

"Associations between Body Mass Index, Body Fat Percentage and Physical Fitness in First Year Physiotherapy Students"

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This research report is a quantitative study performed at the Fontys Paramedic University of Applied Sciences with first year physiotherapy students. This report was a necessary step of the graduation process in order to receive a Bachelor degree in Physiotherapy at the Fontys Paramedic University of Applied Sciences.

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Abstract

Introduction:

Overweight and obesity are common concerns in today's society. A well-known method to assess weight is the Body Mass Index (BMI). The BMI is a surrogate measure for an estimate of the percentage of body fat (Body fat %) in the body, but its use has been criticized due to its ability to misclassify individuals as overweight. Moreover, it has been found that an increased BMI and Body fat % are related to a decreased physical fitness (VO₂max), however this has not been studied in Europe. Therefore, this study's objectives was to describe the BMI, Body fat % and the prevalence of overweight individuals in first year physiotherapy students in the Netherlands, to determine if the category of overweight calculated with BMI is correlated to the category of overweight measured with BMI and the BMI and the Body fat %.

Methods:

A total of 150 participants, aged between 18 and 25 years, were included in this research project. Their BMI was calculated using height and weight measurements, the Body fat % with bioelectrical impedance analysis (BIA) and the VO₂max with a 6 minute Astrand-Ryhming ergometer test. Moreover, Pearson's and Spearman's correlations were carried out to find associations between VO₂max, BMI and Body fat % in females and males. The p-value was set to p<0,0085.

Results:

The prevalence of overweight in individuals in the study population according to the BMI was 19% in females and 23% in males. The correlation between the values for BMI and Body fat % was high in both females (r=0,874, p<0,001) and in males (r=0,836, p<0,001). A weak negative correlation was found between the VO₂max and the Body fat % in females (r=-0,410, p=0,001).

Conclusion:

The prevalence of overweight individuals was higher than expected. Moreover, the BMI was strongly correlated with the Body fat % in this population. However, an increased BMI does not necessarily speak for a higher body fat mass, since of 32 subjects categorized as overweight, 8 were missclassified as overweight according to their BMI. Finally, a weak negative correlation between the VO₂max and the Body fat % was found in the female population, on which it is hard to draw conclusions.

Keywords: Body Mass Index, Body fat percentage, physical fitness, physiotherapy students



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Introduction

Obesity is a common concern in today's society. Worldwide obesity has increased significantly in the last 30 years and has become a global epidemic (1-3). In 2014, 39% of adults older than 18 years were classified as overweight (4). In addition, it has been found that obesity in children and adolescents is also increasing (2). Ng M et al., reported that the amount of overweight children increased by 6% from 1980 until 2013 (2). The same study reported that in 2013, one out of every five children was categorized as overweight (2). Coinciding with the increasing prevalence of overweight worldwide, there is a substantial decrease of physical activity (PA) levels in adolescents and adults (5). According to the World Health Organization (WHO), adolescents aged 11 to 17 years need at least 60 minutes of moderate to vigorous PA per day. However, globally, 81% of the adolescent population did not reach these recommendations in 2010 (5). The WHO identified the transitional period between school and university as a critical extend of time in which obesity can develop (3). Furthermore, it has been reported that PA levels decrease significantly between adolescence and adulthood, the specific age spectrum in which most of the university students are (6,7).

Panhuis-Plasmans et al. stated that, in the Netherlands alone, medical costs related to obesity added up to €1.617 million in 2010 (8). However, obesity does not only have a negative financial impact, but is also a major risk factor for cardiovascular diseases such as hypertension and atherosclerosis (9, 10). Moreover, the WHO states that cardiovascular diseases were the main cause of death in 2012 (10). The WHO has addressed the topic of monitoring and surveilling overweight individuals and PA as one of great necessities worldwide (11). Therefore, an early recognition of overweight patterns and decreased PA levels, and a subsequent intervention, are essential if there is a will of decreasing the epidemic of chronic diseases in the society.

"Overweight" is defined as increased weight caused by excess fat in the body (3). International prevalence of overweight levels is based on cut-off points of the Body Mass Index (BMI) (12). The BMI is a measure that indicates body density, calculated by the individual's body weight and body height (kg/m²). It classifies the subject as underweight, normal, overweight or obese (12). The BMI is a surrogate body composition measurement used to have an educated guess about the individual's body fat mass. The use of BMI to estimate the weight status in individuals is commonly practiced (13). However, the BMI concludes that all individuals have the same approximate body fat mass without taking the age, the gender or the ethnicity into consideration (13). Therefore, all individuals aged 20-74 years with a value above 25 kg/m² are categorized as overweight (14). The risk of using the BMI is that it takes both the fat free mass and fat mass into account (15). Therefore, the influence of higher muscular mass can misclassify individuals as overweight (15, 16). This might be more problematic in young adults, who generally tend to be more physically active than older adults and most likely have a higher muscular mass (6). The body fat mass is commonly expressed as the body fat percentage (Body fat %). In comparison to the BMI, the Body fat % is the percentage of the total body mass that is



body fat. Although BMI is moderately correlated (r=0,60-0,82) to Body fat % in adults (17), correlations found in young adults (r=0,34-0,87) vary a great deal (13,18,19).

The relationship between BMI and Body fat % is not only linked to body build, but also related to the level of PA (20-22). It has been discovered, that individuals that are less physically active have a tendency to become overweight (23). This is due to the fact that when an individual is less active, the body fat, which should be used as an energy source for movement, is stored in the body and leads to an increase in weight (24). To assess the relative level of PA, questionnaires such as the International Physical Activity Questionnaire (IPAQ) or pedometer/accelerometer measurements are used (25, 26). Nevertheless, the IPAQ might not be objective enough (27), and in order to measure PA with a pedometer/accelerometer a longer testing period is required. It has been found out that PA is related to physical fitness (PF) (28). PA is linked to the movements individuals perform, in comparison, PF is defined as a set of attributes that individuals have or achieve that relate to the capacity to engage in PA (28). Moreover, PF can be measured in an easier and less time consuming manner, and can be calculated, amongst others, with tests that estimate the cardiorespiratory fitness (VO₂max) (29). Furthermore, increased BMI and Body fat % have both been associated with decreased levels of PF in university students in the United States (30, 31). Nevertheless, to the author's knowledge, these associations have not yet been studied in university students in Europe.

