch GK, eds. *Gender and stress.* New York: Free Press, 1987:218-54.

86. Brooks-Gunn J, Warren MP. Effects of delayed menarche in different contexts: Dance and nondance students. J. Youth and Adolesc. 1985;14:285-300.

87. van Lenthe FJ, Kemper CG, van Mechelen W. Rapid maturation in adolescence results in greater obesity in adulthood: the Amsterdam Growth and Health Study. Am J Clin Nutr 1996;64:18-24.

88. Garn SM, LaVelle M, Rosenberg KR, Hawthorne VM. Maturational timing as a factor in female fatness and obesity. Am J Clin Nutr 1986;43:879-83.

89. Wellens R, Malina RM, Roche AF, Chumlea WC, Guo S, Siervogel RM. Body size and fatness in young adults in relation to age at menarche. Am. J. Hum. Biol. 1992;4:783–787.

90. de Ridder CM, Thijssen JH, Bruning PF, Van den Brande JL, Zonderland ML, Erich WB. Body fat mass, body fat distribution, and pubertal development: a longitudinal study of physical and hormonal sexual maturation of girls. J Clin Endocrinol Metab 1992;75:442-46.

91. Morrison JA, Barton B, Biro FM, Sprecher DL, Falkner F, Obarzanek E. Sexual maturation and obesity in 9- and 10-year-old black and white girls: the National Heart, Lung, and Blood Institute Growth and Health Study. J Pediatr 1994;124: 889-95.

92. Herman-Giddens ME, Slora EJ, Wasserman RC, et al. Secondary sexual characteristics and menses in young girls seen in office practice: a study from the Pediatric Research in Office Settings network. Pediatrics 1997;99:505-12.

93. Bini V, Celi F, Berioli MG, et al. Body mass index in children and adolescents according to age and pubertal stage. Eur J Clin Nutr 2000;54:214-18.
94. Laron Z. Is obesity associated with early sexual maturation? Pediatrics 2004; 113:171-72.
95. Scott EC, Johnston FE. Critical fat, menarche, and the maintenance of menstrual cycles: a critical review. J Adolesc Health Care 1982;2:249-60.
96. Frisch RE. Pubertal adipose tissue: is it necessary for normal sexual maturation? Evidence from the rat and human female. Fed Proc 1980;39:2395-400.
97. Hadley ME. *Endocrinology (2nd ed.).* New Jersey: Englewood Cliffs, 1988.
98. World Health Organization (1998). Obesity – Preventing and Managing the Global Epidemic. (Report of a WHO Consultation on Obesity.) Geneva: WHO.
99. Troiano RP, Flegal KM, Kuczmarski RJ, Campbell SM, Johnson CL. Overweight prevalence and trends for children and adolescents. The National Health and Nutrition Examination Surveys, 1963 to 1991. Arch Pediatr Adolesc Med 1995;149:1085-91.
100. Salbe AD, Ravussin E. The determinants of obesity. In: Bouchard C, ed. *Physical activity and obesity.* Champaign, Illinois: Human Kinetics, 2000:69-102.
101. Ravussin E, Swinburn BA. Pathophysiology of obesity. Lancet 1992;340:404-8.
102. Ravussin E, Pratley RE, Maffei M, et al. Relatively low plasma leptin concentrations precede weight gain in Pima Indians. Nat Med 1997;3:238.
103. Tataranni PA, Young JB, Bogardus C, Ravussin E. A low sympathoadrenal activity is associated with body weight gain and development of central adiposity in Pima Indian men. Obes Res 1997;5:341-47.
104. Zurlo F, Lillioja S, Esposito-Del Puente A, et al. Low ratio of fat to carbohydrate oxidation as predictor of weight gain: study of 24-h RQ. Am J Physiol 1990; 259:E650-7.
105. Schofield WN. Predicting basal metabolic rate, new standards and review of previous work. Hum Nutr Clin Nutr 1985;39 Suppl 1:5-41.
106. Frankenfield DC, Muth ER, Rowe WA. The Harris-Benedict studies of human basal metabolism: history and limitations. J American Diet Assoc 1998;98:439-45.

