

BONE SOUP AND POPPY SEEDS

Bone Modification in Professional Dance

Written component of Master Thesis

Submitted in partial fulfilment of the requirements for the degree of Master of Arts (MA) at the University of Applied Arts Vienna, Institute of Fine Arts and Media

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Registration number: S11735507

Vienna, Winter Semester 2021/22

Program number: S 066776

Study program: Art & Science

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1. Abstract

Disordered eating and amenorrhea are most common among sports that emphasize leanness, aesthetics, a weight class, or endurance, including gymnastics, ballet, figure skating, lightweight rowing, and running. The environment in which the dancers are training is critical and judgemental. Teachers and very often parents are censorious and perfectionists as well. In the name of Art, many dancers suffer physically and psychologically. The artistic work is more important than the scientific reality of the body.

In the wake of cultural and social changes, people working in the professional dance field must realize that some traditional practices are not ethical anymore. Dancers are such disciplined individuals, but we only see the surface of their existence most often. The performance "Bone Soup and Poppy Seeds" attempts to shed light on the toxic culture surrounding professional dance by scientifically proving an unhealthy lifestyle's damaging effect and showing real personal consequences.

Dance could be an art form where a dancer can practice daily the feeling of flow and mindfulness. However, the pressure to be perfect creates a psychological inflexibility in dancers, prohibiting joy.

We wanted to determine if Hungarian dancers are also victims of unhealthy dance culture with the scientific research phase. With the artistic research phase, the dancers can share their life experiences to present the reality of professional dance and how it modified their bodies, especially their bones.

2. Introduction

2.1. Misconduct in dance

Dance can be art and science practice at the same time. Training the body to become a skilled professional dancer is a highly scientific practice: it involves anatomy and sports science. However, the outcome of all the training is performance art, not competition. That is why artistic creation is considered more important than the scientific reality of the body. In the name of Art, many dancers

suffer physically and psychologically. In the wake of cultural and social changes, the dance world must also wake up.

It takes effort to change outdated ideas in any traditional art form. To consider and implement scientific findings can shake the principles of the discipline, and we can face severe ethical problems in several art practices. We need new ethical guidelines, implement structural and institutional change, and conduct scientific research on artistic methods to generate the changes. Furthermore, we need to educate dancers on evidence-based lifestyle choices to avoid serious health consequences. In this thesis, we use a scientific research method to point out harmful artistic practices to draw attention to misconduct in the dance field.

2.2. The environment in which students become dancers

A dancer needs a disciplined, competitive nature who can accept emotional and physical suffering like an athlete. (Mainwaring & Krasnow, 2001) The environment in which the dancers are training is critical and judgemental. Teachers and very often parents are censorious and perfectionists as well. Parents (or a parent) are often very much involved in their child's dance career, generating more pressure on the dancer.

Ágota Budavári writes in her book "Sportpsychology" about the type of parents who would create difficulties for their children:

- The autocrat: nothing is good enough,
- The competitive: often saying shamefully: "you will become a nobody,"
- The frustrated: the parent wants it more than the child,
- The rationalizing: using passive conflict avoidance,
- The hungry for money: the child is an investment, feeling guilty if it fails,
- The narcissistic: gives performance-dependent love. (Budaváry, 2007)

In the Hungarian Dance University, many ballet dancers live in a dormitory. Many rural students can only see their parents on the weekends. Some of them are only ten years old when they move to Budapest. In the dormitory, they have teachers taking care of them, but they are still not a replacement for a parent who would be giving them security and support whenever they need it.

When the students become adolescents, they start to change shape. For female students, this is when they begin to develop round shapes. They must endure many painful comments during this time. Many students start to develop eating disorders when they hit puberty.

There is another highly toxic practice in ballet institutions: constant weight and skinfold measurements. This procedure influences young dancers to aim for low body weight and risk developing eating disorders. The focus on physical excellence can lead to body image distortion or dissatisfaction. (Goodwin et al., 2013)

Dance could be an art form where a dancer can practice daily the feeling of flow and mindfulness. As a psychological process, mindfulness is a state of mind that appreciates every moment and generates full attention. (Kabat-Zinn, 1982) However, the pressure to be perfect creates a psychological inflexibility in dancers, prohibiting the joy of movement. (Serrano and Espirito-Santo, 2017) Many talented artists lose their love of motion in the daily dance classes, and they might never find it again. Dance could become a healthy occupation by implementing acceptance and compassion.