At Fontys University of Applied Sciences in Eindhoven, The Netherlands, the first year physiotherapy students of 2015-2016 have to participate in a health test. The goal of the test is to familiarize the students with the performance of various health tests, and to provide data concerning the student's health status. Another objective of the health test is to detect risk factors such as being overweight, in order to warn the affected individuals. With this information the individuals are able to take the necessary measures to prevent the development of chronic diseases in the future. Moreover, by stating the prevalence of overweight students in this research report, it is desired to raise awareness that obesity might also be present amongst physiotherapy students, who in the future are seen as role models by their patients. By assessing the outcomes of the health test a preventive monitoring and exercise program can be set up, in order to have a relative reduction in prevalence of overweight individuals and insufficient physical activity, as addressed by the WHO (11). Furthermore, correlations between BMI, Body fat % and PF can be investigated in this population, since to the author's knowledge, such associations have not been identified in European young adults. If the BMI or the Body fat % was in strong negative correlation with PF, it would offer the university an important tool to develop preventive exercise programs.

Therefore, the purpose of this study is a) to describe the BMI, Body fat % and the prevalence of overweight first year physiotherapy students, b) to examine the correlations between BMI and Body fat % in this population, and c) to associate the PF with the BMI and the Body fat %.



Methods

1. Study design and Approach

In this research, a descriptive-correlational design was used to examine associations between BMI, Body fat % and PF.

This research report was part of a bigger study conducted at the Fontys Paramedic University of Applied Sciences, in which first year physiotherapy students of the study years 2015-2016 were tested. Three other research projects were carried out using the results of the assessment done to the first year physiotherapy students.

Four fourth year physiotherapy students were responsible for the information and instructions given to the subjects, as well as for the data collection. The researchers spent a total amount of 5 hours to get familiar with the protocol and the data collection programme. Furtheron, two pilot studies were carried out to become more consistent and efficient in testing the subjects. Moreover, a protocol was set up to standardize the instructions and testing procedure (See Appendix 4).

2. Study participants and Ethical paragraph

A total of 245 students were contacted to participate in the investigation. At the time of this experiment the subjects were taking part in the first year of the physiotherapy programme at the Fontys Paramedic University of Applied Sciences. Most of the students partook in the Dutch program while the remaining students were in the English program. Those that were in the English stream were mostly of European descend. In the study program of the first year the students were encouraged to participate in a medical screening, from which they had an overview of their health status.

The students received an email prior to the experiment with information about the study, an invitational letter and an Informed Consent (See Appendix 1 & 2). Students signed the informed consent and agreed that they have been sufficiently informed about the study and that they participate at their own risk. The students were also verbally informed about the tests. Furthermore, they were informed about that they could decide to stop the tests at any moment and that the data would be treated confidentially. Participants were eligible for this study if they were meeting the inclusion and exclusion criteria listed in Table 1.

Inclusion criteria	Exclusion criteria
- Students following the first year of the physiotherapy	- Participants that were unable to carry out at least the
programme	tests for BMI and Body fat %
- Participants aged between 18 and 25 years	- Participants not willing to sign the inform of consent
	- Participants using heart rate changing medication

Table 1: Inclusion and exclusion criteria



3. Measurements

A series of tests were carried out at the exercise laboratory of the Fontys Paramedic University of Applied Sciences. These tests measured anthromometric values, PF, strength, agility and flexibility. Subjects were recquired to wear sports clothes and training shoes for the testing and were asked not to consume liquids 2 hours before the tests. For this study just the measurements of height, weight, Body fat % and PF were used.

Testing BMI:

The subjects were asked to remove socks and shoes to be tested on height and weight. These were measured with a height and weight scale (Model: DS-103, Dong Sahn Fenix, Seoul, Korea). The BMI was calculated as body weight (kg) divided by height (m) squared (kg/m²). The BMI was measured to the closest 0,1 decimal.

Testing Body fat %:

After being tested for height and weight, the Body fat % was measured with a bioelectrical impedance analysis (BIA) device (Gaia 359, Jawon Medical, Gyeongsangbuk-do, Korea). The subjects were required to step on the platform without socks and shoes, and while on the platform they had to grab the handheld devices for the duration of the test. This method to test the Body fat % is valid, but should be used carefully, since it might overestimate the subject's Body fat % (32).

Calculating VO₂max:

After completing the ten tests mentioned in the protocol (See Appendix 4), the participants performed a 6 minutes Astrand-Ryhming submaximal cycle test (33) on a cycle ergometer (Cycle 4000, Ergo-Fit, Pirmasens, Germany) (See Appendix 3). In the first two minutes of the test a workload was set, in which the subject should have achieved a Heart Rate of over 130 beats per minute (bpm). The Heart Rate was measured every minute for the first 4 minutes and every 15 seconds in the last 2 minutes. The goal of this test was to achieve a steady-state Heart Rate (ssbpm) in the last minute, which should have been between 130 bpm and 170 bpm. The outcomes were measured in Wattage (W) and ssbpm, and were used to estimate the subject's maximum Oxygen intake in a minute (VO₂max/min). In order to estimate the VO₂max the workload was converted from W to kg*m/min (Formula 1). Thereafter, the ssbpm and the workload where introduced into an equation developed by Buono et.al. (34), to get the VO₂max in L/min (Formula 2 & 3). In order to convert the VO₂max from L/min into m/kg/min the subject's weight was applied to the formula (Formula 4).

Workload = W * 6,11829727787

Formula 1: Equation to convert W into kg*m/min (35); (W=Wattage)



$$VO_2max = \frac{0,00193 * Workload + 0,326}{0,769 * ssbpm - 56,1} * 100$$

Formula 2: Equation to estimate the VO₂max in L/min for female subjects (34); (ssbpm=steady state Heart Beat)

$$VO_2max = \frac{0,00212 * Workload + 0,299}{0,769 * ssbpm - 48,5} * 100$$

Formula 3: Equation to estimate the VO₂max in L/min for male subjects (34); (ssbpm=steady state Heart Beat)

 $VO_2max = (\frac{VO_2max \ in \ L/min}{Weight \ in \ kg}) * 1000$

Formula 4: Equation to convert the VO₂max from L/min into m/kg/min

4. BMI, Body fat % and VO₂max classifications

Based on the National Heart, Lung, and Blood Institute, the overweight category was defined as a BMI between 25-29,9kg/m² and obesity as a BMI above $30kg/m^2$ (12). Females with a $\geq 30\%$ Body fat and males with a $\geq 21\%$ Body fat on the Body fat % scale were considered overweight (36,37). These cut-off points are specific for adults between 18 and 65 years. Normal values for the PF calculated in VO₂max, range from 31.0-38.9 ml/kg/min for girls aged between 13 and 19, and for boys in the same age group it ranges from 38.4-50.9 ml/kg/min. For young adults, from 20 to 29 years, normal ranges are 29.0-36.9 ml/kg/min for women and 36.5-46.4 ml/kg/min for men (38).