107. Bogardus C, Lillioja S, Ravussin E, et al. Familial dependence of the resting metabolic rate. N Engl J Med 1986;315:96-100.
108. Boothby WM, Berkson J, Dunn HL. Studis of the energy of metabolism of normal individuals: a standard for basal metabolism with a nomogram for clinical application. American Journal of Physiology 1936;116:468-84.
109. Shock NW, Yiengst MJ. Age changes in basal respiratory measurements and metabolism in males. J Gerontol 1955;10:31-40.
110. Foster GD, Wadden TA, Vogt RA. Resting energy expenditure in obese African American and Caucasian women. Obes Res 1997;5:1-8.
111. Jakicic JM, Wing RR. Differences in resting energy expenditure in African-American vs Caucasian overweight females. Int J Obes Relat Metab Disord 1998;22:236-42.
112. Kaplan AS, Zemel BS, Stallings VA. Differences in resting energy expenditure in prepubertal black children and white children. J Pediatr 1996;129:643-47.
113. Albu J, Shur M, Curi M, Murphy L, Heymsfield SB, Pi-Sunyer FX. Resting metabolic rate in obese, premenopausal black women. American Journal of Clinical Nutrition 1997;66:531-38.
114. Yanovski SZ, Reynolds JC, Boyle AJ, Yanovski JA. Resting metabolic rate in African-American and Caucasian girls. Obes Res 1997;5:321-25.
115. Griffiths M, Payne PR, Stunkard AJ, Rivers JP, Cox M. Metabolic rate and physical development in children at risk of obesity. Lancet 1990;336:76-8.
116. Eckel RH. Insulin resistance: an adaptation for weight maintenance. Lancet 1992;340:1452-53.
117. Odeleye OE, de Courten M, Pettitt DJ, Ravussin E. Fasting hyperinsulinemia is a predictor of increased body weight gain and obesity in Pima Indian children. Diabetes 1997;46:1341-45.
118. Choi JH, Kim JH, Lee MJ, Moon SJ, Lee SI, Baek NS. An ecological analysis of iron status of middle school students in Seoul. Korean Journal of Nutrition 1997;30:960-75.
119. Won HS, Han SS, Oh SY, et al. Guidelines of body mass index in Korean Childhood and adolescent obesity and relationship with physical strength. Korean Journal of Nutrition 2000;33:241-49.

120. Must A, Jacques PF, Dallal GE, Bajema CJ, Dietz WH. Long-term morbidity and mortality of overweight adolescents. A follow-up of the Harvard Growth Study of 1922 to 1935. N Engl J Med 1992;327:1350-55.
121. Pápai J. Alkati típusok és személyiségjellemzők a pubertás idején. Magyar Sporttudományi Szemle 2004;1:52-57.
122. Sroufe LA, Rutter M. The domain of developmental psychopathology. Child Dev 1984;55:17-29.
123. Lerner RM. A life-span perspective for early adolescence. In: Lerner RM, Foch TT, eds. *Biological-psychosocial interactions in early adolescence.* New Jersey: Erlbaum, 1987:9-34.
124. Faust MJ. Alternative constructions of adolescent growth. In: Brooks-Gunn J, Petersen AC, eds. *Girls at puberty: Biological and psychosocial perspectives.* New York: Plenum, 1983:105-25.
125. Young CM, Sipin SS, Roe DA. Body composition of preadolescent and adolescent girls. Journal of the American Dietetic Association 1980;3:25-31.
126. Allgood-Merten B, Lewinsohn PM, Hops H. Sex differences and adolescent depression. J Abnorm Psychol 1990;99:55-63.
127. Alsaker FD. Pubertal Timing, Overweight, and Psychological Adjustment. The Journal of Early Adolescence 1992;12:396-419.
128. Faust J. Correlates of the drive for thinness in young female adolescents. Journal of Child Clinical Psychology 1987;16:313-19.
129. Hops H, Lewinsohn PM, Andrews JA, Roberts RE. Psychosocial correlates of depressive symptomatology among high school students. Journal of Clinical Child Psychology 1990;19:211-20.
130. Richards MH, Casper RC, Larson R. Weight and eating concerns among pre- and young adolescent boys and girls. J Adolesc Health Care 1990;11:203-9.
131. Rierdan J, Koff E, Stubbs ML. Depressive symptomatology and body image in adolescent girls. Journal of Early Adolescence 1987;7:205-16.
132. Kaplan SL, Busher J, Polack S. Perceived weight, actual weight, and depressive symptoms in a general adolescent sample. International Journal of Eating Disorders 1988;7:107-13.

133. Rierdan J, Koff E. Weight, weight-related aspects of body image, and depression in early adolescent girls. Adolescence 1997;32:615-24.
134. Simmons RG, Rosenberg F. Sex, sex roles, and self-image. Journal of Youth and Adolescence 1975;4:229-58.
135. Muris P, Meesters C, Merckelbach H, Sermon A, Zwakhalen S. Worry in normal children. J Am Acad Child Adolesc Psychiatry 1998;37:703-10.
136. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. Psychological Rewiew 1977;84:191-215.
137. Schwarzer R, Jerusalem M. Generalized Self-Efficacy scale. In: J. Weinman, S. Wright, Johnston M, eds. *Measures in health psychology: A user's portfolio. Causal and control beliefs.* Windsor, UK: NFER-NELSON, 1995:35-7.
138. Weinberg RS, Gould D, Jackson A. Expectations and performance: An empirical test of Bandura's self-efficacy theory. Journal of Sport Psychology 1979; 1:320-31.
139. Wegner M, Schwarzer R, Jerusalem M. Generalized Self-Efficacy. In: Schwarzer R, ed. *Measurement of perceived self-efficacy - Psychometric Scales for Cross-Cultural Research.*: Forsung an der Universität Berlin, 14, 1993.
140. Kopp M, Schwarzer R, Jerusalem M. Hungarian questionnaire. Measurement of perceived self-efficacy - Psychometric Scales for Cross-Cultural Research.: Forschung an der Freien Universität Berlin., 1993:19.
141. Sdorow L. *Psychology.* Dubuque, IA: Wm. C. Brown Publishers, 1990.
142. Goodwin DW. *Anxiety.* New York: Oxford University Press, 1986.
143. Costello EJ, Egger HL, Angold A. Developmental epidemiology of anxiety disorders. In: Ollendick TH, March JS, eds. *Phobic and anxiety disorders in children and adolescents: A clinician's guide to effective psychosocial and pharmacological interventions.* New York: Oxford University Press, 2004:61-91.
144. Ialongo N, Edelsohn G, Werthamer-Larsson L, Crockett L, Kellam S. The significance of self-reported anxious symptoms in first grade children: prediction to anxious symptoms and adaptive functioning in fifth grade. J Child Psychol Psychiatry 1995;36:427-37.

