



Content

ABDELRAHMAN MANSOUR ABDELGABER

THE IMPACT OF USE THE NEURAL MUSCULAR FACILITIES FOR THE SENSITIVE RECEPTORS IN THE FINAL STAGE OF THE REHABILITATION PROGRAMS FOR INJURY WITH THE MUSCULAR "TEARS" IN THE FLEXIBILITY OF THE HAMSTRING MUSCLES / p. 239

BADAU DANA, PREBEG GORAN, MITIĆ DUŠAN, BADAU ADELA

FITNESS INDEX AND VO₂max OF PHYSICAL EDUCATION STUDENTS / p. 246

BĂDICU GEORGIAN, BALINT LORAND

THE REASONING OF PRACTICING LEISURE SPORTS ACTIVITIES FOR THE LEVEL OF PHYSICAL HEALTH IN THE ROMANIAN ADULT POPULATION / p. 252

BĂLAN VALERIA

THE STUDY IN CONNECTION WITH THE EDUCATION LEVEL OF THE COORDINATION AT THE DOWN'S SYNDROME CHILDREN / p. 262

BUȚU IOANA MARIA, TEODORESCU SIMONA ANEMARI, CĂTUNĂ CRISTIAN, ALUPOAIE MIHAELA

STUDY ON THE DEVELOPMENT OF MOBILITY TO GYMNAST 10-12 YEARS / p. 267

CALOTĂ NICOLETA DANIELA, OPREA CARMEN, IONESCU ELENA VALENTINA

KINESIOTHERAPY, KEY TO LUMBAR DISK HERNIA RECOVERY PROCESS / p. 273

CICMA IOAN TEODOR

THE OPTIMIZATION MANAGEMENT OF THE GOAL THROWS FROM THE EXTREMES IN HANDBALL GAME, JUNIOR PLAYERS I (GIRL'S) / p. 278

CICMA IOAN TEODOR, CICMA ANNE-LYZE

THE OPTIMIZATION OF SOME PSYCHIC-BEHAVIORAL AND PERSONALITY TRAITS THAT ARE NEEDED IN THE HANDBALL GAME, OF THE JUNIOR I HANDBALL PLAYERS (GIRL'S) / p. 284

CONSTANTINESCU ANAMARIA, FINICHIU MARIN

THE EVALUATION OF THE EFFORT'S CAPABILITY FOR PUPILS IN GRAMMAR SCHOOL DURING PHYSICAL TRAINING CLASSES / p. 289

COSMA GERMINA, DUMITRU ROXANA, LICĂ ELIANA, ALBINĂ ALINA, COSMA ALEXANDRU

AEROBIC GYMNASTICS ON KANGOO-JUMPS BOOTS AND ITS IMPACT ON STUDENTS' FITNESS / p. 294

COSMA GERMINA, DRAGOMIR MARIAN, NANU COSTIN, ALBINĂ CONSTANTIN, CIUVĂȚ DRAGOȘ

IMPROVING THE STUDENTS' POSTURE THROUGH INTERACTIVE TECHNOLOGIES / p. 300

CUCUI IONELA ALINA

STUDY ON OPTIMIZATION OF SAMPLES MOTIVATIONAL LEVEL ATHLETES THROWING/ p. 306

DAMIAN ROXANA, IONESCU BONDOC DRAGOS

PSIHOMOTRIC TRAINING MODEL FOR HANDBALL PLAYERS – JUNIORS, LEVEL 3 / p. 313



DINA METWALY
IMPACT OF HYDROGYMNASTICSON MOTOR ABILITIES AND SOCIAL BEHAVIOR AMONG PRESCHOOL CHILDREN / p. 321

DOCU AXELERAD ANY, DOCU AXELERAD DANIEL
GAIT IN PATIENTS WITH IMBALANCE SYNDROMES / p. 328

DOCU AXELERAD ANY, DOCU AXELERAD DANIEL
PERFORMANCE OF OBSTACLE STEPPING IN PATIENTS WITH PARKINSON'S DISEASE / p. 334

DUMITRESCU REMUS
FACTORS INFLUENCING OBJECTIVE AND SUBJECTIVE MOTOR ACTIVITIES INCLUDED IN THE BUDGET SHARE OF FREE TIME STUDENTS OF THE UNIVERSITY OF BUCHAREST / p. 339

DUMITRU MARIANA, MOROIANU MIRUNA
ASSESSMENT MODALITIES FOR THE STUDENTS OF THE FACULTY OF PSYCHOLOGY AND EDUCATIONAL SCIENCE / p. 347

FIEROIU EMIL
ISSUES CONCERNING THE ROLE OF PHYSIOTHERAPY IN PARKINSON'S DISEASE OF PATIENTS RECOVERY / p. 355

FIEROIU EMIL
OPTIMIZING THE CONTRIBUTION OF PHYSICAL THERAPY IN RESPIRATORY FUNCTION OF PATIENTS WITH ANKYLOSING SPONDYLITIS / p. 362