5. Statistical methods

Data was processed with Microsoft Excel 2013 (Microsoft, Washington, USA) and statistical analysis was performed using the Statistical Package for the Social Sciences v.20 (IBM SPSS, Chicago, USA). The Shapiro-Wilk test was carried out to investigate if the population was normally distributed; the p-value was set to p<0,05 for this test. The population was described by gender with means and standard deviations (SD) if normally distributed, and those parameters that were not normally distributed were described in median, interquartile range (IQR), minimum and maximum values. Minimum and maximum values were shown in order clarify which parameters were measured as minimal and maximal values. Therefore, it could be observed the outliers of the parameters could be observed. The population was divided by gender and were described as normal weight or overweight according to their BMI or Body fat %. Associations between BMI, Body fat % and calculated VO₂max were analyzed using the Pearson's moment correlation coefficient (r) or the Spearman's rank correlation coefficient, depending on the parameters's distribution. The size of the portelation so described according to Table 2. Due to the number of correlations done the p-value was decreased to p<0,0085 with the Bonferroni correction.



Size of Correlation	Interpretation
0.90 to 1.00 (-0.90 to -1.00)	Very high positive to excellent (negative) correlation
0.70 to 0.90 (-0.70 to -0.90)	High positive (negative) correlation
0.50 to 0.70 (-0.50 to -0.70)	Moderate positive (negative) correlation
0.30 to 0.50 (-0.30 to -0.50)	Weak positive (negative) correlation
0.00 to 0.30 (0.00 to -0.30)	Negligible to no correlation

Table 2: Interpretation on the size of correlation (39)

Results

The Shapiro-Wilk tests showed that the age, weight, BMI and VO₂max parameters for female subjects were not normally distributed except for the height and the Body fat % values (p<0,05). For male subjects, all parameters were normally distributed except for the age values (p<0,05). Of the starting 245 participants contacted, 193 came to participate in the testing. A total of 43 subjects were excluded due to their age. After applying inclusion and exclusion criteria, 150 subjects were included in the research report, of which 64 were female and 86 were male. Figure 1 shows this procedure in more detail.



Figure 1: Exclusion and inclusion criteria selection process



A total amount of 19 subjects included in the research report did not carry out the Astrand-Ryhming test, as a result there were less participants in the descriptive data for the estimated VO₂max for females and males. The anthropometric and physiological characteristics of the female population are presented Table 3.

	n	Mean	SD	Median	IQR	Minimum	Maximum
Age (years)	64			19,0	± 3,0	18	25
Height (m)	64	1,67	± 0,08				
Body fat % (%)	64	25,5	± 4,8				
Weight (kg)	64			63,4	± 10,3	47,4	95,3
BMI (kg/m²)	64			22,4	± 3,5	17,9	39,2
VO₂max (ml/kg/min)	58			40,3	± 14,8	23,5	80,2

Table 3: Descriptive data for female subjects

n=Number of participants; SD=standard deviation; IQR=interquartile range; BMI=Body Mass Index; Body fat %=Body fat percentage; VO₂max=calculated Maximal Oxygen Uptake per minute

The anthropometric and physiological characteristics of the male population are presented in Table 4. In the male population the age parameter was not normally distributed (p<0,05).

	n	Mean	SD	Median	IQR	Minimum	Maximum
Age	86			20	± 3,0	18	25
Height (m)	86	1,80	± 0,07				
Body fat % (%)	86	16,2	± 4,8				
Weight (kg)	86	75,1	± 10,0				
BMI (kg/m²)	86	23,0	± 2,4				
VO₂max (ml/kg/min)	73	51,6	± 10,0				

Table 4: Descriptive data for male subjects

n=Number of participants; SD=standard deviation; IQR= interquartile range; BMI=Body Mass Index; Body fat %=Body fat percentage; VO₂max=calculated Maximal Oxygen Uptake per minute



Table 5 presents the prevalence of overweight subjects according to gender.

	BMI normal	BMI overweight	Body fat % normal	Body fat % overweight
Female	52	12	54	10
Male	66	20	72	14

Table 5: Overweight prevalence according to BMI and Body fat %

Number of subjects considered overweight or normal weight according to their BMI and Body fat %; BMI=Body Mass Index

32 subjects were categorized as overweight according to their BMI (21% of the entire research population), of which 12 were female and 20 were male. Only 3 participants were categorized as obese according to their BMI, of which all were female. 24 subjects were categorized as overweight according to their Body fat % (16%), of which 10 were female and 14 were male. Table 6 shows the correlations made between BMI, Body fat % and calculated VO₂max of the female subjects by the Spearman's rank correlation coefficient. A correlation of BMI and Body fat % was made. The correlations were conducted to assess if the BMI or Body fat % can be associated with the subject's estimated VO_2max .

Table 6: Spearman	correlations between	BMI and Body	/ fat % in	female subjects
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		r	p-value
male	BMI and Body fat %	0,874	p<0,001
	VO₂max and BMI	-0,201	p=0,131
Е	VO₂max and Body fat %	-0,410	p=0,001

r=correlation coefficient; BMI=Body Mass Index; VO₂max=calculated Maximal Oxygen Uptake per minute; significant difference (p<0,0085)

A high positive correlation (r=0,874, p<0,001) was found between BMI and Body fat % in the group of females. There was a weak negative correlation (r=-0,410, p=0,001) of the estimated VO₂max and the Body fat % for female subjects. Table 7 states the Pearson's correlations between BMI, Body fat % and VO₂max in the male group.