145. Pine DS, Cohen P, Gurley D, Brook J, Ma Y. The risk for early-adulthood anxiety and depressive disorders in adolescents with anxiety and depressive disorders. Arch Gen Psychiatry 1998;55:56-64.
146. Woodward LJ, Fergusson DM. Life course outcomes of young people with anxiety disorders in adolescence. J Am Acad Child Adolesc Psychiatry 2001;40: 1086-93.
147. Beidel DC, Turner SM. At risk for anxiety: I. Psychopathology in the offspring of anxious parents. J Am Acad Child Adolesc Psychiatry 1997;36:918-24.
148. Biederman J, Faraone SV, Hirshfeld-Becker DR, Friedman D, Robin JA, Rosenbaum JF. Patterns of psychopathology and dysfunction in high-risk children of parents with panic disorder and major depression. Am J Psychiatry 2001;158:49-57.
149. McClure EB, Brennan PA, Hammen C, Le Brocque RM. Parental anxiety disorders, child anxiety disorders, and the perceived parent-child relationship in an Australian high-risk sample. J Abnorm Child Psychol 2001;29:1-10.
150. Merikangas KR, Dierker LC, Szatmari P. Psychopathology among offspring of parents with substance abuse and/or anxiety disorders: a high-risk study. J Child Psychol Psychiatry 1998;39:711-20.
151. Merikangas KR, Avenevoli S, Dierker L, Grillon C. Vulnerability factors among children at risk for anxiety disorders. Biol Psychiatry 1999;46:1523-35.
152. Spielberger CD, Gorsuch RL, Lushene RE. *Manual for the State-Trait Anxiety Inventory /Self-Evaluation Questionnaire/.* Palo Alto, California: Consulting Psychologists Press, 1970.
153. Declaration of Helsinki. The revised 1975. In: Greenwald RA, Ryan MK, Mulvihill JE, eds. *Human subjects research.* New York: Plenum Press, 1964.
154. Szmodis I., Mészáros J., T. S. Alkati és működési mutatók kapcsolata gyermek-, serdülő- és ifjúkorban. Testnevelés- és Sportegészségügyi Szemle 1976;17:255-72.
155. Sipos K, Sipos M. The development and validation of the Hungarian form of the State-Trait Anxiety Inventory for Children (STAIC-H). Magyar Pediater 1979; 13:47.
156. Hull CL. *Principles of behavior*. New York: Appelton-Century, 1943.

157. Spence PC. A theory of emotionally based drive (D) and its relation to performance in simple learning situations. American Psychologist 1958;13:131-41.
158. Edwards CD. Stress in the school: A study of anxiety and self-esteem in black and white elementary school children. Unpublished Doctoral Dissertation, Florida State University, Florida. 1972.
159. Johnson DT, Spielberger CD. The effects of relaxation training and the passage of time on measures of state- and trait-anxiety. Journal of Clin Psychology 1968; 24:20-3.
160. Lamb DH. *The effects of public speaking on self-report, physiological and behavioral measures of anxiety*. Florida State University, Florida, 1969.
161. Veldman DJ. *Fortran Programming for the Behavioral Sciences.* New York: Holt, Rinehart, & Winston, 1967.
162. Carrel AL, Clark RR, Peterson S, Eickhoff J, Allen DB. School-Based Fitness Changes Are Lost During the Summer Vacation. Arch Pediatr Adolesc Med 2007;161:561-64.
163. Sohmiya M, Kanazawa I, Kato Y. Seasonal Changes in Body Composition and Blood HbA1c Levels Without Weight Change in Male Patients With Type 2 Diabetes Treated With Insulin. Diabetes Care 2004;27:1238-39.
164. Plasqui G, Kester ADM, Westerterp KR. Seasonal variation in sleeping metabolic rate, thyroid activity, and leptin. Am J Physiol Endocrinol Metab 2003; 285:E338-43.
165. von Hippel PT, Powell B, Downey DB, Rowland NJ. The effect of school on overweight in childhood: gain in body mass index during the school year and during summer vacation. Am J Public Health 2007;97:696-702.
166. Kamimura MA, Avesani CM, Cendoroglo M, Canziani MEF, Draibe SA, Cuppari L. Comparison of skinfold thicknesses and bioelectrical impedance analysis with dual-energy X-ray absorptiometry for the assessment of body fat in patients on long-term haemodialysis therapy. Nephrol. Dial. Transplant. 2003;18:101-105.
167. Hetzler RK, Kimura IF, Haines K, Labotz M, Smith J. A comparison of bioelectrical impedance and skinfold measurements in determining minimum wrestling weights in high school wrestlers. J Athl Train 2006;41:46-51.