FRĂȚILĂ MARIANA
THE RHYTHM IN THE SCORE OF A PHYSICAL STATE OF GRACE / p. 368

GAVOJDEA ANA-MARIA
COMPARATIVE STUDY OF THE BIOMECHANICAL CHARACTERISTICS OF LANDINGS PERFORMED AT VAULT / p. 373

HAMDY FAYED
THE EFFECT OF COMPLEX TRAINING ON ANTIOXIDANTS, CERTAIN PHYSICAL EDUCATION AND RECORD LEVEL OF 50M CRAWL SWIMMING FOR YOUNG SWIMMERS / p. 379

HANU ELENA, TEODORESCU SILVIA VIOLETA
PRIVATE SPORTS ORGANIZATION MANAGEMENT AND SOCIAL RESPONSIBILITY / p. 386

IONESCU OANA – CRISTIANA, CORDUN MARIANA
VIEWS ON THE IMPORTANCE OF COORDINATION CAPACITIES FOR PEOPLE WITH AMBLYOPIA / 391

IVAN PAULA, GHEORGHE DANIEL
OPINIONS OF SPECIALISTS ON ROMANIAN SPECIFIC STRENGTH TRAINING RUNNING MIDDLE RUN / p. 396

LUPU ELENA
A STUDY REGARDING THE CONNECTION BETWEEN SPORTS GAMES AND PEAK EXPERIENCES FOR STUDENTS / p. 402



MAN MARIA CRISTINA, GANERA CĂTĂLIN

A STUDY ON THE INFLUENCE OF TRAINING AT ALTITUDE (2000m) ON THE BLOOD HEMOGLOBIN AND ERYTHROIETIN VALUES IN ATHLETICS (AEROBIC RESISTANCE) / p. 409

MARINESCU GHEORGHE, TICALĂ LAURENȚIU DANIEL, RĂDULESCU ADRIAN

METABOLIC COST OF THE EFFORT SPECIFIC TO WATER POLO GAME, BASED ON THE RELATIONSHIP BETWEEN PH AND LACTIC ACID CONCENTRATION IN JUNIOR III / p. 419

MARWA EL DAHSHOURY

THE OBSTACLES WHICH FACING THE DEVELOPMENT OF PHYSICAL EDUCATION CURRICULUM IN THE ARAB REPUBLIC OF EGYPT- DELPHI METHOD / p. 425

MARWAN RAGAB

THE EFFECTS OF MENTAL TOUGHNESS TRAINING ON ATHLETIC COPING SKILLS AND SHOOTING EFFECTIVENESS FOR NATIONAL HANDBALL PLAYERS / p. 431

MESHARI EISA ALRUWAIH

EFFECTS OF SOCCER UNIFIED PROGRAM ON ADAPTIVE BEHAVIORAL FOR CHILDREN WITH MENTAL RETARDATION / p. 436

MESHARI EISA ALRUWAIH

EFFECT OF BLENDED LEARNING ON STUDENT'S SATISFACTION FOR STUDENTS OF THE PUBLIC AUTHORITY FOR APPLIED EDUCATION AND TRAINING IN KUWAIT / p. 442

MIHAI ILIE

STUDY CONCERNING THE MONITORING OF THE LOWER LIMBS STRENGTH CHARACTERISTICS EVOLUTION IN DRY LAND TRAINING IN SWIMMERS AGED 10 - 14 YEARS / p. 449

MOCANU PETRONELA, LORAND BALINT

PARTICULAR ASPECTS OF TRAIL RUNNING AND THE SOMATO - FUNCTIONAL AND MOTRIC PROFILE OF PRACTICANTS / p. 455

MOHAMED KAMAL EMEISH

EFFECT OF S.A.QEXERCISES ON CERTAIN PHYSICAL VARIABLES AND JUMP SHOTIN HANDBALL / p. 462

MOHAMED MOSTAFA

THE EFFECT OF MENTAL TOUGHNESS TRAINING ON ELITE ATHLETE SELF-CONCEPT ANDRECORD LEVEL OF 50M CRAWL SWIMMING FOR SWIMMERS / p. 468

NADIA ABD-EL-KADER, EMAN ABDALLA KOTTB, REHAB AHMED HAFEZ

A DESIGN OF PHYSICAL EDUCATION TEXTBOOK FOR PUPILSIN THE THIRD GRADE OF PRIMARY THROUGH MODULES / p. 474

NAHED ISMAIL

THE RELATIONSHIP BETWEENDECISION-SUPPORTSYSTEMS ANDTHE QUALITY OF ADMINISTRATIVE DECISIONSIN CERTAIN EGYPTIAN SPORTS FEDERATIONS / p. 482

