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Changes over Four Years in Body Composition and Oxygen Uptake of Young Adult Males after University Graduation

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Abstract Lifestyle changes and challenges following university graduation often present a sharp contrast to the relatively free and basically pleasant university life enjoyed by the typical college student. Adaptation to a new work environment, relocation to a new community, concerns of marriage and family, personal finances, including income and budgeting (automobile and mortgage payments, savings, etc.), and adjustment to independent living result in an unfamiliar schedule of duties, often too sedentary in nature.

The aim of this study was to analyse the changes observed in young working professionals by comparing selected body composition estimates, and physiological working capacity variables at the time of university graduation and four years later.

Anthropometric and functional cardio-respiratory exercise test data were collected in 26 physically active (but non-athletic) volunteer males at the time of their university graduation in 2000 and 4 years later in 2004. By the end of this four-year period body weight, body mass index (BMI), the sum of 5 skinfold thicknesses, and relative body fat content increased significantly. Both mean BMI and weight-related body fat content were within the categorized risk range at the time of the second data collection. Parallel with unfavourable changes in body composition, peak minute ventilation, aerobic power, oxygen pulse, and maximum treadmill running distance had decreased significantly during this time. We attributed the significant changes observed mainly to the dramatically changed lifestyle. The subjects could not maintain their previous level of habitual physical activity. *J Physiol Anthropol 26(4): 437–441, 2007* http://www.jstage.jst.go.jp/browse/jpa2
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Introduction

The change from the relatively free and basically pleasant university environment to a lifestyle of professional obligations is a remarkable phase after graduation. Adaptation to a new community and very often to a formerly unknown work environment, concerns of marriage and family, purchase, renting of or building one's flat or house, etc., result in an unfamiliar schedule of duties.

The previous system of values also changes, and the creation of a relatively stable and secure financial background is the primary focus of this new phase of life. As incomes generally increase, young professionals more often than not end up in a structured work environment with more and mainly task-oriented hours of work, and less free time for recreation and relaxation. Career-minded individuals have less energy for exercise and as leisure time activity becomes reduced, physical activity becomes more often viewed as a chore, or worse yet, a waste of time. That is unfortunate because it is obvious nowadays that the maintenance of and improvement in physical fitness and mental health requires regular habitual physical activity (Haskell, 1995; U.S. Department of Health and Human Services, 1996). The results of a longitudinal study demonstrated that a relatively high level of physical activity is of utmost importance for preserving physical fitness at adult age in both sexes (Kemper, 1995), though no clear agreement exists yet regarding the required intensity and duration. The most commonly accepted suggestion (American College of Sports Medicine, 2005) expresses habitual exercise by intensity, duration, and energy consumption, namely, an intensity of 40% to 85% of maximum oxygen consumption, 20 to 60 minutes, and a target power output of between 150 and 200 kcal per activity session.

The aim of the study was to analyse the changes observed in young working professionals by comparing selected body composition estimates and physiological working capacity variables at the time of university graduation and four years later. Until now there have been no studies dealing with a re-measurement of anthropometric and exercise physiological variables in graduate subjects aged between 25 and 35 years in Hungary. Possibly the reason for their absence is that this age group had not yet been a target group for health services.

Subjects and Methods

A total of 26 volunteer male university students from three Hungarian universities (Semmelweis Medical University, Eötvös Lóránd University of Science, and Technical University, Budapest) and representing various fields of study (general medicine, pharmacology, dentistry, engineering, arts and sciences) took part in the investigation. At the time of the first data collection, their mean calendar age was 23.66 ($\pm$0.50) yr. Their mean weight (72.92$\pm$7.51 kg) and height (177.35$\pm$4.56 cm) were typical for young male adults (Gyenis and Joubert, 2002). None of them were competitive athletes or physical education students. When interviewed, these subjects were found physically more active than Hungarian university students in general. They had regular sessions (of 80–90 minutes duration) of soccer, basketball, tennis, or swimming 3 times a week during the semester, and 4–5 times during the 6 weeks of the exam periods. According to the statistics of Bucsy-Martos (2003), this level of habitual physical activity occurs only in 8–10% of academic-level students in Hungary. An almost sedentary lifestyle is more characteristic of the final university year (Kovács et al., 2002). Frenkl and Mészáros (1979) reported a significant increase in body fat content and a decrease in cardio-respiratory performance during the university years, even in physical education majors.