168. Wattanapenpaiboon N, Lukito W, Strauss BJ, Hsu-Hage BH, Wahlqvist ML, Stroud DB. Agreement of skinfold measurement and bioelectrical impedance analysis (BIA) methods with dual energy X-ray absorptiometry (DEXA) in estimating total body fat in Anglo-Celtic Australians. Int J Obes Relat Metab Disord 1998;22:854-60.

169. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 2000; 320:1-6.

170. Cole TJ, Flegal KM, Nicholls D, Jackson AA. Body mass index cut offs to define thinness in children and adolescents: international survey. BMJ 2007; 335:194-.

171. Brooks-Gunn J. Antecedents and consequences of variations in girls' maturational timing. J Adolesc Health Care 1988;9:365-73.

172. Smolak L, Krieg DB, Hayward C, Shisslak CM, Taylor CB. The reliability of self-reported menarcheal timing. The Journal of Early Adolescence 2007;27: 386-98.

173. Story M, Stevens J, Evans M, et al. Weight loss attempts and attitudes toward body size, eating, and physical activity in American Indian children: relationship to weight status and gender. Obes Res 2001;9:356-63.

174. Houston BK, Fox JE, Forbes L. Trait anxiety and children's state anxiety, cognitive behaviors, and performance under stress. Cognitive Therapy and Research 1984;8:631-41.

175. Wadden TA, Foster GD, Stunkard AJ, Linowitz JR. Dissatisfaction with weight and figure in obese girls: discontent but not depression. Int J Obes 1989;13:89-97.

176. Young-Hyman D, Tanofsky-Kraff M, Yanovski SZ, et al. Psychological status and weight-related distress in overweight or at-risk-for-overweight children. Obesity (Silver Spring) 2006;14:2249-58.

177. Tóth L, Sipos K. Tizenkét-tizennégy éves túlsúlyos és normál testsúlyú tanulók pszichológiai jellemzőinek, motoros és iskolai teljesítményének vizsgálata. Kalokagathia 1995;2:30-38.

PUBLICATIONS OF ESZTER VÖLGYI

International publications:

1. **Völgyi E,** Tylavsky FA, Lyytikäinen A, Suominen H, Alén M, Cheng S. Assessing body composition with DXA and bioimpedance. Effects of obe-sity, physical activity and age. Obesity (Silver Spring) 2008;16:700-705. **IF: 3.491**
2. Leibinger É, Hamar P, **Völgyi E**, Dancs H. Hungarian PE teacher's opinions about current issues of PE learning and teaching methods. Kinesiologia Slovenica 2007;13:14-20.
3. Mészáros Z, Mészáros J, Szmodish BM, Pampakas P, Osváth P, **Völgyi, E.** Primary shool child development – Issues of socio-economic status. Kinesiology, (In Press.)

Hungarian publications:

1. **Völgyi E**, Ember A, Kalabiska I, Csende Zs. Antropometriai és pszichikus változók hosszmetszeti vizsgálata nyugat-magyarországi lányoknál. Magyar Sporttudományi Szemle (In Press.)
2. **Völgyi E**, Kyprianou P, Mészáros Zs, Sipos K. Ciprusi fiúk antropometriai tulajdonságainak és ACSI-28 teszteredményeinek összehasonlítása In: Mónus A. Szerk. *V. Országos Sporttudományi Kongresszus. Válogatott tanulmányok*. Budapest, 2007:100-106.
3. **Völgyi E,** Kalla L. A testösszetétel és a motorikus teljesítmény kapcsolata 11-14 évesfiúknál. *Diplomadolgozat.* (73 oldal) Semmelweis Egyetem, Budapest, Hungary, 2004.
4. **Völgyi E.** Felnőtt férfiak testösszetétele és fittségi állapota. *Szakdolgozat.* (41 oldal) Semmelweis Egyetem, Budapest, Hungary, 2004.
5. **Völgyi E,** Kalla L, Zsidegh M, Prókai A, Vajda I, Mészáros J.. Kövér és sovány fiúk futóteljesítménye. In: K. Penszka, Z. Korsós, Pap I, Szerk. *III. Kárpát-medencei Biológiai Szimpózium,* Magyar Biológiai Társaság, Budapest, 2003:193-198.
6. Zsidegh P, Mészáros Zs, Faludi J, Pampakas P, **Völgyi E,** Zsidegh M. Prepubertás korú fiúk testi és fizikai teljesítmény-fejlődésének megítélése egy integrált paraméter alapján. Magyar Sporttudományi Szemle, 2007;8:17-24.