Table 7. Pearson's correlations between	VO.max and BMI/Bod	v fat % in mal	a subjacts
Table 7. Fearson's correlations between	VU2IIIAX aliu Divii/DUU	y lat 70 m mai	e subjects

		r	p-value
	BMI and Body fat %	0,836	p<0,001
Male	VO₂max and BMI	-0,153	p=0,196
	VO₂max and Body fat %	-0,177	p=0,134

r=correlation coefficient; BMI=Body Mass Index; VO₂max=calculated Maximal Oxygen Uptake per minute; significant difference (p<0,0085)

The correlation of BMI and Body fat % had a high positive association (r=0,836, p<0,001). No other correlations were of significant difference.

Discussion

The aim of this study was to describe the BMI, Body fat % and the prevalence of overweight first year physiotherapy students. Furthermore, another purpose was to examine the correlations between the values of BMI and Body fat %, which proved that the BMI is strongly correlated to the Body fat % in both female and male subjects in this study. Additionally, a further aim of this study was to associate the values of VO₂max to the BMI and Body fat % values, and the outcomes show that there is a weak negative correlation between VO₂max and Body fat % in the female population.

Studies conducted by the Dutch Health Monitoring Institutions (young, Dutch adults between the ages of 19 to 30) reveal an overweight prevalence of 26% among the studied population, regardless of their gender (40). Direct comparison to previous found parameters is difficult, due to the age grouping difference. Dutch Health Monitoring Institutions categorized young adults in classes of 10 years starting from 19 years old. However, since the majority of the students subjected of this study —first year physiotherapy students— are between 18 to 25 years old, the closest category to subjected students, which is 19 to 30 years old, is selected for comparison.

The prevalence of overweight individuals found in this study was lower than the previously mentioned finding (19% for female subjects and 23% for male subject). However, it reveals that still one out of every five individuals is subjected to be categorized as being overweight. A concerning factor is that a high number of individuals in this study's population are at greater risk of developing cardiovascular diseases and other diseases related to being overweight (5,6). Therefore, it is important to inform the University of Fontys and other Educational Institutes about the findings in order to prevent the offset of such diseases in this specific population.

Being overweight results mainly from a sedentary lifestyle and/or from excessive caloric intake (41). One of the two mentioned conditions, or a combination of both, might be the reason of the



prevalence of overweight in this study population. The prevalence of overweight is based on BMI cutoff points. However, the BMI should be reassessed in order to come up with new cut-off points that are more specific, since all individuals with a BMI above 25 kg/m² are immediately categorized as being overweight, no matter of the ethnicity, age, gender or the level of PA. Nevertheless, the use of BMI as a surrogate measure for Body fat % is commonly used (13). BMI criticizing studies suggest that the use of the BMI might be a deficient index of Body fat % in individuals with an increased muscular mass and university aged athletes and non-athletes (15). This might have been the case in this study's subjects, since all of them were engaged in an active university study and some of them had a high muscle mass.

The present study also shows that the Body fat % values of young women (median=25,3%) and men (mean=16,2%) were in the normal ranges of Body fat %, respecting to the gender. Arroyo et al. (42) reported higher mean values of Body fat % in young women (29%) and in young men (20%), using the same technique as this study to measure Body fat %. The BIA device was used for this measurement, as it was the only device available for the researcher. That might have influenced the Body fat % results, since the equations used in this device overestimate the Body fat % in thin subjects and underestimate it with an increased fat mass (47).

Strong positive correlations between BMI and Body fat % were found both in females r=0,87 (p<0,001) and in males r=0,84 (p<0,001). Possible reasons for the strong correlations between BMI and Body fat % were that not many subjects had a very high or very low measured Body fat %. In unison to this report, Streeter et al. also reported strong correlations between BMI and Body fat % in the same age category (18). Their findings were similar to the results presented in this study; r=0,82 (p<0.001) for females and r=0,74 (p<0.001) for males. However, a recent study which was carried out in Poland reported weaker correlations between BMI and Body fat % (19). Lutoslawska et al. reported correlation coefficients of r=0,49 (p<0,001) for active female subjects, and r=0,44 (p<0,003) for sedentary females (19). On the other hand, active male subjects had a correlation coefficient of r=0,67 (p<0,05) and inactive males of r=0,53 (p<0,001) (19). The correlations between BMI and Body fat % obtained in this study are stronger than the ones previously reported in the literature. However, according to literature an increased BMI does not necessarily speak for a higher body fat mass (15). This can also be observed in the findings of this study, where 32 subjects were categorized as overweight according to their BMI. Nevertheless, of those 32 individuals, 8 were not categorized as overweight according to their Body fat %. Therefore, due to its ability to missclassify individuals as overweight, it is suggested that the use of BMI should be handled with care in young adults.

The outcomes of the Astrand-Ryhming test positions the present study groups in the normal ranges of VO₂max (38). Therefore, it can be assumed that the majority of the subjects had a normal to good level of PF. Pibris et al. and Wetter et al. (30, 31) have found out that in young adults, the VO₂max had an indirect correlation with the BMI in both genders. In this research report, no significant correlations between the BMI and the calculated VO₂max were found, which rejects the hypothesis



that an increased BMI can relate to decreased PF in the present research project. This outcome might have been influenced by the fact that many subjects that had an increased BMI possibly had an average PF compared to the rest of the study population.

Pribis et al. and Wetter et al. (30, 31) also found out that there are associations between an increased Body fat % and decreased PF in both genders. Since this had not been studied in a sample of the European young adult population, it was important to test this hypothesis in the Netherlands. There was no significant correlation between the two values in the male population of this study. However, there was a weak negative correlation in the female population r=-0,410 (p=0,001). This outcome might be due to the fact that some female individuals with an increased Body fat %, were less physically fit. It is difficult to draw conclusion on this particular subject in this study, due to the weak correlation between Body fat % and PF. Moreover, sedentary behavior and lack of physical activity could have led to an increase in Body fat % and also a decrease of PF in the female subjects.

