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Case Report

Human Joints and Skin Surfaces Random Lubrication Implemented by Run in Electro-Magnetic and Acoustic Emission Field

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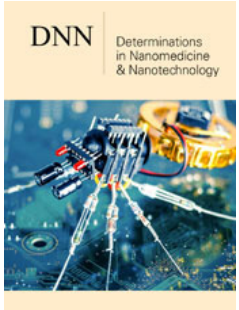

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Abstract

The topic of the case study presented concerns the influences of the pulsed Electro-Magnetic (EM) and Acoustic Emission (AE) field treatments on the human cartilage joints surfaces [1-11], limited by the two Phospholipid Bilayers (PL).The human random hydrodynamic sweat lubrication is considered in the thin gap between the human skin and tightly fitting sport-dress surface [9]. Moreover, relations are presented between decrements of bio-liquid dynamic viscosity and consequences resulting after various joint diseases. The thesis is proved here, i.e. running in the presence of EM and AE fields, increases the dynamic viscosity of bio-lubricant liquids and sweat, thus it increases energy burn, metabolism and, finally, it leads to the decrements of the body weight and hence it accelerates the slimming process [9].

Keywords: Run walk training; Variable EM and AE field-therapy; HS lubrications; PL interactions; Magneto electronic devices; Bone dias; AE therapy and diagnosis; Slimming process and betterments after therapy effects

Abbreviations: EM: Electro-Magnetic; AE: Acoustic Emission; PL: Phospholipid Bilayers; GSA: Gland Sweat African; AFM: Atomic Force Microscopy; SF: Synovial Fluid; HS: Human Sweat; BMI: Body Mass Index; HMA: Human Metabolic Age ; BMR: Basal Metabolic Rate

Material and Methods

The research into the random methods used in this study include the following: the EM field produced by a new Polish Apparatus MF-24, MT-3, German Mag-cell Arthro magneto electronic devices for the human body skin and joint cartilage treatment, the Bone Dias Apparatus applied in AE therapy produced in Germany, (Univ. Applied Sci. Giessen) see (Figure 1), the Segmental Body Composition Analyzer Tanita MC 780MA and the Garmin Ltd.2015 pedometer. The Author gained experience in German research institutes. Analytical and computational calculations results were obtained after measurements and information from students and patients [12-15]. In human joint cartilage calculations, the Phospholipid Bilayer (PL) is applied [5]. The methods presented in this study have now been divided exactly in the following parts, namely: theoretical methods, experimental methods and anamnesis methods. The general theoretical methods are described by the equilibrium of momentum, the continuity equation for the bio-liquid flow, the Young-Kelvin Laplace equation for PL and the heat transfer equation for the cellular hyper-elastic structure of cartilage tissue in the human joint and skin tissue on the human body [7-8,11]. The calculations are performed using the Professional Mathcad 15 Program.