7. Mészáros Zs, Mészáros J, Uvacsek M, Pampakas P, Osváth P, **Völgyi E,** Frenkl R. A szomatikus és motorikus fejlődés különbségei 7-11 éves fiúk-nál – a szocio-ökonómiai status hatásai. Sportorvosi Szemle, 2007;48:114-119.
8. Mészáros J, Zsidegh M, Mészáros Zs, Tatár A, **Völgyi E,** Prókai A, Vajda I, Mohácsi J. Testzsírtartalom és szomatikus fejlődés. In: Mónus A. Szerk. *IV. Országos Sporttudományi Kongresszus II. kötet*, Budapest, 2005:46-51.
9. Prókai A, **Völgyi E,** Mészáros Zs, Tatár A, Zsidegh M, Uvacsek M, Vajda I, Mészáros J. Relatív testzsírtartalom és motorikus teljesítmény. In: Mónus A. Szerk. *IV. Országos Sporttudományi Kongresszus II. kötet*, Budapest, 2005:238-243.
10. Tatár A, Zsidegh M, Prókai A, Vajda I, **Völgyi E,** Mészáros J. Sportoló és nem sportoló fiúk testi felépítése és fizikai teljesítménye. In: Mónus A. Szerk. *IV. Országos Sporttudományi Kongresszus I. kötet*, Budapest, 2005:233-238.
11. Zsidegh M, Tatár A, Mészáros J, **Völgyi E,** Prókai A, Vajda I, Mohácsi J. Testösszetétel és motorikus teljesítmény - nemzetközi összehasonlítás. In: Mónus A. Szerk. *IV. Országos Sporttudományi Kongresszus I. kötet*, Budapest, 2005:245-248.

International abstracts

1. **Völgyi E,** Csende Z, Mészáros J. Body composition and psychological factors in Hungarian girls (3-year follow up). 13th Annual Congress of the European College of Sport Science, Portugal, 2008.
2. **Völgyi E,** Faludi J, Zsidegh M, Sipos K, Csende Z. Body com-position and psychological functions in Hungarian girls (2.5-year follow up). In: T. Jürimäe, Jürimäe J. Eds. *Acta Kinesiologiae Universitatis Tartuensis,* 2007;12: Supplement 203. **(Highly Recommended Poster)**
3. **Völgyi E,** Tylavsky FA, Suominen H, Cheng SM, Lyytikäinen A, Alén M, Kujala UM, Kröger H, Cheng S. Regular physical activity has only temporary effect on bone gain in pubertal girls: A 6.5 year follow-up study. 2007 Abstracts, 29th Annual Meeting of the American Society for Bone and Mineral Research. Journal of Bone and Mineral Research, 2007;22(1):S136. **IF: 6.635 (Plenary Poster, Young Investigator Travel Grant)**
4. **Völgyi E,** Lyytikainen A, Suominen H, Alén M, Häkkinen K, Cheng S. Comparison of DXA and two bioimpedance methods in assessing whole body fat mass in

men and women with different body mass index and physical activity. The 8th Scandinavian Congress of Medicine and Science in Sports Programme and abstracts, Finland, 2006:103.

5. **Völgyi E,** Kyprianou P, Mészáros Z, Sipos K. Comparison between anthropometric properties and coping strategies in Cypriot school-boys. 4th European Sports Medicine Congress Abstracts, Cyprus, 2005:95. **(Young Investigator Award)**
6. **Völgyi E,** Mészáros Zs, Prókai A, Zsidegh M, Csende Zs, Mészáros J. Body composition and motor fitness differences: Hungarian-Hungarian comparison. 23rd Pediatric Work Physiology Meeting Program and abstracts, Switzerland, 2005:20.
7. **Völgyi E,** Kalla L. Running performance in lean and obese boys. The 16th International Conference on Sports Sciences for Students. Semmelweis University, Budapest, Faculty of PE and Sports Sciences, 2004:17. **2nd place**.
8. Ma HQ, **Völgyi E,** Suominen H, Wang Q, Rahkila P, Cheng SM, Lyytikäinen A, Alén M, Cheng S. Tibial bone mineral density and geometric properties in females of three generations. 2007 Abstracts, 29th Annual Meeting of the American Society for Bone and Mineral Research. Journal of Bone and Mineral Research 2007;22,Suppl.1:S495. **IF: 6.635**
9. Lyytikäinen AE, Tylavsky F, Wang Q, Suominen H, Alén M, Ristimaa V, **Völgyi E,** Cheng SM, Rahkila P, Kujala UM, Seeman E, Cheng S. Body composition - Bone relationship in females is hormonal stage dependent: A longitudinal study. 2007 Abstracts, 29th Annual Meeting of the American Society for Bone and Mineral Research. Journal of Bone and Mineral Research 2007:22,Suppl. 1:S495**. IF: 6.635**
10. Cheng S, Wang Q, Rahkila P, Alen M, Mahonen A, Kröger H, Suominen H, Lyytikäinen A, **Völgyi E,** Kujala UM, Tylavsky F, Seeman E. Concerted growth of bone length and width - Influence of sex hormones, IGF-1 and muscle size. 2007 Abstracts, 29th Annual Meeting of the American Society for Bone and Mineral Research. Journal of Bone and Mineral Research 2007;22,Suppl.1:S24. **IF: 6.635**
11. Faludi J, Zsidegh M, Prókai A, **Völgyi E,** Uvacsek M, Mészáros J. Relationship between classification labels of overweight or obesity and motor performance in

boys aged 11-13. In: T. Jürimäe, Jürimäe J Eds. *Acta Kinesiologiae Universitatis Tartuensis*. 2007;12,Suppl.:80.