2.3. The ideal body for dance

I started dancing at the age of 14. I did not know anything about performing arts, but I saw a dance teacher in my hometown who looked younger than her age. I wanted that. I understood I would not get that look if I sat all day in a traditional high school. I auditioned to a ballet academy, but I had no previous training, so they sent me to a contemporary dance school. I got accepted because of my body type. I never had to endure dieting because I had the correct proportions from my "lucky" genes. Esthetically my body was ideal but far from ideal for the physical demand of this athletic profession.

Long legs and long lines are an esthetic value based on traditions. The socially accepted standard of beauty is constantly changing. The ballet figure evolved around two hundred years ago in European-centered professional dance practices when romanticism formed the ideal ballet dancer. Tamara Lee Gebert summarizes very well in her dissertation how it happened in dance history:

"New artistic tastes developed; people sought a return to nature and all its mysteries. An interest in folklore, fairy tales, legends, and old literature accompanied a timeless human need for periodic escapism and fantasy. Ballet became a major vehicle for that need. When Marie Taglioni initiated dancing on pointe as the Sylphide in *La Sylphide* (1832), ballet gained favor, and the Romantic era was born in dance. Ballet flourished, and new scientific methods for training dancers included a focus on the technical invention of the pointe shoe, which produced a new effect of weightlessness and femininity. For the first time, supernatural creatures could move on the stage with startling lightness." (Lee Gebert, 1995)

2.4. The aim of the research study

The appearance of weightless mysterious creatures is still the norm in classical ballet. Many dancers develop unhealthy habits, consume few calories, and develop eating disorders to attain weightlessness. In contemporary dance, the demand is a much more natural body. Many contemporary choreographers prefer various body types in their productions, and the dancers are more muscular and athletic. Our scientific research study wants to find the differences between ballet dancers' bodies and contemporary dancers' bodies. We want to determine if the ballet dancers' body-modification regimes create a lightweight body and if the data shows the anthropometric difference between ballet dancers and contemporary dancers.

2.5. Differences between dance styles

Ballet has undergone tremendous development. Poses, steps, leaps characterized it, and an aristocratic way of performing, replaced by a new aesthetic. The male dancers became athletic, virtuoso turns, and choreographers added big jumps to the repertoire. Dancers with an extreme range of motion appeared among the female dancers. Today, female dancers are also more muscular and athletic, but their weight does not change due to the lifts, so they do not increase muscle mass.

The most striking difference between the styles is the movements, which have an aesthetic reason. Ballet wants to shape the human body into an etheric being, a phenomenon beyond this world that transcends man. On the other hand, contemporary dance can have a thousand different purposes depending on the

theme of the performance. We may see contemporary dancers like circus performers, or wild people, or as if they were ordinary civilians. That is why the two styles of dance are so different.

There are no such strong rules in contemporary dance as in ballet. Dancers often use improvisational elements that can push their bodies into unpredictable movements, so they need a workout that makes the reflexes safe as if the body is taking care of itself. They also put weight on their hands during their daily practices, practically never happening during ballet classes. Increasing muscle mass is permissible if it does not affect joint mobility. Depending on the role, it may even be aesthetically beneficial.

The career span of the two styles is also different. Ballet dancers start professional dance training at the age of 6 to 10, while contemporary dancers dance only on a hobby level before 14. The ballet dancers are already on the opera house stage at 18 and retire around 40. Contemporary dancers get their first professional job at around the age of 22-24, and we find plenty of performers over the age of 40. Dance is an activity with a high number of injuries. The fragile balance of aesthetic requirements and anatomical abilities are the leading causes of injuries.