NAIBA GEORGE

MANAGEMENT ROLE IN PROMOTING TOURISM ON ARGEȘ VALLEY / p. 488

NEGREA VALENTIN, MUȘAT GEORGE

CONTRIBUTIONS REGARDING THE OPTIMIZATION OF PHYSICAL TRAINING IN HIGH SCHOOL BASKETBALL / p. 493



OLTEAN ANTOANELA, DAMIAN MIRELA

ASPECTS OF COORDINATION IN MENTALLY RETARDED ADULTS / p. 498

OMAIMA KAMAL

EFFECTS OF CORE STRENGTH TRAINING ON KARATE SPINNING WHEEL KICK AND CERTAIN PHYSICAL VARIABLES FOR YOUNG FEMALE / p. 504

PASSALIA ANNUNZIATA, SUDANO MAURIZIO, BIANCALANA VINCENZO

THE EFFECTS OF A STRUCTURED TRAINING PROGRAM BASED BOTH ON GYM EXERCISES AND AQUATIC FITNESS IN WOMEN AFFECTED BY METABOLIC SYNDROME / p. 510

SABAU ELENA, NICULESCU GEORGETA, POPESCU FLORENTINA, PORFIRESCU CRISTIANA, GEVAT CECILIA, LUPU ELENA

STUDY OF DYNAMIC POSTURAL CONTROL IN YOUNG ADULTS / p. 515

SAYEDA ABDEL REHEEM

THE IMPACT OF A PROPOSED PROGRAM USING (RESISTANCE, FOCUS ATTENTION AND SPEED OF RESPONSE) ON CERTAIN JUMPS IN BALLET / p. 521

SERMİN AĞRALI ERMİS, BELGİN GOKYUREK, MUSTAFA YAŞAR SAHİN, FATİH YENEL

THE EXAMINING OF THE ACADEMICS 'S LEVEL ON THE DIFFERENT VARIABLES OF ORGANIZATIONAL COMMITMENT : SAMPLE OF PHYSICAL EDUCATION / p. 528

SOPA IOAN SABIN, POMOHACI MARCEL

IMPROVING PERFORMANCE OF A BASKETBALL TEAM (10-12 YEARS) THROUGH DEVELOPING COHESION OF THE SPORT GROUP / p. 534

TAMER SÖKMEN, AYSEL USTA, BELGİN GÖKYÜREK, TEMEL ÇAKIROĞLU

THE COMPARISON OF OBESE STUDENTS' SELF-ESTEEM BEFORE AND AFTER THE EXERCISE PROGRAMME / p. 541

TRANCĂ SORIN CĂTĂLIN, TRANCĂ CRISTINA, CONSTANTIN ADRIANA

S.RUGBY – THE FIRST STEP TO MINI-RUGBY / p. 547

URZEALĂ CONSTANȚA, TEODORESCU SILVIA

STUDY REGARDING THE SOCIAL DIFFICULTIES FELT BY THE FAMILY OF THE CHILD WITH TYPE 1 DIABETES MELLITUS / p. 555

VAIDA MARIUS, OPREA VIOREL

COMPARATIVE STUDY ON THE IMPORTANCE OF DIDACTIC MANAGEMENT IN MOTIVATIONAL FACTORS RELATED TO ACTIVITIES OF PHYSICAL EDUCATION AND SPORT / p. 564

VASILIU ANA-MARIA

SELF-ESTEEM AS AN INDICATOR OF QUALITY OF LIFE / p. 570

VASILIU ANA-MARIA

MEASURING THE LEVEL OF PHYSICAL ACTIVITY OF ADULTS / p. 575

ERKAN YARIMKAYA, EKREM LEVENT İLHAN, EYLEM GENCER

INVESTIGATION OF THE EFFECT OF SPORTS-BASED PLAY PROGRAM IN CHILDREN ON DEPENDENCY LEVEL FOR COMPUTER GAMES / p. 581



ERKAN YARIMKAYA, EKREM LEVENT İLHAN, EYLEM GENCER
THE EFFECT OF AWARD ON THE ABILITY OF SHOOTING IN ATHLETICISM AS A MOTIVATION
FACTOR / p. 589

OĞUZ KAAN ESENTÜRK, EKREM LEVENT İLHAN, OKAN BURÇAK ÇELİK
EXAMINATION OF SELF-ESTEEM LEVELS ACCORDING TO SOME VARIABLES / p. 596

ÇELİK O. BURÇAK, İLHAN E. LEVENT, ESENTÜRK O. KAAN
INVESTIGATION OF TIME MANAGEMENT SKILLS OF COLLEGE STUDENTS WHO PLAY SPORTS
AND DON'T PLAY SPORTS / p. 602

EKREM LEVENT İLHAN, ÇELİK OKAN BURÇAK, OĞUZ KAAN ESENTURK, KARASAHINOĞLU
TUGCE
THE EFFECT OF TEACHING APPROACH WITH DRAMATIZATION USED IN SCIENCE AND
TECHNOLOGY LESSON TO THE STUDENTS ACHIEVMENT LEVEL / p. 610