12. Zsidegh M, Faludi J, Prókai A, **Völgyi E,** Uvacsek M, Mészáros J. Kinanthropometric characteristics of overweight and obese boys. "Nutrition, metabolism and the brain." Post-Congress Satellite meeting of the European Congress on Obesity. Tihany. Obesitologia Hungarica, Supplementum, 2007;7(2): 55.
13. Csende Zs, Meszaros Zs, **Volgyi E**. Relationship between skill entropy classification and motor performance. Clinical Neuroscience, 2005;79: 46-47.
14. Faludi J, Zsidegh M, **Völgyi E,** Prókai A, Mészáros J. Body composition and fitness level of pubertal ice-hockey players. 23rd PWP Meeting, Program and abstracts, Switzerland, 2005:36.

ACKNOWLEDGEMENTS

The author would like to express her sincere appreciation especially to her advisor, Dr. János Mészáros for his inspiration, advice, guideance, generous time and commitment throughout the course of the research. He encouraged the author to develop independent thinking and research skills and continually stimulated her analytical thinking and scientific writing.

The author extends many thanks to Dr. Zsolt Csende, for his guidance and suggestions in editing and writing of this dissertation and scientific publications.

The author very grateful for Dr. Kornél Sipos who helped her to select the proper questionnaires for her dissertation and for Dr. Judit Faludi and Dr. Miklós Zsidegh, for their assistance in scientific abstract writing for conferences.

Last but not the least, very special mention must be given to her family without whose encouragement, enthusiasm, support and understanding she would not have been able to complete all the requirements for the Ph.D. degree.

APPENDICES

Table appendix 1. Material for the transformation of calendar age into decimal system

Jan 1	Feb 2	Már 3	Ápr 4	Máj 5	Jún 6	Júl 7	Aug 8	Sze 9	Okt 10	Nov 11	Dec 12
000	085	162	247	329	414	496	581	666	748	833	915
003	088	164	249	332	416	499	584	668	751	836	918
005	090	167	252	334	419	501	586	671	753	838	921
008	093	170	255	337	422	504	589	674	756	841	923
011	096	173	258	340	425	507	592	677	759	844	926
014	099	175	260	342	427	510	595	679	762	847	929
016	101	178	263	341	430	512	597	682	764	849	932
019	104	181	266	348	433	515	600	685	767	852	934
022	107	184	268	351	436	518	603	688	770	855	937
025	110	186	271	353	438	521	605	690	773	858	940
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
027	112	189	274	356	441	523	608	693	775	860	942
030	115	192	276	359	444	526	611	696	778	863	945
033	118	195	279	362	447	529	614	699	781	866	948
036	121	197	282	364	449	532	616	701	784	868	951
038	123	200	285	367	452	534	619	704	786	871	953
041	126	203	288	370	455	537	622	707	789	874	956
044	129	205	290	373	458	540	625	710	792	877	959
047	132	208	293	375	460	542	627	712	795	879	962
049	134	211	296	378	463	545	630	715	797	882	964
052	137	214	299	381	466	548	633	718	800	885	967
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
055	140	216	301	384	468	551	636	721	803	888	970
058	142	219	304	386	471	553	638	723	805	890	973
060	145	222	307	389	474	556	641	726	808	893	975
063	148	225	310	392	477	559	644	729	811	896	978
066	151	227	312	395	479	562	647	731	814	899	981
068	153	230	315	397	482	564	649	734	816	901	984
071	156	233	318	400	485	567	652	737	819	904	986
074	159	236	321	403	488	570	655	740	822	907	989
077		238	323	405	490	573	658	742	825	910	992
079		241	326	408	493	575	660	745	827	912	995
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
082		244		411		578	663		830		997

Sample: The date of investigation is 17/12/1982. The date of birth of the subject is 01/09/1970. Procedure: Integers are given by the years of birth and the investigation. The decimals source from the table at the crossing of days (horisontal lines) and mounths (columns). You have to subtract the date of investigation from the date of birth.