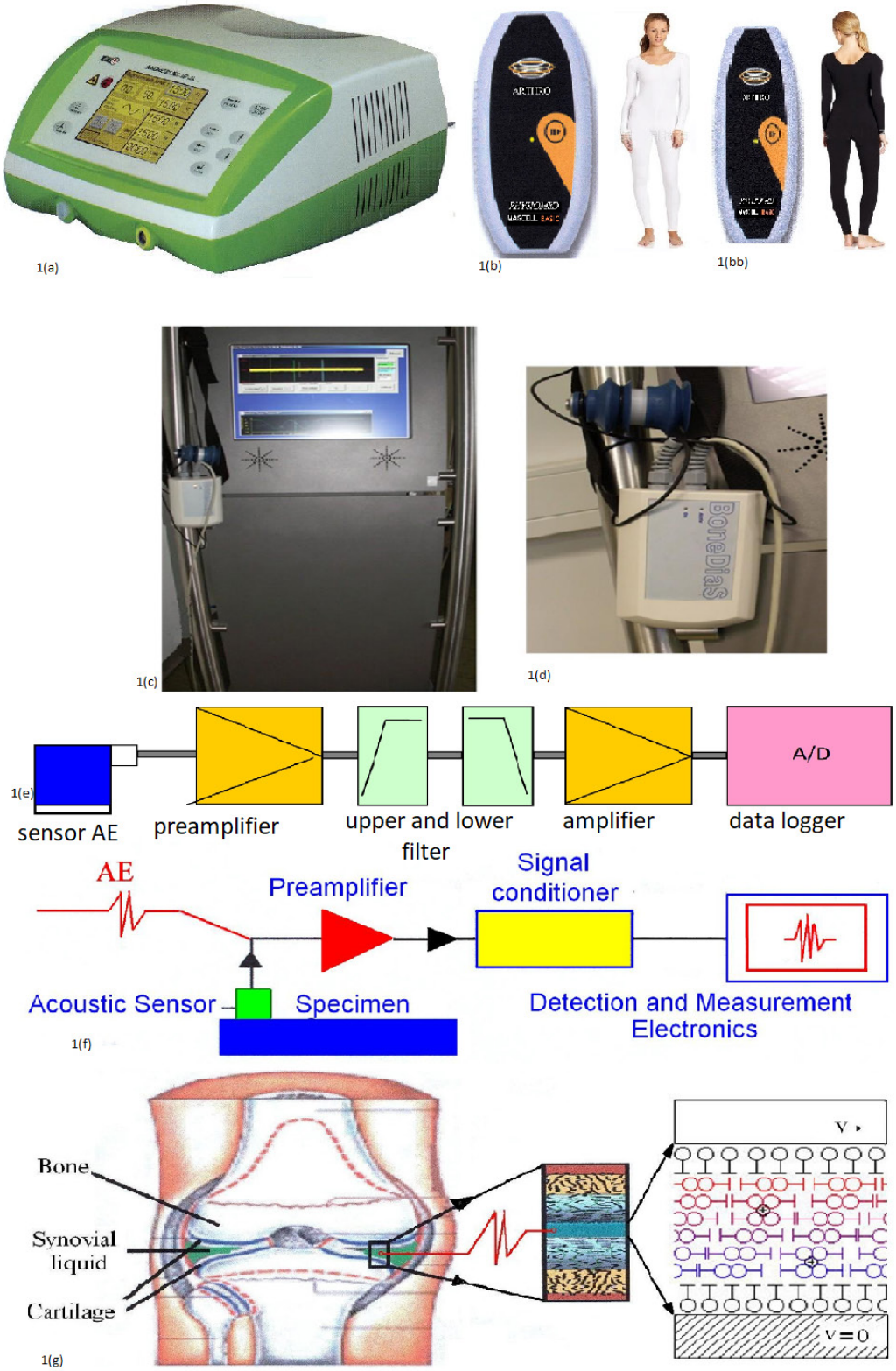

Figure 1: Application of the electronic and acoustic devices: 1a) A new Polish multi-channel Apparatus MF-24 with a new control system [9], 1b) Gymnastic implementation by the electro-magnetic field from Germany Apparatus Mag-cell Arthro [10],1c) Bone Dias general view with respect to the orthopedic diagnostics and ill cartilage treatments [11], 1d) Sensor, Bone Dias filter and amplifier AE after Burkhard Ziegler [11],1e) Path of measurement devices in typical AE-Apparatus, 1f) Scheme of an AE measurement system, 1g) Left side: application of an acoustic emission sensor at a human knee joint, and on the right side: Molecular substantiation. The ⊕- symbols are marking the places in which an elementary acoustic wave provokes the bumping of two molecules and generates the friction effect connected with the dynamic viscosity increments [11].

View of General Results

The EM-therapy and AE diagnosis and therapy results presented in this study see (Figure 2), concern betterments during typical human cartilage diseases and the causes of the effects of the slimming process gained before and after run-walk training. The run-walk training results presented in this study concern the effects of the slimming process gained without and after the EM & AE field therapy. The aforementioned effects are directly and indirectly connected with human bio liquids and sweat dynamic viscosity variations. The bio-liquid dynamic viscosity usually has values from 0.10Pas to 0.40Pas and sweat dynamic viscosity varies from 0.001 Pas to 0.005Pas see (Figure 3). Human training sweat produced by the Gland Sweat African (GSA) includes ca. 100 % more lipid-proteins than sweat produced by the Gland Sweat European (GSE). Hence, the sweat dynamic viscosity value from GSA is ca. 50% larger than sweat viscosity from GSE. By virtue of the measurements using Atomic Force Microscopy (AFM) and computer calculations, we provide a new extended description and interpretation of the influences of Pseudoplastic bio-liquid dynamic viscosity on the human limb skill. Dynamic viscosity (Pas) of the non-Newtonian, Pseudoplastic bio-liquids increases vs.: 1. Decrements of Shear Rate [1/s], 2. Decrements of the elasticity modulus [Pa] during the rotating or linear motion of the superficial layer of the hyper-elastic cartilage or the bone surface [16] which is bio-liquid lubricated, 3. Increments of the Elasticity Modulus [Pa] during the squeezing motion of the superficial layer of the cartilage or the bone surface which is bio-liquid lubricated, 4. Increments of the magnetic induction field [T=kg/As2], 5. Increments of the characteristic value of acoustic emission intensity [W/m2], 6. Increments and decrements of the dimensionless power hydrogen ion concentration [pH], 7. Increments of collagen fiber concentration [mol/mm3], 8. Decrements of the wettability cartilage surface [in Grad] which is bio-liquid lubricated [5,7-8,17]. The human body slimming process is presented in (Figure 4).