KARASAHINOĞLU TUGCE, EKREM LEVENT İLHAN
PERCEPTIONS ABOUT PHYSICAL EDUCATION TEACHER IN STUDENTS' DRAWINGS / p. 617

OĞUZ KAAN ESENTÜRK¹, EKREM LEVENT İLHAN¹, OKAN BURÇAK ÇELİK¹
EXAMINATION OF HIGH SCHOOL STUDENTS' SPORTSMANLIKE CONDUCTS IN PHYSICAL
EDUCATION LESSONS ACCORDING TO SOME VARIABILITY / p. 627

BULBUL HUSNİYE, SARITAŞ NAZMİ
DETERMINATION OF THE EATING HABITS AND PHYSICAL ACTIVITY STATUS OF THE WOMEN
WHO DO SPORTS IN KAYSERİ / p. 635

MACİT ÖZGE, SARITAŞ NAZMİ, YILMAZ ALPASLAN
EXAMINATION OF ATHLETES VERTICAL JUMP HEIGHTS AND RECORDS IN THE SQUAT EMG
STUDY / p. 645

ALPHABETICAL AUTHOR INDEX / p. 657

Technical Requirements to Elaborate Scientific Papers / p. 658



❖ ALPHABETICAL AUTHOR INDEX

A

ABDELRAHMAN M.A. / p. 239
ALBINĂ A. / p. 294
ALBINĂ C. / p. 300
ALUPOAIE M. / p. 267
AYSEL U. / p. 541

B

BADAU A. / p. 246
BADAU D. / p. 246
BALINT L. / p. 252
BĂDICU G. / p. 252
BĂLAN V. / p. 262
BELGİN G. / p. 528, 541
BIANCALANA V. / p. 510
BULBUL H. / p. 635
BUȚU I.M. / p. 267

C

CALOTĂ N.D. / p. 273
CĂTUNĂ C. / p. 267
ÇELİK O.B. / p. 602
CICMA A.L. / p. 284
CICMA I.T. / p. 278, 284
CIUVĂȚ D. / p. 300
CONSTANTIN A. / p. 547
CONSTANTINESCU A. / p. 289
CORDUN M. / p. 391
COSMA A. / p. 294
COSMA G. / p. 294, 300
CUCUI I.A. / p. 306

D

DAMIAN M. / p. 498
DAMIAN R. / p. 313
DINA M. / p. 321
DOCU A.A. / p. 328, 334
DOCU A.D. / p. 328, 334
DRAGOMIR M. / p. 300
DUMITRU R. / p. 294
DUMITRESCU R. / p. 339
DUMITRU M. / p. 347

E

EKREM L.I. / p. 581, 589, 596,
610, 617, 627
EMAN A.K. / p. 474
ERKAN Y. / p. 581, 589
ESENTÜRK O.K. / p. 602
EYLEM G. / p. 581, 589

F

FATİH Y. / p. 528
FIEROIU E. / p. 355, 362
FINICHIU M. / p. 289
FRĂȚILĂ M. / p. 368

G

GANERA C. / p. 409
GAVOJDEA A.M. / p. 373
GEVAT C. / p. 515
GHEORGHE D. / p. 396

H

HAMDY F. / p. 379
HANU E. / p. 386

I

İLHAN E.L. / p. 602
IONESCU B.D. / p. 313
IONESCU E.V. / p. 273
IONESCU O.C. / p. 391
IVAN P. / p. 396

K

KARASAHINOGLU T. / p. 610,
617

L

LICĂ E. / p. 294
LORAND B. / p. 455
LUPU E. / p. 402, 515

M

MACİT Ö. / p. 645
MAN M.C. / p. 409
MARINESCU G. / p. 419
MARWA E.D. / p. 425
MARWAN R. / p. 431
MESHARI E.A. / p. 436, 442
MIHAI I. / p. 449
MITIĆ D. / p. 246
MOCANU P. / p. 455
MOHAMED K.E. / p. 462
MOHAMED M. / p. 468
MOROIANU M. / p. 347
MUSTAFA Y.S. / p. 528
MUŞAT G. / p. 493

N

NADIA A.E.K. / p. 474
NAHED I. / p. 482

NAIBA G. / p. 488

NANU C. / p. 300
NEGREA V. / p. 493
NICULESCU G. / p. 515

O

OĞUZ K.E. / p. 596, 610, 627
OKAN B.Ç. / p. 596, 610, 627
OLTEAN A. / p. 498
OMAIMA K. / p. 504
OPREA C. / p. 273
OPREA V. / p. 564

P

PASSALIA A. / p. 510
POMOHAÇI M. / p. 534
POPESCU F. / p. 515
PORFIRESCU C. / p. 515
PREBEG G. / p. 246

R

RĂDULESCU A. / p. 419
REHAB A.H. / p. 474

S

SABAU E. / p. 515
SARITAŞ N. / p. 635, 645
SAYEDA A.R. / p. 521
SERMİN A.E. / p. 528
SOPA I.S. / p. 534
SUDANO M. / p. 510