Physiotherapy students, during their study, enlarge their knowledge about the human body and the positive effects of movement; so, as a consequence they could promote a healthy lifestyle. This reflect on the weight status of the study population by having a smaller prevalence of overweight students than the general population. As we mentioned earlier, the prevalence of overweight in this study is lower than young adult population of the Netherlands. However, one should remind that this study does not cover the exact age range of the young adult population of the Netherlands. The WHO has addressed the topic of monitoring and surveilling overweight individuals as one of great necessities worldwide (11). Furthermore, the WHO identified the transitional period between school and university as a critical extend of time in which obesity can develop (3). Therefore, it might be of importance for the University that holding the physiotherapy study, to provide a training program for aerobic and anaerobic capabilities to students in order to decrease the risk factors related to being overweight (43,44). Furthermore, it is suggested to teach the students about a healthy nutrition. That will not only help students to feel physically better, but also mentally better. It is because keeping a diet and regular exercise to increase your PF improves the mood, the self-concept and the work behavior (45,46). Besides benefiting the students to achieve their maximum potential, it might benefit their future patients when they become a professional physiotherapist.

It also should be mentioned that this research report is limited by the fact that the Body fat % cut-off points were specifically drawn out of different studies to get the lowest cut-off points possible for males and females. This was due to the fact that the cut-off points found were always for adults from 18 to 65 years of age. It is speculated that the young adult population would have lower Body fat % than adults above 25 years of age. Moreover, objective findings gathered on the BMI of the study population were not compared to previous studies, due to the irregular distribution of the outcomes. As it is already mentioned at the beginning of this section, results obtained in this study are affected by the use of the BIA device. Its use has been validated to assess the Body fat % of individuals (32). Nevertheless, in literature, it has been recommended to use more reliable techniques, such as the



dual energy X-Ray absorptiometry, the isotope dilution, the skinfold measurements or circumference measurements to estimate the Body fat % (47,48). However, the author did not have the necessary material to his disposal and the study facilities could not provide these measurement tools. The only available devices were the skinfold measurement and the BIA. The BIA was chosen due to the fact that the skinfold measurements are not reliable when done by an inexperienced assessor, since the positioning of the device on the skin might vary too much from subject to subject. On the other hand, another limitation of this study was the use of the Astrand-Ryhming test to predict the estimated VO₂max. Its use has been validated in the past (49), nevertheless, the calculation formula has the ability to underestimate the level of PF (49). Due to the absence of a doctor that could perform the maximal oxygen consumption test, the Astrand-Ryhming test was chosen instead. Moreover, 19 of the subjects included in this research report did not have calculated VO₂max values. The reason for this is that in some cases the assessors carried out the test inaccurately, and in other cases the subjects were unable to complete the test due to disability.

Outcomes of this study show that the BMI is strongly correlated with the Body fat % in the study population, but the use of the BMI should, nevertheless, be handled with care. None of the previous studies, in knowledge of the author, have demonstrated as strong correlations as this one. However, generalizing of outcomes of this study to the whole population of young adults in the Netherlands is not advised. The reason for this is that factors like physical activity, dietary habits, and economic status, amongst others, might vary compared to the study population that was tested. Furthermore, the researcher had the possibility to assess almost 245 individuals, of which, 193 individuals were tested. Of 193 subjects, a total of 150 were included in the study. This number is higher than the number of subjects that were targeted in a very similar study —first year physiotherapy students of the same university— which was carried out a year before of this study in 2014-2015 (50).

This study's findings are interesting and should be validated in other countries across Europe, with different prevalence of overweight. Future studies should use more reliable tools to assess Body fat % and VO₂max. Another topic that should be focused on is to create a table for normal values of BMI and Body fat % for the population of young adults, since such cut-off points for this particular group do not exist. Furthermore, it is of relevance to assess the population of first year physiotherapy students every year in the future, to discover if there are trends of an increasing BMI, Body fat % and a decreasing PF, like shown in university students in the United States (30,31). However, creating a preventive and monitoring program in order to decrease the prevalence of overweight and to increase the PA levels in these young adults is also of importance, since with a correct program a substantial decrease in risk factors will be attained.



Conclusion

The study population's prevalence of overweight individuals according to the BMI was 19% for females and 23% for males, which was lower than previous findings. Nevertheless, it is suggested to carry out a monitoring and prevention program to decrease the chance of developing chronic diseases related to being overweight. The correlation between the values for BMI and Body fat %, to assess the validity of the BMI to measure the Body fat % in young adults, was strong in females r=0,87 (p<0,001) and in males r=0,84 (p<0,001). However, an increased BMI does not necessarily speak for a higher body fat mass, since of the 32 subjects categorized as overweight, 8 were missclassified as overweight according to their BMI. Finally, there was a weak negative correlation between the VO₂max and the Body fat % in females r=0,410 (p=0,001), on which it is hard to draw conclusions.



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Appendices

Appendix 1: Information letter in Dutch and English

Informatiebrief

Beste medestudent,

Als onderdeel van ons afstudeeronderzoek willen we jullie, eerstejaars studenten fysiotherapie, uitnodigen om deel te nemen aan een fysieke screening. In de bijlage vinden jullie een overzicht van de tijdsplanning wanneer je ingedeeld bent. We zullen een aantal metingen verrichten, de duur daarvan zal ongeveer 60 minuten in beslag nemen.

- BMI (lengte, gewicht, vetpercentage)
- Bloeddruk en hartslag
- Buikomvang
- Reactietijd, spronghoogte en balans test
- Handknijpkracht
- VO2 Sub--maximaaltest op de fiets
- Rugspier kracht
- Lenigheid van de hamstrings en lage rug (Sit & Reach)
- Sit--ups
- Cholesterol en glucose gehalte in het bloed
- Side--step

Daarnaast dient er ook een vragenlijst ingevuld worden, deze kun je invullen als je klaar bent met de testen en kan dan meteen ingeleverd worden. Voor een correcte meting is het van belang een aantal voorwaarden te stellen. Het is niet toegestaan zware lichamelijke inspanning te verrichten in de 24 uur voorafgaand aan de test. Daarnaast dient in de twee uur voorafgaand aan het onderzoek niets genuttigd te worden wat de hartslag zou kunnen beïnvloeden, zoals koffie, energydranken etc. Ook mag een uur voor de test niets meer gedronken worden. Tijdens de meting zal er gezorgd worden voor wat te drinken mocht je daar behoefte aan hebben.

De resultaten van de tests en vragenlijsten zullen vertrouwelijk behandeld worden, en zullen automatisch verwerkt worden in een database voor statistische verwerking.