Table appendix 2. The standards of original Parízková technique

mm	Male	Female	Adol.	mm	Male	Female	Adol.
35	3,5	0,2	6,0	69	12,0	11,5	14,9
36	3,8	0,4	6,3	70	12,2	11,8	15,1
37	4,1	0,8	6,7	71	12,3	12,0	15,2
38	4,5	1,3	7,1	72	12,5	12,2	15,4
39	4,8	1,7	7,4	73	12,7	12,5	15,6
40	5,1	2,1	7,7	74	12,9	12,7	15,8
41	5,4	2,6	8,0	75	13,0	12,9	16,0
42	5,7	3,0	8,4	76	13,2	13,1	16,1
43	6,0	3,4	8,7	77	13,3	13,4	16,3
44	6,3	3,8	9,0	78	13,5	13,6	16,5
45	6,6	4,2	9,3	79	13,7	13,8	16,6
46	6,9	4,5	9,6	80	13,8	14,0	16,8
47	7,1	4,9	10,0	81	14,0	14,2	17,0
48	7,4	5,3	10,1	82	14,2	14,5	17,1
49	7,7	5,6	10,3	83	14,3	14,7	17,3
50	8,1	6,0	10,7	84	14,5	14,9	17,5
51	8,2	6,3	10,9	85	14,6	15,1	17,6
52	8,4	6,6	11,1	86	14,8	15,3	17,8
53	8,7	7,0	11,4	87	14,9	15,5	17,9
54	8,9	7,3	11,7	88	15,0	15,7	18,1
55	9,1	7,6	11,9	89	15,2	15,9	18,2
56	9,4	7,9	12,1	90	15,3	16,1	18,4
57	9,5	8,2	12,4	91	15,5	16,3	18,5
58	9,8	8,5	12,6	92	15,6	16,4	18,6
59	10,0	8,8	12,8	93	15,7	16,6	18,8
60	10,2	9,1	13,0	94	15,9	16,8	18,9
61	10,4	9,4	13,3	95	16,0	17,0	19,1
62	10,6	9,7	13,5	96	16,1	17,2	19,2
63	10,8	9,9	13,7	97	16,3	17,3	19,3
64	11,0	10,2	13,9	98	16,4	17,5	19,5
65	11,2	10,5	14,1	99	16,5	17,7	19,6
66	11,4	10,7	14,2	100	16,7	17,9	19,7
67	11,6	11,0	14,5	101	16,8	18,1	19,9
68	11,8	11,2	14,7	102	16,9	18,2	20,0
103	17,0	18,4	20,1	139	20,8		24,1
104	17,1	18,6	20,3	140	20,9		24,1
105	17,3	18,7	20,4	141	21,0		24,2
106	17,4	18,9	20,5	142	21,1		24,3
107	17,5	19,0	20,6	143	21,2	24,1	24,4
108	17,6	19,2	20,7	144	21,3		24,5
109	17,7	19,4	20,8	145	21,3	24,3	24,6
110	17,9	19,5	20,9	145	21,8		24,7
111	18,0	19,7	21,1	146	21,4		24,7
112	18,1	19,8	21,2	147	21,5		24,8
113	18,2	20,0	21,3	148	21,6		24,9
114	18,3	20,1	21,5	149	21,7		25,0

Table appendix 2 cont.

mm	Male	Female	Adol.	mm	Male	Female	Adol.
115	18,4	20,3	21,6	150	21,8	24,9	25,1
116	18,5	20,4	21,7	151	21,8	25,0	25,1
117	18,6	20,6	21,8	152	21,9		25,2
118	18,7	20,7	21,9	153	22,0		25,3
119	18,8	20,9	22,0	154	22,1		25,4
120	18,9	21,0	22,1	155	22,2	25,4	25,5
121	19,0	21,1	22,2	160	22,6	26,0	25,9
122	19,1		22,3	165	23,0	26,5	26,3
123	19,2		22,5	170	23,3	27,0	26,7
124	19,4		22,6	175	23,7	27,5	27,1
125	19,5	21,7	22,7	180	24,1	28,0	27,4
126	19,6		22,8	185	24,4	28,5	28,0
127	19,7	22,0	22,9	190	24,7	28,9	28,1
128	19,8	22,2	23,0	195	25,1	29,4	28,5
129	19,9	22,3	23,1	200	25,4	29,8	28,8
130	20,0	22,4	23,2	205	25,7	30,2	29,1
131	20,1		23,3	210	26,6	30,6	29,5
132	20,1		23,4	215	26,3	31,0	29,8
133	20,2		23,5	220	26,3	31,4	30,1
134	20,4		23,6	225	26,9	31,8	30,4
135	20,4	23,0	23,7	230	27,1	32,2	30,7
136	20,5		23,8	235	27,4		30,9
137	20,6		23,9	240	27,7	32,9	31,2
138	20,7		24,0	245	27,9		31,5
250	28,2	33,6	31,7				
255	28,4		32,0				
260	28,7	34,3	32,3				
265	28,9		32,5				
270	29,1	35,0	32,8				
275	29,4	35,3	33,0				
280	29,6	35,6	33,2				
285	29,8	35,9	33,5				
290	30,0	36,2	33,7				
295	30,3	36,5	33,9				
300	30,5	36,8	34,1				
305	30,7		34,4				
310	30,9		34,7				
315	31,1		34,8				
320	31,3		34,9				
325	31,5		35,2				
330	31,7		35,4				
335	31,9		35,6				
340	32,0		35,8				
345	32,2		36,0				
350	32,4		39,5				

Table appendix 3

Self-efficacy towards physical exercise

(Fuchs, R. – Wegner, M. – Schwarzer, R. 1993)

I am confident that I can perform a planned exercise even if…

	Not at all confident			Maybe		Very confident	
1. …I am tired.	1	2	3	4	5	6	7
2. …I feel depressed.	1	2	3	4	5	6	7
3. …I have worries.	1	2	3	4	5	6	7
4. …I am angry about something.	1	2	3	4	5	6	7
5. …I feel tense.	1	2	3	4	5	6	7
6. …friends are visiting.	1	2	3	4	5	6	7
7. …others want me to join them in an activity.	1	2	3	4	5	6	7
8. …my family/my partners takes up much of my time.	1	2	3	4	5	6	7
9. …I find no one to exercise with.	1	2	3	4	5	6	7
10. …the weather is bad.	1	2	3	4	5	6	7
11. …I still have a lot of work to do.							
12. …there is an interesting program on TV.							