T

TAMER S. / p. 541
TEODORESCU S. / p. 555
TEODORESCU S.A. / p. 267
TEODORESCU S.V. / p. 386
TEMEL Ç. / p. 541
TICALĂ L.D. / p. 419
TRANCĂ C. / p. 547
TRANCĂ S.C. / p. 547

U

URZEALĂ C. / p. 555

V

VAIDA M. / p. 564
VASILIU A.M. / p. 570, 575

Y

YILMAZ A. / p. 645



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Results. Body fat estimated with accu-measure caliper was moderate correlated with body fat estimated with FUTREX for women ($r = 0.41$)...

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Key Words: skinfolds method, near-infrared method, percentage of body fat, fat mass, free fat mass, Romanian students.

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Key Words: skinfolds method, near-infrared method, percentage of body fat, fat mass, free fat mass, Romanian students.

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Relationship between skinfolds and near-infrared (FUTREX 1000) methods for body fat estimation in Romanian university students

^a
IONESCU TUDOR MADALIN, PHD ¹, MARCU ANDREI, MS ²

Abstract

Objective. The aim of this study was to examine the relationship between skinfolds method (accu-measure caliper) and near-infrared method (FUTREX 1000 Personal Body Fat Tester) for body fat percent, fat mass and free fat mass estimations, in Romanian university students.

Methods. We used Romanian university students (27 males and 97 females). The body fat percentage was measured by two methods: the skinfolds measurements (accu-measure caliper) and near-infrared measurement (Futrex 1000).

Results. Body fat estimated with accu-measure caliper was moderate correlated with body fat estimated with FUTREX for women ($r = 0.41$) and for men ($r = 0.55$). Fat mass (skinfolds method) skinfolds method and free fat mass (skinfolds method) were moderate correlated with fat mass (near-infrared method), respectively free fat mass (near-infrared method) for women ($r = 0.41$, respectively $r = 0.41$) and correlated for men ($r = 0.60$, respectively $r = 0.60$).

Conclusions. We cannot consider that one method of body composition analysis (skinfolds method or near-infrared method) is more accurate than the other because we don't apply a gold standard method of measurement, for subjects. However, near-infrared method trends to have higher estimations of body fat, then skinfolds method on Romanian students.

Key Words: skinfolds method, near-infrared method, percentage of body fat, fat mass, free fat mass, Romanian students.

Introduction

The increase in obesity is a global phenomenon that is even being addressed by the World Health Organization (World Health Organization, 2003), as well as by medical and government organizations in the world.

One of factors that contribute to body composition changes, respectively to body fat percent grow up is physical inactivity or sedentary lives (National Institutes Of Health, 1998).

Factors, such as age, gender, level of adiposity, physical activity and ethnicity influence the choice of method and equation. To date, race-specific SKF (American Indian women, Black men, and Asian adults), BIA (American Indian women and Asian adults), and NIR (American Indian women and White women) equations have been developed (Heyward, 1996).

Infrared is not an indicator of body composition in the pre-adolescent population on an individual basis. This method continues to be no accurate, cost-



effective means to assess individual body composition by a rapid, noninvasive methodology (Michael, Jan, Wendy, 2003).

Larger prediction errors have been reported with the lower cost, hand-held Futrex 1000 model. Because of these errors, the manufacturer's equations for the Futrex 1000 are not recommended to assess body composition (Wagner and Heyward, 1999).

Kamimura et al. cannot consider that one method of body composition analysis (SKF method, bioelectrical impedance analysis, or NIR method) is more accurate than the other because they didn't apply a gold standard method, for patients on long-term hemodialysis therapy. However, the most simple, long-established, and inexpensive method of SKF thickness seems to be still very useful for assessing body fat (Kamimura, Jose Dos Santos, Avesani, Fernandes Canziani, Draibe, Cuppari, 2003).

In a healthy group of 29 subjects examined by Elia et al., NIR method had little or no advantage over other simple methods in predicting body composition measured by classical whole-body densitometry. NIR method was also found to underestimate body fat increasingly as the degree of adiposity increased. This under-estimation was found to be particularly marked in a small and separate group of grossly obese women, BMI greater than 50 kg/m², whose body composition was assessed by total body potassium as well as by densitometry (Dumitru, 1997).

Heyward et al. concluded that all three field methods, respectively SKF, bioelectric impedance and NIR compared with hydrostatic weighting, accurately estimate the percent of body fat for nonobese women; however, none of these three methods is suitable for estimating the percent of body fat for obese women (Heyward, Cook, Hicks, Jenkins, Quatrochi, Wilson, 1992).