De tests zullen worden uitgevoerd in het inspanningslab van de Fontys Paramedische Hogeschool aan de Theodoor Fliednerstraat te Eindhoven. Het inspanningsslab bevindt zich bij binnenkomst direct rechts, voorbij de kapstokken.

Het is mogelijk dat je gevraagd wordt om een week lang een Activ8 te dragen, dit is een klein kastje wat je dagelijkse fysieke activiteit meet. Mocht je hiervoor worden uitgekozen, dan zal de nodige informatie uitvoer met je besproken worden.

Wat je nodig hebt:



- student nummer
- geschikte kleding: sportschoenen

Denk eraan:

- geen zware fysieke inspanning vanaf 24 uur voorafgaand aan de test
- niets nuttigen wat de hartslag zou kunnen beïnvloeden vanaf 2 uur voorafgaand aan de test
- niets drinken (ook geen water) vanaf een uur voorafgaand aan de test

Met vriendelijke groet,

Mies van den Biggelaar, Renáta Rácz, Marius van Roosmalen, Judith van de Lockand

Information letter

Dear 1st graders,

As part of our thesis, we require your participation in completing our projects. Fontys want to carry out a follow--up analysis of their physiotherapy students, and fortunately of us, we can use this information in our projects.

We will be carrying out a series of procedures, with a total run time of ~ 1 hour per student:

- BMI
- Bloodpressure and heartrate
- Circumference
- Reactiontime and jump hight
- Gripstrength
- VO2 Sub-maximal test on bicycle
- Back strength
- Agility
- Sit--ups
- Cholesterol and glucose

As well as filling out a questionnaire. After which you can start with the measurements (please if you're able to fill in and print the questionnaire before your appointment at the exercise lab.) In the event of participating in our project, it will be necessary to avoid any physical activity 24 hours prior to your scheduled appointment, and the consumption of food or drinks 2 hours prior to your appointment which may alter heart rate values, such as coffee, energy drinks etc. As well as not to drink anything 1 hour before the appointment. The results from your tests will be kept anonymous, and will be automatically updated into a software program for the use of statistical analyses. The tests will be carried out in Fontys University of Applied Sciences, Theodor Fleidnerstraat building (Room 0.106). Through the rotating doors, immediately on the right (past the coat hangers).

You might get asked to wear an Activ8 accelerometer for a week (this is a measurement tool which measures your daily physical activity), when you're chosen for this measurement you will be informed about the details.

You will need:



- -- fill out the questionnaire prior to appointment
- -- student number
- -- suitable attire: trainers

Remember not to:

- -- physically exert yourself 24 hours prior to appointment
- -- drink or eat 2 hours prior to appointment which may alter heart rate values
- -- drink at all 1 hour prior to appointment (including water!)

Kind Regards,

Mies van den Biggelaar, Renáta Rácz, Marius van Roosmalen, Judith van de Lockand



Appendix 2: Inform of Consent in Dutch and English

Toestemmingsverklaring

Voor deelname aan het wetenschappelijk onderzoek:

• Ik ben over het onderzoek geïnformeerd.

• Ik heb de informatiebrief gelezen.

• Ik ben in de gelegenheid gesteld om vragen over het onderzoek te stellen, en heb het recht ook in de toekomst vragen te stellen over het onderzoek.

• Ik heb over mijn deelname aan het onderzoek kunnen nadenken.

• Ik heb het recht om mijn toestemming, zonder opgaaf van reden, op ieder moment weer in te trekken.

• Ik weet dat de over mij verzamelde gegevens alleen gebruikt zullen worden voor bovenstaand onderzoek en dat deze vertrouwelijk en volgens de geldende ethische normen zullen worden behandeld.

• Ik stem toe met deelname aan het onderzoek.

Naam:

Geboortedatum:

Handtekening:

Ondergetekende, verantwoordelijke onderzoeker, verklaart dat de hierboven genoemde persoon zowel schriftelijk als mondeling over het bovenvermelde onderzoek is geïnformeerd.

Naam:

Handtekening:

Informed Consent

For taking part in the scientific study:

• I have been informed about the study.

• I have read the information letter.

• I have been given the opportunity to ask questions about the study, and am also allowed to ask questions in the future.

Datum:

Datum:



• I have been able to think about taking part in the study.

• I have the right to withdraw my consent at any given time, without stating the reason for this withdrawal.

• I know that the data which will be collected will only be used for the purpose of this study and that they will be handled with confidentiality and according to current ethical standards.

• I consent to participation in this study.

Name:

Date of birth:

Signature:

Date:

I, the researcher responsible for the study, hereby declare that the person named above has been informed both verbally and in writing about the study mentioned above.

Name:

Signature:

Date:



Appendix 3: Protocol of the Astrand-Ryhming cycle ergometer test

Uitvoeringsstandaard Astrand fietstest

Achtergrondinformatie:

De Ästrand fietstest (1-3) is een test om het fysieke uithoudingsvermogen te meten. Het is een submaximaal test. D.m.v. de berekening van de VO2max of het aflezen van een nomogram1, (4) kan een indruk van het uithoudingsvermogen worden verkregen

Benodigdheden: Fietsergometer, hartslagmeter, Astrand & Rhyming nomogram met leeftijdscorrectie

Uitgangshouding:

De patiënt doet een hartslagband om en neemt plaats op de fiets. Stel het zadel op de juiste hoogte in, zodanig dat in de laagste stand van het pedaal, de knie zeer licht is gebogen (1700).

Instructie:

U gaat fietsen met een snelheid van ongeveer 60 omwentelingen per min. U krijgt eerst een korte warming-up van 2 min. Hierna wordt (eventueel in korte stappen) de beoogde testbelasting ingesteld. De test duurt ongeveer 6 min. met daarna een cooling down.