All subjects were personally interviewed about their lifestyle. They were definitely sedentary at the time of the second investigation. According to their self-reported observations, following graduation they could only maintain a very moderate level of physical activity even up to December 2000 (merely six months after graduation). They further stated that between 2001 and 2004 they were completely involved in their professional career and were definitely lacking regular physical activity.

The interview and a routine sport medical investigation were made before the exercise physiological studies. Anthropometric and functional cardio-respiratory exercise test data were collected first in April 2000, then in August 2004, i.e., four years after graduation. The recorded body dimensions were height, body weight, upper arm girth extended, lower arm girth, chest circumference in respiratory mid-position, thigh and calf circumferences, and thicknesses at the recommended sites of the biceps, triceps, subscapular, suprailiac, front thigh, and medial calf skinfolds. A Sieber-Hegner anthropometer and a Lange skinfold caliper were used, and the technical recommendations of the International Biological Program (Weiner and Lourie, 1969) were followed. Relative body fat content was estimated by the modified Parizkova (1961) technique. Parizkova's original conversion table was transformed into regression formulas by Szmodis and co-workers (1976). Body mass index ($kg \cdot m^{-2}$) was also calculated. Absolute muscle mass was estimated by the technique of Drinkwater and Ross (1980).

Oxygen uptake, heart rate, minute ventilation at peak exercise intensity, and running distance were measured during graded treadmill running until exhaustion. Gas samples were taken at 30 s intervals by an analyser system (Jaeger model μ-DATASPIR, Germany) that automatically corrected volumes and gas concentrations to ambient conditions. A Jaeger-model LE-6000 treadmill served as the stress test apparatus. Following an individual warm-up, the exercise started at a belt speed of 5 $km \cdot h^{-1}$ and zero level of inclination. After an initial two-minute period, the work rate was increased every two minutes as follows: 8 $km \cdot h^{-1}$ at zero inclination; 10 $km \cdot h^{-1}$ at zero inclination; and 12 $km \cdot h^{-1}$ at zero inclination. Thereafter, if additional workloads were necessary, the 12 $km \cdot h^{-1}$ speed was maintained, but the inclination was increased by steps of 3% (3%, 6%, 9%, etc.). The subjects were encouraged to run until complete exhaustion. However, it was the subjects who decided about the termination of the test: they stopped the treadmill by pressing the button located on the handrail just in front of them.

The volume of body weight-related minute ventilation ($l \cdot kg^{-1} \cdot min^{-1}$), weight-related oxygen uptake ($ml \cdot kg^{-1} \cdot min^{-1}$) as well as oxygen pulse (O_2 $ml \cdot beat^{-1}$) were calculated by using the gas exchange parameters measured at peak exercise intensity.

Differences between the respective means were tested for significance by *t*-tests for dependent samples at the 5% level of random error.

Results

Descriptive and comparative statistics for the anthropometric measures are summarised in Table 1. The consequences of a sedentary lifestyle of 4 years were significant ($p<.05$) in all the observed variables and were negative. Obviously, stature was an exception. The mean increase in body weight was 6.73 kg, with a remarkable upward change (30%) in standard deviation. Unchanged mean stature and increased mean body weight resulted in a significant (2.22 $kg \cdot m^{-2}$) increase in BMI. The mean BMI was above 25.0 in 2004.

Although the relative increase in BMI was only 10%, an almost 50% increase was observed in the sum of the 5 skinfold thicknesses, while estimated relative body fat content increased by 35%. The estimated absolute muscle mass did not change significantly, but mean relative muscle mass in 2004 was significantly less as an obvious result of the heavier body weight.

Mean running distance covered during the treadmill test was 1395$\pm$337 meters in 2000 and 1167$\pm$353 meters in 2004.