One study concluded that, SKF is higher correlated with under water weighting than did FUTREX 5000 with under water weighting for males (0.95 versus 0.80), females (0.88 versus 0.63), and the whole group (0.94 versus 0.81) and FUTREX 5000 overestimated body fat in lean subjects with less than 8% fat and underestimated it in subjects with greater than 30% fat. Analyzing this, the authors concluded that, SKF give more information and more accurately predict body fat, especially at the extremes of the body fat continuum (McLean and Skinner, 1992).

The present findings indicate that, the FUTREX 5000 provide more accurate estimates of body fat percent than the FUTREX 5000A or FUTREX 1000

instruments (Smith, Johnson, Stout, Housh, Housh, Evetovich, 1997). Continued research with expanded populations is needed to further demonstrate and evaluate the utility of FUTREX 5000A device (Cassady, Nielsen, Janz, Wu, Cook, Hansen, 1993).

Conway et al. concluded that, body composition (percentage fat) estimated in 53 adults (23 to 65 years of age) by infrared interactance, is correlated with SKF ($r = 0.90$) measurements. They concluded that, the method is safe, noninvasive, rapid, easy to use, and may prove useful to predict percentage body fat, especially in the obese (Conway, Norris, Bodwell, 1984).

SKF method is still a reliable technique of BF estimation, but if it's not realized with the most accurately instruments the results trends to have errors in BF estimation and FM, respectively FFM (Cyrino, Okano, Glaner et al., 2003). The NIR method is still a questionable technique for BF estimation (McLean and Skinner, 1992; Michael, Jan, Wendy, 2003; Wagner and Heyward, 1999).

The objective of this study is to examine the relationship between skinfolds (SKF) method (accu-measure caliper) and near-infrared (NIR) method (FUTREX 1000 Personal Body Fat Tester) for body fat percent (BF), fat mass (FM) and free fat mass (FFM) estimation, in Romanian university students.

Methods

The subjects were white Caucasian and students at faculties of Ovidius University in Constanta. The aims and methods of the study were explained to the participants, who chose freely to participate in this study. As a result, the sample included 127 students (97 females and 27 males), with age between 18 and 23 years old.

Body height was evaluated with an error of 0.1 centimeters and body weight was evaluated with a calibrated digital scale, with an error of 0.25 kilograms. For this measurement the subjects were dressed summarily. BMI was calculated to estimate the category of weight for each subject by using the Quetelet formula (Dumitru, 1997).

Percent of body fat was estimated with two methods. The first method consisted in calculation of body fat percent with Jackson and Pollock, (1978), equation, for male subjects and Jackson, Pollock and Ward, (1980), equation, for female subjects. The abdominal (taken vertically with a broad grip, 5cm. lateral to the omphalion (centre of the umbilicus)), chest (taken obliquely along the natural cleavage line of the pectoral between the axilla and nipple) and thigh (vertical fold taken midway between the



inguinal crease and proximal border of the patella)
skinfolts were measured for ...

.....
.....
.....

Results

In table 1 the differences between sexes were significant only for body height (t = 9.838) and body weight (t = 5.841).

Table 1. Physical characteristics of the subjects

Variables	M ± SD	
	Males (n = 27)	Females (n = 97)
Age (years ^{months})	19 ⁷ ± 0 ¹¹	20 ¹ ± 2 ⁸
Body height (cm)	1.789 ± 0.078 *	1.63 ± 0.059
Body weight (kg)	66.074 ± 11.135 *	52.722 ± 7.842
BMI (kg/m ²)	20.598 ± 2.929	19.811 ± 2.485

* differences between sexes, p<0.05.
BMI, body mass index; M, mean; SD, standard deviation; n, number of subjects.

In table 2 the differences between sexes were significant for all variables (BFskf, t = 13.278; FMskf, t = 6.346; FFMskf, t = 11.498; BFnir, t = 7.856; FMnir, t = 2.883; FFMnir, t = 9.861). All variables from SKF method had significant correlations with their correspondent variable from NIR method, when body height, body weight and age

were controlled. BFskf was moderate correlated with BFnir for women (r = 0.41) and for men (r = 0.55). FMskf and FFMskf were moderate correlated with FMnir, respectively FFMnir for women (r = 0.41, respectively r = 0.41) and correlated for men (r = 0.60, respectively r = 0.60).

Table 2. Differences between SKF method and NIR method

Variables	Skinfold method (Accu-measure caliper) M ± SD	
	Males (n = 27)	Females (n = 97)
BFskf (%)	8.962 ± 4.407 *†	21.886 ± 4.704 *
FMskf (kg)	6.25 ± 4.006 *†	11.806 ± 4.085 *
FFMskf (kg)	59.824 ± 8.207 *†	40.915 ± 4.512 *
Variables	Infrared method (Futrex 1000) M ± SD	
	Males (n = 27)	Females (n = 97)
BFnir (%)	13.074 ± 5.988 †	22.805 ± 4.475
FMnir (kg)	8.97 ± 5.431 †	12.164 ± 3.615
FFMnir (kg)	57.104 ± 8.225 †	40.557 ± 5.486

* correlated with BFnir, FMnir and FFMnir for males, respectively for women, when height, weight and age are controlled, p<0.05;
† differences between sexes, p<0.05.
BFskf, body fat - skinfolds method; FMskf, fat mass - skinfolds method; FFMskf, free fat mass - skinfolds method; BFnir, body fat - infrared method; FMnir, fat mass - infrared method; FFMnir, free fat mass - infrared method; M, mean; SD, standard deviation; n, number of subjects.