Uitvoering:

Warming up: laat de patiënt eerst ±2 min. met een laag wattage fietsen. Breng vervolgens het wattage op de testbelasting (eventueel in korte stappen). Trapfrequentie wordt tussen 50-60 omwentelingen per min gehouden. leder minuut wordt de hartfrequentie (HF) gemeten. De laatste twee minuten wordt de HF iedere 15 sec. gemeten. Indien een min of meer constante HF (steady state, niet meer dan 5 sl/min verschil) wordt bereikt wordt de gemiddelde HF van de laatste twee minuten berekend. Na de 6de min. vindt een cooling down plaats waarna de test is afgelopen. De VO2max wordt berekend met behulp van het Astrand & Rhyming nomogram (Figuur 1) met leeftijdscorrectie (Tabel 1). Vanaf de verticale lijn met de gefietste belasting trekt men een lijn naar de gemiddelde HF. Men leest het maximale zuurstof verbruik af en vermenigvuldigt dit indien nodig met de leeftijdsfactor. De HF moet boven de 130 slagen/min komen om een valide berekening te kunnen doen1. Indien dit niet het geval is dient het wattage te worden opgevoerd tot de HF boven 130 slagen/min komt en wordt er weer gefietst tot de steady state is bereikt, welke 2 min wordt volgehouden. Indien de HF de maximaal benadert (gelet op de leeftijd van de patiënt) wordt de test afgebroken. Gebruik eventueel een RPE schaal om de ervaren inspanning te meten.

Figuur 1. Astrand & Rhyming nomogram





Tabel 1. Astrand & Ryhming Fiets Ergometer Test: Correctie factor voor leeftijd of bekende maximale hartfrequentiea (HF)

Leeftijd	Factor	Maximale HF	Factor
15	1.10	210	1.12
25	1.00	200	1.00
35	0.87	190	0.93
40	0.83	180	0.83
45	0.78	170	0.75
50	0.75	160	0.69
55	0.71	150	0.64
60	0.68		
65	0.65		

a Gebruik de correctie factor wanneer de patiënt boven de 30-35 jaar is of wanneer de maximale HF bekend is. De waarde uit het nomogram moet worden vermenigvuldigd met de correctie factor (4)



Referenties van Uitvoeringsstandaard Astrand fietstest:

1. Astrand PO, Ryhming I. A nomogram for calculation of aerobic capacity (physical fitness) from pulse rate during sub-maximal work. J Appl Physiol 1954; 7(2):218-221.

2. Astrand PO. Human physical fitness with special reference to sex and age. Physiol Rev 1956; 36(3):307-335.

3. Astrand PO. Quantification of exercise capability and evaluation of physical capacity in man. Prog Cardiovasc Dis 1976; 19(1):51-67.

4. Cink RE, Thomas TR. Validity of the Astrand-Ryhming nomogram for predicting maximal oxygen intake. Br J Sports Med 1981; 15(3):182-185.



Appendix 4: Testing protocol

- 1. The study participant enters the testing area wearing sports clothes and on bare feet
- 2. The participant then has to sign the Informed Consent (Appendix 2)
- 3. After signing, a specific number is given to the subject in order to type it in the THP2 program, which gathers all the measured data into one program
- 4. The first measurement is the height and weight measurement on bare feet
- 5. Next is the body fat percentage with the biolectrical impedance analysis device, on which the participants is required to be on with bare feet and is not allowed to have any metal objects on their body in order for the measurement to work optimally. The subject is required to hold the holders for the duration of the test and is not allowed to move or speak.
- 6. The third test is the blood pressure and heart rate measurement. The subject sits on a chair while being measured and is required not to move or speak during the test.
- 7. The fourth test is the hand grip strength test. The dynamometer is adjusted to the size of the subjects hand and then in the first test the subjects squeezes the dynanometer with his/her right hand as hard as possible during 3 seconds. Thereafter, the second test is done with the left hand.
- 8. The fifth test was the back strength test. Here the subject is instructed to fully extend their knees while pulling the bar up, in order to test the back strength and not so much the strength of lifting in the legs. The subjects are required to do the test two times and hold the lift for at least 5 seconds.
- 9. The sixth test is the hamstring and lower back flexibility test. The subject is required to extend their knees during the whole testing time and is required to do the test twice.
- 10. The seventh test is the 1 minute sit-up test. Here the subject is required to do as many sit-ups as possible in 60 seconds with his/her feet locked into a bar.
- 11. The eight test is the side-step test, in which the subject is required to side-step as many times as possible from one side to the other on a pressure plate platform in 20 seconds. The subject is required to wear sport shoes in order to complete this test. Men are required to go until the outer yellow line of the platform while side-stepping and the women are required to go until the inner yellow line of the platform.
- 12. After the side-step test, the subject's waist circumference is tested. The subject is required to lift up his/her shirt in order to avoid extra material between the meter and the skin.
- 13. The tenth test is a blood glucose and cholesterol level measurement test, in which the subject is pinched on the side of one finger in order to draw a sample of blood to put to be assessed on the device.
- 14. The last test is a 6 minute Astrand-Ryhming cycle-ergometer test to measure cardiorespiratory fitness. The participant wears a heart rate monitoring device and is required not to talk during the test. The protocol for this test is in Appendix 3.



Appendix 5: B8. Confidentiality statement

Name: Marius J. van Roosmalen

Student No°: 2202009

Title:

"Associations between Body Mass Index, Body Fat Percentage and Physical Fitness in First Year Physiotherapy Students"

Content (description):

The Body Mass Index, Body Fat Percentage and Physical Fitness was measured in first year physiotherapy students in Eindhoven, The Netherlands. Findings show that there was a higher than expected prevalence of overweight in this study population. Furthermore, there were strong correlations Body Mass Index and Body Fat Percentage in both genders. And at last, a weak negative association between Body Fat Percentage and Physical Fitness was found in the female group.

1. By signing this Statement, the Fontys Paramedic University of Applied Sciences in Eindhoven commits itself to keep any information concerning provided data and results obtained on the basis of research of which is taken cognizance as part of the above practical research project and of which it is known or can be reasonably understood that said information is to be considered secret or confidential, in the strictest confidence.

2. This confidentiality requirement also applies to the employees of the Fontys Paramedic University of Applied Sciences, as well as to others who by virtue of their function have access to or have taken cognizance of the aforesaid information in any way.

3. The above notwithstanding, the student will be able to perform the practical research project in accordance with the statutory rules and regulations.