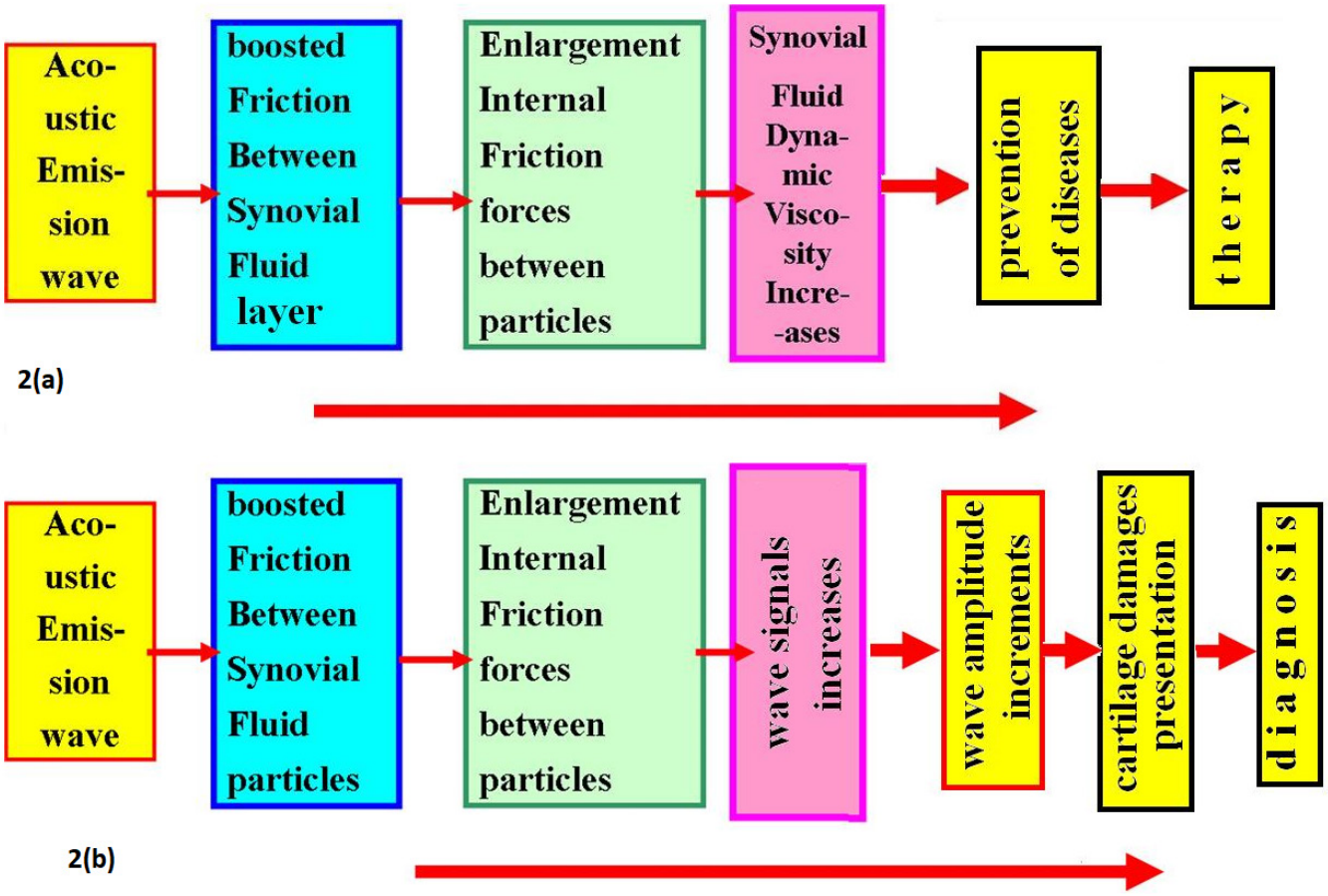

Figure 2: Two possibilities after AE treatment in logical implications of resulting steps: a) For therapy, b) For diagnosis.