Table 1 Changes in the anthropometric parameters and running distance

Variable	2000		2004	
	Mean	SD	Mean	SD
BH	177.35	4.56	177.08	4.52
BM	72.92	7.51	79.65*	9.82
BMI	23.18	2.12	25.40*	2.73
Σ5skf	47.14	15.99	69.29*	17.49
%F	15.41	3.62	20.75*	3.19
%M	43.91	1.47	40.93*	1.59
M kg	32.04	2.88	32.57	3.27
Dist	1395.09	337.07	1167.52*	353.91

Abbreviations: SD=standard deviation, BH=height (cm), BM=body weight (kg), BMI=body mass index ($kg \cdot m^{-2}$), Σ5skf=sum of biceps, triceps, subscapular, suprailiac, and calf skinfolds (mm), %F=body fat content expressed as a percentage of body weight, %M=muscle mass expressed in percentage of body mass, M (kg)=muscle mass estimated by the Drinkwater-Ross technique, Dist=running distance (m) in the treadmill exercise, * =difference between the means significant at the 5% level of random error.

Table 2 Changes in the exercise physiological parameters

Variable	2000		2004	
	Mean	SD	Mean	SD
MV	113.23	14.61	103.87*	15.63
MV/BM	1.56	0.19	1.30*	0.21
HR	191.50	6.66	189.75	7.20
VO_2 max	3.55	0.38	3.34*	0.37
Rel. VO_2	48.69	4.23	41.93*	4.04
RER	1.15	0.05	1.14	0.06
O_2P	18.66	2.02	16.81*	2.21

All parameters refer to peak exercise intensity. Abbreviations: SD=standard deviation, MV=minute ventilation ($l \cdot min^{-1}$), MV/BM=minute ventilation relative to body weight ($l \cdot kg^{-1} \cdot min^{-1}$), HR=heart rate ($beat \cdot min^{-1}$), VO_2=absolute aerobic power ($l \cdot min^{-1}$), Rel. VO_2=aerobic power relative to body weight ($ml \cdot kg^{-1} \cdot min^{-1}$), RER=respiratory exchange ratio, O_2P=oxygen pulse ($O_2\,ml \cdot beat^{-1}$) at peak exercise intensity, * =difference between the means significant at the 5% level of random error.

Since standard deviations changed negligibly, the decrease in cardio-respiratory performance referred to all the subjects.

Table 2 shows the results of the physiological working capacity test. Of the observed physiological variables, only heart rate at peak exercise intensity did not change significantly. This was expected since the latter is largely a function of age. In spite of the decreased means, none of the standard deviations of the cardio-respiratory variables at peak exercise intensity changed noticeably. Consequently, decreased performance was again characteristic of the whole group investigated.

We note that the cardiac performance measured in 2004 was poorer than the mean representative of non-active 17-year-old boys reported by Nieman (1995). The greatest change in variance was observed in oxygen pulse.

Discussion

The significant differences observed both in body composition and the cardio-respiratory parameters at peak exercise intensity agree with those of other relevant reports (Prentice and Jebb, 2000; Rowland, 2003). While the aerobic power of our active but non-athletic university students was in the upper third of the suggested respective norm (Nieman, 1995) in 2000, four years later (when they were only 27–28 years old) it was more comparable to the suggested norm range for healthy males of 40–49 years. The previously favourable body composition and exercise physiological performance was attributable to a much sounder attitude to exercise: the volunteers in the first investigation were obviously more active and better motivated. All exercise physiological functions of the cardio-respiratory system are very sensitive to changes in habitual physical activity and body composition. The significant reduction of 228 m in mean distance (a 19% decrease) was therefore, in our view, the joint consequence of a more sedentary lifestyle and increased body fat content. Bánhegyi and associates (1999) pointed out that hypoactivity of only 2–3 months was enough to reduce the contractility of cardiac muscle.

Comparison with a report of the Central Office of Statistics (Sághi et al., 2002) confirmed that the habitual physical activity of the then-still-undergraduate students investigated by us in 2000 was remarkably above the average for their peer group, while it was not only significantly below it 4 years later, but practically zero. It has to be noted that a physically more active lifestyle is in general only characteristic of such middle-aged Hungarian professionals as suffer from various but as yet not very serious consequences of their sedentary lifestyle (e.g. obesity, hypertension, high total cholesterol level, etc.). Even so, their mostly non-organised daily physical activity amounts to a mere 30–32 minutes.