Discussion

Compared with the anthropometric reference data 1988 – 1994 from United States (National Health and Nutrition Examination Survey, 2005), body height for our subjects was slightly higher for men and slightly lower for women, compared with the corresponding values for Americans. The body weight was lower, for both men and women, compared with the corresponding values for Americans.

Acknowledgments

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Attention!!! First of all, the article is written on a single column until it is finalized. After finalizing it, you select the whole text after the abstract until the first table or chart and you turn it into two columns. The same operation is done, in order, for (the whole) texts between charts and/or tables; also, the (whole) text, from the last table or chart until the bibliography inclusive, will be turn into two columns. **The paper must be 5-10 pages.**

Tables

The tables including data will be done on a single column and they cannot be introduced into the text as photographs. The counting (consecutive) and the title of the table (conclusive and concise) will be written on the top right hand. The reference to the table (the quotation in the text) will be found in the text that precedes the table. The number of the table, the title of the table, the results, the statistical section and the abbreviation section will be a constitutive part of the table. It is recommended that you merge the data in as few tables as possible. The additional black lines in the tables including data will be colored in white (Table Tools, Design, Pen Color, White, urmat de Draw Table prin care se trasează peste liniile negre suplimentare culoarea albă).

Table 1. Physical characteristics of feminine subjects

Variables	Subjects with dominant upper and lower right limb(n = 8)		Subjects with dominant upper and lower left limb (n = 8)	
Height (cm.)	163,25 ± 4,95	3,032%	162,5 ± 4,309	2,652%
Weight (kg.)	66,088 ± 7,343	11,111%	67,038 ± 5,352	7,984%
IMC (kg/m ²)	24,745 ± 1,827	7,383%	25,368 ± 1,439	5,673%
Percentage of body fat(%)	26,625 ± 2,873	10,791%	26,55 ± 2,964	11,164%
Fat mass (kg.)	17,739 ± 3,56	20,069%	17,91 ± 3,235	18,063%

The values are presented as M ± DS și CV%.

IMC, index of body mass; M, mean; DS, standard deviation; CV, variability coefficient; n, number of subjects.

The connection between the data in the table and the statistical section will be done through identification letters counted in alphabetical order or identification symbols used in the order *, †, ‡, §, ||, ¶, **, ††, ‡‡, etc.; inside the table, the letters or the identification symbols will be written in the superscript(Home, Superscript) immediately after the data, and inside

the statistical section, the identification letters will be written before the hyphen and the statistical comments and the identification symbols immediately before the statistical comments (without a hyphen).



The tables from other publications should be used with the author's (authors') permission, indicating the bibliographic source where it was taken from.

Example: $0,851 \pm 0,044^a$

Example: a – significantly different compared to the force ratio F150 Right side flexion/ F150 Left side flexion, 0° , for the subjects who practise football, respectively athletics (triple jump), $F(2, 12) = 5,5$;

Table 2. Means of results of maximum isometric force ratios for feminine subjects who practise different sports

Force ratio	Handball (n = 5)	Football (n = 5)	Athletics (triple jump) (n = 5)
F130 Flexion/ F110 Extension (30°)	$0,589 \pm 0,109$ 18,506%	$0,556 \pm 0,075$ 13,489%	$0,565 \pm 0,05$ 8,85%
F150 Right side flexion/ F150 Left side flexion (0°)	$0,851 \pm 0,044^{ab}$ 5,17%	$0,942 \pm 0,056^c$ 5,945%	$0,919 \pm 0,03^d$ 3,264%
F120 Right side rotation/ F120 Left side rotation (-30°)	$0,972 \pm 0,07$ 7,202%	$0,825 \pm 0,227$ 27,515%	$1,052 \pm 0,019^e$ 1,806%

a – significantly different compared to the mean of the force ratio F150 Right side flexion/ F150 Left side flexion, 0° , for subjects who practise football, respectively, athletics (triple jump), $F(2, 12) = 5,5$;

b – significantly different compared to the mean of the force ratio F150 Right side flexion/ F150 Perfectly ballanced left side flexion (when all the force ratios are equal to 1), 0° , $t=7,572$;

c – significantly different compared to the mean of the force ratio F150 Right side flexion/ F150 Perfectly ballanced left side flexion (when all the force ratios are equal to 1), 0° , $t=2,316$;

d – significantly different compared to the mean of the force ratio F150 Right side flexion/ F150 Perfectly ballanced left side flexion (when all the force ratios are equal to 1), 0° , $t=6,037$;

e – significantly different compared to the mean of the force ratio F120 Right side rotation/ F120 Perfectly ballanced lesft side rotation (when all the force ratios are equal to 1), -30° , $t=6,12$;

The values are presented as $M \pm DS$ and CV%; Significance limit established at $p < 0,05$.