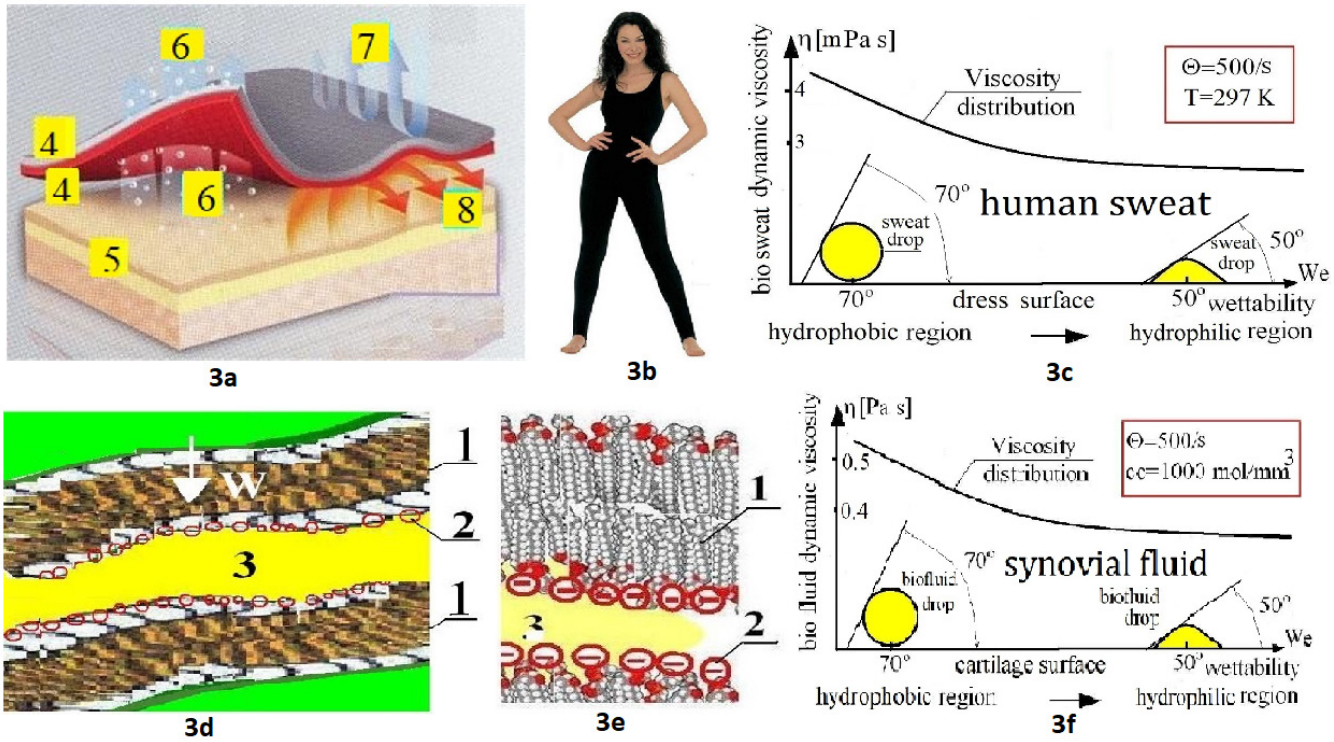

Figure 3: The effects of bio-hydrodynamic lubrication: 3ab) Fragments of two lubricated cooperating cartilage surfaces restricted with the phospholipid bilayers, 3c) synovial fluid dynamic viscosity versus wettability of the internal cartilage surface, 3d) movable non-rotational sweat lubrication between human skin-and tight fitting sport dress, 3e) two-piece thin elastic woman dress, 3f) bio-sweat dynamic viscosity versus wettability of the internal dress surface. Notations:1-PL bi-layer, 2-lipids with negative charge, 3-SF-synovial fluid, 4-sport dress, 5-human skin, 6-sweat pressure, 7-sweat outlet, 8-heat flux; Q-shear rate, cc-collagen fiber concentration in synovial fluid, T-temperature.