Table appendix 4

HOW-I-FEEL QUESTIONNAIRE

Developed by C. D. Spielberger, C. D. Edwards, J. Montuori and R. Lushene

STAIC FORM C-1

NAME _____ AGE _____ DATE _____

DIRECTIONS: A number of statements which boys and girls use to describe themselves are given below. Read each statement carefully and decide how you feel *right now*. Then put an X in the box in front of the word or phrase which best describes how you feel. There are no right or wrong answers. Do not spend too much time on any one statement. Remember, find the word or phrase which best describes how you feel right now, *at this very moment.*

1.	I feel	☐	very calm	☐	calm	☐	not calm
2.	I feel	☐	very upset	☐	upset	☐	not upset
3.	I feel	☐	very pleasant	☐	pleasant	☐	not pleasant
4.	I feel	☐	very nervous	☐	nervous	☐	not nervous
5.	I feel	☐	very jittery	☐	jittery	☐	not jittery
6.	I feel	☐	very rested	☐	rested	☐	not rested
7.	I feel	☐	very scared	☐	scared	☐	not scared
8.	I feel	☐	very relaxed	☐	relaxed	☐	not relaxed
9.	I feel	☐	very worried	☐	worried	☐	not worried
10.	I feel	☐	very satisfied	☐	satisfied	☐	not satisfied
11.	I feel	☐	very frightened	☐	frightened	☐	not frightened
12.	I feel	☐	very happy	☐	happy	☐	not happy
13.	I feel	☐	very sure	☐	sure	☐	not sure
14.	I feel	☐	very good	☐	good	☐	not good
15.	I feel	☐	very troubled	☐	troubled	☐	not troubled
16.	I feel	☐	very bothered	☐	bothered	☐	not bothered
17.	I feel	☐	very nice	☐	nice	☐	not nice
18.	I feel	☐	very terrified	☐	terrified	☐	not terrified
19.	I feel	☐	very mixed-up	☐	mixed-up	☐	not mixed-up
20.	I feel	☐	very cheerful	☐	cheerful	☐	not cheerful

CONSULTING PSYCHOLOGISTS PRESS

577 COLLEGE AVENUE, PALO ALTO, CALIFORNIA

Table appendix 5

HOW-I-FEEL QUESTIONNAIRE

STAIC FORM C-2

NAME _____ AGE _____ DATE _____

DIRECTIONS: A number of statements which boys and girls use to describe themselves are given below. Read each statement and decide if it is *hardly-ever,* or *sometimes,* or *often* true for you. Then for each statement, put an X in the box in front of the word that seems to describe you best. There are no right or wrong answers. Do not spend too much time on any one statement. Remember, choose the word which seems to describe how you usually feel.

1.	I worry about making mistakes	☐	hardly-ever	☐	sometimes	☐	often
2.	I feel like crying	☐	hardly-ever	☐	sometimes	☐	often
3.	I feel unhappy	☐	hardly-ever	☐	sometimes	☐	often
4.	I have trouble making up my mind . . .	☐	hardly-ever	☐	sometimes	☐	often
5.	It is difficult for me to face my problems .	☐	hardly-ever	☐	sometimes	☐	often
6.	I worry too much	☐	hardly-ever	☐	sometimes	☐	often
7.	I get upset at home	☐	hardly-ever	☐	sometimes	☐	often
8.	I am shy	☐	hardly-ever	☐	sometimes	☐	often
9.	I feel troubled	☐	hardly-ever	☐	sometimes	☐	often
10.	Unimportant thoughts run through my mind and bother me	☐	hardly-ever	☐	sometimes	☐	often
11.	I worry about school	☐	hardly-ever	☐	sometimes	☐	often
12.	I have trouble deciding what to do . . .	☐	hardly-ever	☐	sometimes	☐	often
13.	I notice my heart beats fast	☐	hardly-ever	☐	sometimes	☐	often
14.	I am secretly afraid	☐	hardly-ever	☐	sometimes	☐	often
15.	I worry about my parents	☐	hardly-ever	☐	sometimes	☐	often
16.	My hands get sweaty	☐	hardly-ever	☐	sometimes	☐	often
17.	I worry about things that may happen . .	☐	hardly-ever	☐	sometimes	☐	often
18.	It is hard for me to fall asleep at night .	☐	hardly-ever	☐	sometimes	☐	often
19.	I get a funny feeling in my stomach . . .	☐	hardly-ever	☐	sometimes	☐	often
20.	I worry about what others think of me .	☐	hardly-ever	☐	sometimes	☐	often