Our subjects consistently reported that they were in definite need of regular physical activity, and that they had continuously missed it since their graduation. Yet, under the pressure of time, earning money, and job promotion above all, as well as the concerns of marriage or change in partnership, and looking after their children, they were unable to satisfy this need. We have to refer here to the English National Fitness Survey (1992), which reported on the reasons given for stopping regular participation in moderate exercise or active recreation. The three most frequently cited reasons were associated with work, loss of interest, and the need for time to do other things. Interestingly enough, our subjects also reported two of the reasons mentioned.

This kind of reasoning or "excuse" of the subjects seems right and acceptable; one might even satisfy oneself that although they stopped regular recreational activity years before, they at least preserved their positive attitude to regular physical activity. Hypoactivity is more complex, however, than we sometimes think. If one considers seriously the categories of Doganis and Theodorakis (1995), any excuse like the one above must be wrong, because they claim—and most likely they are right—that the attitude to regular physical activity has three determinative elements:

— The cognitive element, which includes the individual's beliefs, convictions, ideas, or knowledge about regular physical activity.

— The affective element, which expresses the appreciation, wishes or feelings of the individual concerning this kind of physical activity.

— The behavioural element, which includes a predisposition to act.

In our opinion it was the behavioural element of our subjects that changed remarkably.

Our main conclusion is that it was mainly the lack of regular physical activity that resulted in the observed deterioration of physical as well as physiological working capacity and marked increase in body fat content, even at that young age and in a relatively short time. Although our results referred to a small and formerly relatively active volunteer sample, the rapid decline with age in the physical performance capacity and health conditions of the adult Hungarian population (cf. Frenkl et al., 2006) makes it urgent to extend similar studies to other cross-sectional or longitudinal samples.

In respect of the further details of our study we have yet to add some comments.

Despite Blackburn and Kanders' (1987) evaluation of a BMI of between 25 and 30 $kg \cdot m^{-2}$ as being only "overweight", we share the opinion (cf. Jéquier, 1987; Lohman, 1992; U.S. Department of Health and Human Services, 1988) that health risks associated with obesity begin with BMIs above 25 $kg \cdot m^{-2}$.

The 20.75% group mean for fat (Table 1) would lie at the 25th percentile when compared to US norms for healthy 20–29-year-old males (Armstrong and Lauzen, 1994). As the changes in the respective standard deviations were not too large, we can infer a general and unfavourable gain in depot fat. The disproportionate changes in body weight, BMI, and relative fat content and an unchanged muscle mass imply some decrease in lean body mass. This must have occurred, obviously, at the expense of relative muscle mass. One may only speculate that in view of the muscle mass being approximately the same the functional properties of muscle could also have changed.

The increase in body fat content is a more serious concern. Illyés's report (2001) on middle-aged Hungarian women and men has clearly vindicated that idea that the trend of body fat accumulation will continue: the prevalence of overweight and obesity was found by him to be 45% in females and 40% in males at the age of 40 to 50, and even more frequent at older ages.

Concerning risk factors associated with an increase in body fat content and/or decrease in physiological working capacity, we refer the reader to Bouchard's comprehensive monograph (2000).

Also, the decrease in absolute minute ventilation at peak exercise intensity and in aerobic power can be associated with a more sedentary lifestyle. We attributed a part of the reduced relative minute ventilation ($l \cdot kg^{-1} \cdot min^{-1}$) and aerobic power ($ml \cdot kg^{-1} \cdot min^{-1}$) to the heavier body weight.

Since oxygen pulse at peak exercise intensity ($O_2\ ml \cdot beat^{-1}$) refers to peak exercise heart function, and, furthermore, since unimpaired cardiac function is a precondition of good physiological performance, the mean decrease of 1.85 $ml \cdot beat^{-1}$ was simply alarming. This implies that—by using indirect logic—an approximately 2-litre decrease in cardiac output at peak exercise intensity can be assumed.

We are aware that a radical change of adult lifestyle and habits is apparently associated with additional expense and effort, but in the long run it would be more economical (considering future health benefits) to insist on it.

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