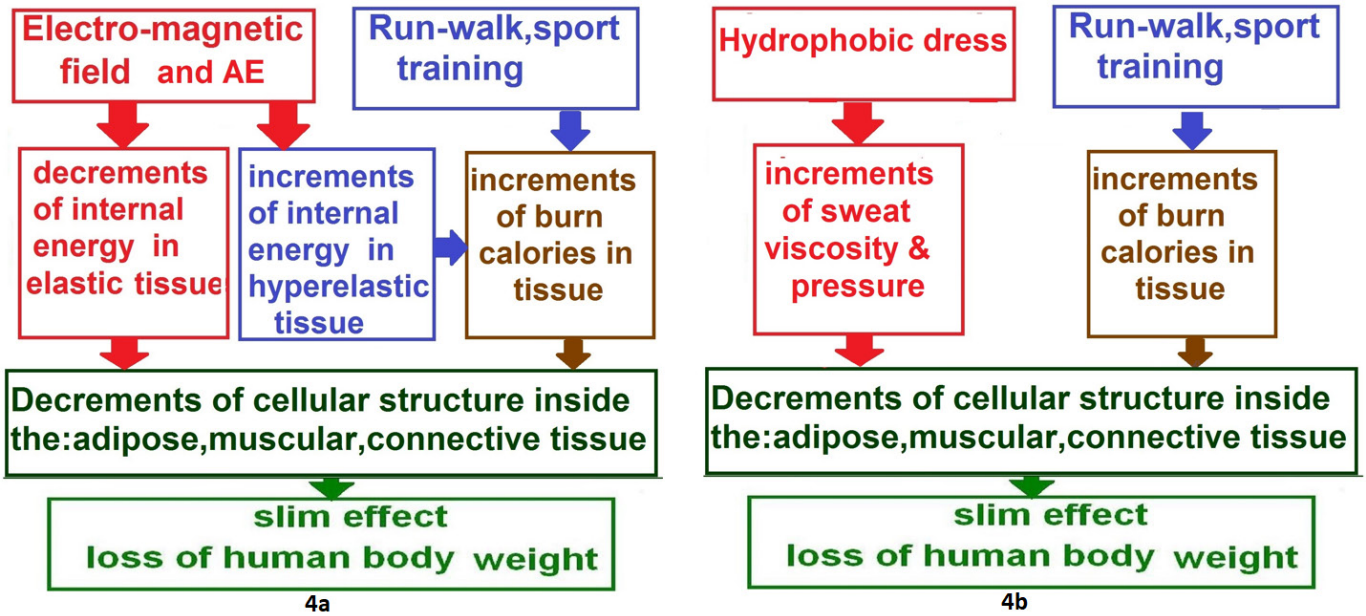

Figure 4: A view of the sliming process of human tissue: 4a) After synovial fluid lubrication implemented by the EM, AE field, 4b) After human sweat lubrication using hydrophobic dress.

Conclusion

The main conclusions obtained in this research are as follows:

The run-walk training implemented by the EM and AE field leads to the random increments of the dynamic viscosity of Synovial Fluid (SF) and Human Sweat (HS), changes in internal random energy contained in the human body, muscle and cartilage limited by PL, increases in the joint load carrying capacity and the efficiency of human limbs; hence, it accelerates the slimming process connected with body weight decrements as well betterment effects during the therapy [9,18]. 2. The main reason of the loss of the human joints and limbs' motion skill is the low value of the dynamic viscosity of the bio-liquid lubricant (this may be synovial fluid). 3. The present study demonstrates the influence of the physical properties of the human skin or articular tissue with a PL restricted a random gap height on the viscosity of SF in the area of the boundary layer of the surface flown around. According to the author, the influence of the physical properties of biological surfaces flown around on the viscosity of the fluid in the boundary layer will be even more visible in lamellar flows, where the gap height reaches a value of ca. 2-3nm, i.e. the order of the thickness of the PL membrane [6]. 4. The pulsed EM and AE field applied during the run and sport training simultaneously with the increments of the dynamic viscosity of bio-liquid lubricants has the following consequences:

i. Decreases in the Body Mass Index (BMI in kg/m^2) in comparison with the body human weight and BMI in kg/m^2 values occurring after a run or walk without EM and AE field effects;

ii. Decreases in the Human Metabolic Age (HMA);

iii. Increases in the Basal Metabolic Rate (BMR in Kcal) index in comparison with the HMA and with the BMR values in Kcal occurring after a run or walk without PEMF effects;

iv. Increases in water contents and decreases both in external and internal fat in the human body, in comparison with water contents as well as both external and internal fat in the human body, which occurs after a run or walk without EM and AE effects [9,11].