Student:		Supervisor:	
Name:		Name:	
(signature) Coordinator: for recei	Date://	(signature) Name:	Date://
		(signature)	Date://



Appendix 6: B9. Conveyance of Rights Agreement

AGREEMENT

Pertaining to the conveyance of rights and the obligation to convey/return data, software and other means

The undersigned:

 Mr. <u>Marius Joris van Roosmalen</u> [*full name as stated in passport*], residing at <u>5625HG, Eindhoven</u>
 [*postal code, place of residence*] at the <u>Malagijsweg 16</u> [*street and house number*], hereinafter to be called "**Student**"

and

2. Fontys Institute trading under the name Fontys University of Applied Sciences, Rachelsmolen 1, 5612 MA Eindhoven, hereinafter to be called "**Fontys**"

CONSIDERATION

- A. Student is studying at the Fontys Paramedic University of Applied Sciences in Eindhoven and is performing or will perform (various) activities as part of his/her studies, whether or not together with third parties and/or commissioned by third parties, as part of research supervised by the lectureship of Fontys Paramedic University of Applied Sciences. The aforesaid activities will hereinafter be called "Lectureship Study Activities". At the time of the signing of this Statement, the Lectureship of Fontys Paramedic University of Applied Sciences supervises in any case the studies listed in <u>Appendix 1</u>, but this list is not an exhaustive one and may change in the future.
- B. It is of essential importance to Fontys Paramedic University of Applied Sciences that (the results of) the Lectureship Study Activities can be further developed and applied without any restriction by Fontys Paramedic University of Applied Sciences and/or used for the education of other students. Fontys wishes in any event but not exclusively (i) to be able to share with and/or convey to third parties (the results of) the Lectureship Study Activities, (ii) to publish these under its own name, where the Student may be named as co-author providing that this is reasonable under the circumstances, (iii) to be able to use these as a basis for new research projects.



- C. In case intellectual ownership rights and/or related claims on the part of Student will be/are attached to (the results of) the Lectureship Study Activities, parties wish taking into account that which was mentioned under (B) Fontys Paramedic University of Applied Sciences to be the only claimant with regard to said rights and claims. The Student therefore wishes to convey all his/her current and future intellectual property rights as well as related claims concerning (results of) the Lectureship Study Activities to Fontys, subject to conditions to be specified hereafter;
- D. Student furthermore wishes to enter into the obligation again taking into account that which was mentioned under (B) to convey all data collected by him/her as part of the (results of) the Lectureship Study Activities to Fontys and not to retain any copies thereof, and also to return all data, software and/or other means previously provided by Fontys as part of (the results of) the Lectureship Study Activities, such as measuring and testing equipment, to Fontys without retaining copies thereof, all the above being subject to conditions to be specified hereafter.

AGREE THE FOLLOWING

1. Conveyance of intellectual property rights

1.1 Student herewith conveys to the Fontys Paramedic University of Applied Sciences all his/her current and future intellectual property rights and related claims concerning (the results of) the Lectureship Study Activities, for the full term of these rights.

1.2 Intellectual property rights and/or related claims are understood to refer to, in any case – but not limited to – copyright, data bank law, patent law, trademark law, trade name law, designs and model rights, plant breeder's rights, the protection of know-how and protection against unfair competition.

1.3 The conveyance described under 1.1 shall be without restriction. As such, the aforesaid conveyance shall include all competences related to the conveyed rights and claims, and said conveyance shall apply to all countries worldwide.



1.4 Insofar as any national law requires any further cooperation on the part of Student for the conveyance mentioned under 1.1, Student will immediately and without reservation lend such cooperation at first request by Fontys Paramedic University of Applied Sciences

1.5 Fontys accepts the conveyance described under 1.1.

2. Waiver of personal rights

2.1 Insofar as permitted under article 25 'Copyright' and any other national laws that may apply, Student waives his/her personal rights, including – but not limited to – the right to mention Student's name and the right to oppose any changes to (the results of) the Lectureship Study Activities. If and insofar as Student can claim personality rights pursuant to any national laws notwithstanding the above, Student will not appeal to said personality rights on unreasonable grounds.

2.2 In deviation from that which was stipulated under 2.1, the Fontys Paramedic University of Applied Sciences may decide to mention the name of Student if this is reasonable in view of the extent of his/her contribution and activities.

3. Compensation

Student agrees that he/she will receive no compensation for the conveyance and waiver of rights as described in this Statement.

4. Guarantee concerning intellectual property rights

Student declares that he/she is entitled to the aforesaid conveyance and waiver, and declares that he/she has not granted or will grant in future, license(s) for the use of (the results of) the Lectureship Study Activities in any way to any third party/parties. Student indemnifies Fontys from any claims by third parties within this context.

5. Obligation to convey/return data, software and other means

5.1 At such a time as Student is no longer performing any Lectureship Study Activities and/or is no longer a student at Fontys, Student is obliged to convey to Fontys all data, in the widest sense of



the word, collected by him/her as part of (results of) the Lectureship Study Activities, including – but not limited to – studies and research results, interim notes, documents, images, drawings, models, prototypes, specifications, production methods, process descriptions and technique descriptions.

5.2 Student guarantees not to have kept any copies in any way or form of the data meant under 5.1.

5.3 Student is obliged to return to Fontys all data, software and other means provided to him/her by Fontys as part of the Lectureship Study Activities, and guarantees not to have kept copies in any way or in any form, of the provided software and/or other means.

5.4 Student agrees that if he acts and/or proves to have acted contrary to the obligations mentioned under 5.1 up to and including 5.3, (a) he/she shall be liable for all and any damages incurred or to be incurred by Fontys, and (b) that this will qualify as fraud and that Fontys can apply the appropriate sanctions hereto. The sanctions to be applied by Fontys may consist of, among other things, the denying of study credits, the temporary exclusion of the Undersigned from participation in examinations, but also the definitive removal of the registration of the Undersigned as a student at Fontys.

6. Waiver

Student waives the right to terminate this Agreement.

7. Further stipulations

7.1 Insofar as this Agreement deviates from the Student Statute, this Agreement shall prevail.

7.2 This Agreement is subject to Dutch law. All disputes resulting from this statement will be brought before the competent judge in Amsterdam.



Student:	Fontys Institute
	trading under the name Fontys Hogescholen
	Supervisor:
Name:	Name:
(signature)	(signature)
Date: / /	Date: / /
Place:	Place:

I, Ms. M.H. de Waard, sworn translator for the English language registered at the Court in Groningen, the Netherlands, and registered in the Dutch Register of Sworn Translators and Interpreters (Rbtv) under nr. 2202, herewith certify the above to be a true and faithful translation of the attached Dutch document into the English language.

Groningen, 23 May 2012,

[M.H. de Waard]