M, mean; DS, standard deviation; CV, variability coefficient; n, number of subjects; t, test t student ; F, test ANOVA.

Figures

The tables which contain figures will be done on a single column. The counting (consecutive) and the title of the figure (conclusive and concise) will be written on the bottom left side immediately after the figure. The reference to the figure (the quotation in the text) will be found in the text that precedes the table which contains the figure. The figure, the number of the figure, the title of the figure, the statistical section (if necessary) and the abbreviation

section will be a constitutive part of the table that contains the figure. When symbols, numbers or letters are used to identify the parts of the figure, each of them should be explained clearly in the statistical section. It is recommended that you merge the data in as few figures as possible. The lines of the table that contains the figure will be transparent. (Table Tools, Design, Borders, No Borders).

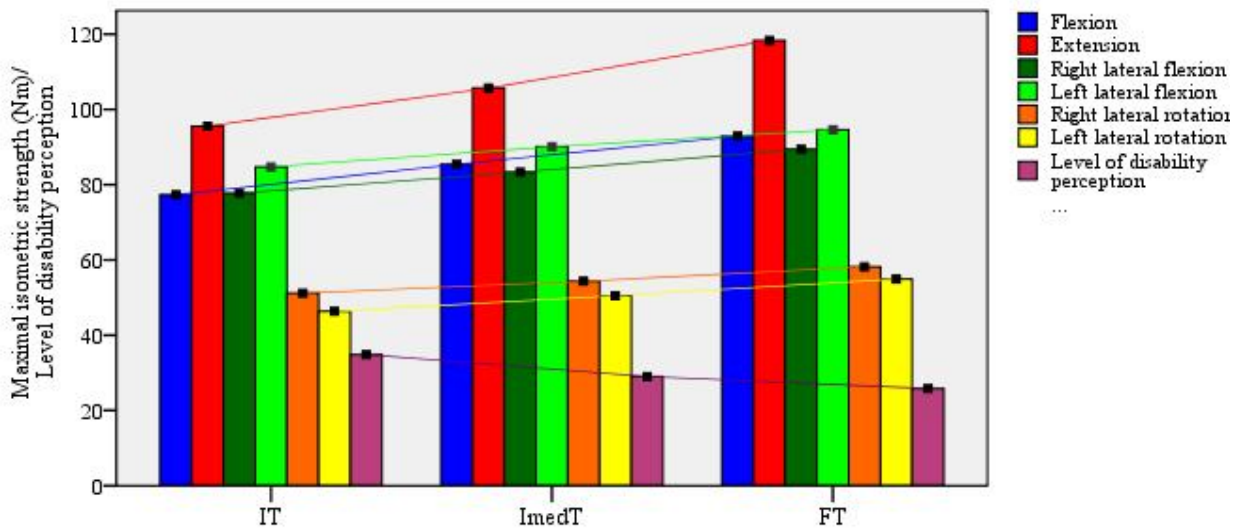


Figure 27. The evolution of means of maximum isometric force and the degree of perception at different tests. Nm, Newton*meter; IT, initial testing; ImedT, intermediary testing; FT, final testing.

The figures will have a resolution of minimum 250 dpi for a better understanding after the print. The figures will be presented in original sizes in the text (sizes chosen by the author(s) of the paper), not to be subsequently modified. The electronic formats accepted are: Bitmap (.bmp), JPEG (.jpg, .jpeg) or GIF (.gif).

The results and the statistical explanations will be presented in one way – data in the table, figure in the table or text; these ways of presenting can be combined but they do not have to repeat themselves.

Measures

Length, height, weight and volume will be specified in metrical units (meter, kilogram or litre or their decimal multiples). Temperature will be specified in degrees Celsius (°C). Blood pressure will be specified in mm column of mercury (mmHg). Other clinical measurements will be specified in the International System of Units (International System of Units (SI)).

Abbreviations and symbols

The standard abbreviations must be used. You should avoid introducing abbreviations into the title or in the

abstract. An abbreviation in parentheses will be preceded by the full description, only the first time the abbreviation is used in the text and only if the abbreviation is not a standard measure unit.

Example: Body weight, body composition, resting metabolic rate (RMR), respiratory quotient (RQ), temperature, fasting serum glucose, insulin, free fatty acids, and ghrelin were assessed at baseline and after 21 d (12-h fast) and 22 d (36-h fast) of alternate-day fasting.

RMR and RQ did not change significantly from baseline to day 21, but RQ decreased on day 22 ($P < 0.001$), which resulted in an average daily increase in fat oxidation of ≥ 15 g.

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