5. The hydrodynamic pressure and load carrying capacity caused by sweat lubrication, occurring in the gap between the human skin and the dress has an influence on the metabolic process after the following effects:

i. The decrements of the BMI index, decrements of external and internal body fat and the decrements of HMA values are larger in the case when the tightly fitting dress was used in comparison with the abovementioned decrements for the loose dress.

ii. The water, muscle mass and the BMR index are larger in the case when the tightly fitting dress was used in comparison with the abovementioned increments for the loose dress.

References

1. Bagnato GL, Miceli G, Marino N, Sciortino D, Bagnato GF (2016) Pulsed electromagnetic fields in knee osteoarthritis: a double blind, placebo-controlled, randomized clinical trial. Rheumatology 55(4): 755-762.
2. Cunha FR, Rosa A, Dias NJ (2016) Rheology of very dilute magnetic suspensions with microstructures and nanoparticles. Magnetism & Magnetic Materials 397: 266-274.
3. Czaban, Frycz M, Horak W (2013) Effect of the magnetic particles concentration on the ferro-oil's dynamic viscosity in presence of an external magnetic field in the aspect of temperature changes. Journal of Kones Powertrain and Transport 20(2): 55-60.
4. Ianniti T, Fistetto G, Esposito A, Rottigi V, Palmieri B (2013) Pulsed electromagnetic field therapy for management of osteoarthritis-related pain, stiffness and physical function: Clinical experience in the elderly. Clinical Interventions in Aging 8: 1289-1293.
5. Pawlak Z, Petelska AD, Urbaniak W, Fusuf KQ, Oloyede A (2012) Relationship between wettability and lubrication characteristics of the surfaces of contacting phospholipids-based membranes. Cell Biochem & Biophysics 65(3): 335-345.
6. Wierzcholski K, Maciołek R (2020) A new contribution in stochastic hydrodynamic lubrication for arbitrary bio-surfaces. Tribologia 3: 63-76.
7. Wierzcholski K (2021) A new progress in random hydrodynamic lubrication for movable non-rotational curvilinear bio-surfaces with phospholipids bilayers. Recent Progress in Materials 3(2): 38.
8. Wierzcholski K, Miszczak A (2021) Estimation of random bio-hydrodynamic lubrication parameters for joints with phospholipid bilayers. Bull of Polish Academy of Sciences Technical Sciences 69(1): 1-17.
9. Wierzcholski K (2017) Nanotribology impact of run-walk, electro-magnetic hydrodynamic human joint and skin lubrication on the slimming and metabolic process. Annals of Nanoscience & Nanotech 1(1): 1-8.
10. Wuschech H, Hehn U, Mikus E, Funk RH (2015) Effects of PEMF on patients with osteoarthritis: Results of a prospective, placebo-controlled double-blind study. Bio Electro Magnetics 36(8): 576-585.
11. Ziegler B, Wierzcholski K (2010) A new measurements method of friction forces regarding slide. Journal bearing by using AE Tribologia 1(229): 149-156.
12. (2014) Devices-Equipment for Physicotherapy.
13. (2014) Resmedica Health and Fitness.
14. (2014) Current Courses in Poland.
15. www.tanita.com
16. Chagnon G, Rebouah M, Favier D (2015) Hyper-elastic energy for soft biological tissues: A Review. J of Elasticity 120(2): 129-160.
17. Gadomski A, Bełdowski P, Miguel PR, Urbaniak W, Wayne KA, et al. (2013) Some conceptual thoughts toward nanoscale oriented friction in a model of articular cartilage. Mathematical Biosciences 244(2): 188-200.
18. Negm A, Lorberg A, Macintyre NJ (2013) Efficacy of flow frequency pulsed subsensory threshold electrical stimulation vs placebo in pain and physical function in people with knee osteoarthritis: Systematic review with meta-analysis. Osteoarthritis and cartilage 21(9): 1281-1289.