3. Literature review

3.1. Effects of dance-specific movements

The classical ballet dancer combines sporting performance with aesthetic values. (Hamilton et al., 1992) Ballet dancers participate in long dance technique classes, multi-hour rehearsals, and long shows. They commit to a high level of training that involves many repetitive (jumps) movements during adolescent growth at a young age. (Ekegren et al., 2014) Contemporary dance requires versatility, a lot of improvisation, and spontaneous action. (Weiss et al., 2008) Strict training in both dance styles requires intense physical and artistic skills and consequently may increase dancers' propensity for musculoskeletal injuries. (Allen et al., 2012)

Due to the incidence of musculoskeletal injuries, Luke classified dance as a high-risk activity. (Luke et al., 2002) Kenny and al. estimate an injury rate of 4.7 per 1,000 dance hours for professional adolescent ballet students. They found fewer

injuries researching elite adolescent gymnasts (2.6 per 1,000 hours) and skaters (4/1000 hours). (Kenny et al., 2016)

In a five-year study, 95% of dancers employed for more than one year in a Swedish ballet ensemble suffered injuries during the study period. (Nilsson et al., 2001). Epidemiological studies of ballet dancers show that 90% of professional dancers and 63% of student dancers have had some kind of dance injury during their careers. (Lewis et al., 1997) In 2019, Van Winden and al. measured a higher proportion in one of the most famous dance universities: Codarts University of the Arts Rotterdam. The 1-year injury rate was 81%, of which 58% were severe injuries. The most affected areas were the ankles/feet, the lower back, and the knees. (Van Winden et al., 2019)

3.2. Risk factors for injuries

A 2016 review of the literature by Kenny et al. Found that the most common musculoskeletal injuries in dance are due to overload and lower limb injuries are the most common. The risk factors:

- Previous Injury: A dancer who has already had an injury is more likely to be injured.
- Risk factors for anthropometric indicators in order of danger: low body mass index (BMI), low fat, increased femoral circumference, age.

From the literature, we can conclude that injuries appear already during studies, which will later be the most significant risk factors among dancers taking a job.

There are also anatomical factors, and the hours of dancing are also a risk factor. In this research, we focus on anthropometric characteristics. We look closer at differences in body mass index (BMI) and low-fat content in different dance styles.

3.3. Anthropometric comparisons in the literature

Our research takes place in Hungary. Hungarian dancers get very little research. The anthropometric data of the three groups of modern dancers (MD), folk dancers (FD), and handball (HB) show that the body structure and body

composition of the dancers and handball are the same. Bobály and al. found no significant difference in any of the variables. The study involved 27 women who belonged to three study groups:

- MD: (n: 9, age: $22 \pm 2,9$ years) 8 hours per week training session (4×2 hours/week),
- FD: (n: 9, age: $23 \pm 2,5$ years) 9 hours (3×3 hours / week),
- HB: (n: 9, age: 20 ± 2.7 years) 10 hours per week (5×2 hours/week)

The differences were not significant. The research shows tendencies:

- MD: lowest body weight (58,31 kg), lowest BMI (20,73 kg / m²),
- FD: lowest lean mass (45,75 kg),
- HB: highest body weight (67,6 kg), highest lean mass (51,37 kg), highest BMI (22,77 kg / m²).

Based on the data obtained, the authors hypothesized that there might be significant differences between anthropometric data for a larger number of participants. (Bobály et al., 2013.)

Ten ballet dancers (18.9 ± 1.4 years) and ten athletes and amateur dancers (18.1 ± 1.2 years) took part in the 2005 measurements of Petőfi and Ángyán. Among their body sizes, ballet dancers' body mass index and waist-hip ratio were significantly lower than those of the control group (body mass index 19.2 kg / m² and 21 kg / m², respectively, $p < 0.04$ waist-hip ratio: 0.8 and 0.9, respectively) ($p < 0.01$) (Petőfi and Ángyán, 2005) The literature proves that the body mass index of Hungarian ballet dancers is lower than that of athletes, but that of artists dancing other styles is the same.

3.4. The relation between anthropometric data, bone density data, and diet

There is evidence that the anthropometric data (body weight, body mass index) and diet correlate with bone density in the literature.

Quintas and al. collected dietetic, anthropometric, and bone density data from 74 women who practiced different sports (15 skiers, 26 basketball players, and 33 ballet dancers) compared to those of 90 women who led sedentary lifestyles. Results: The sportswomen had higher bone mineral contents and bone densities

than controls. However, the dancers showed similar spinal and hip values as those of the control group and lower forearm values. Low body weight and body mass index and insufficient energy intake—characteristic of the dancers—were associated with poorer bone mineralization. The worst bone density status was that of the dancers, who, as a group, displayed characteristics that have negative impacts in this respect (low energy intake and low body weight). (Quintas et al. 2003)

Dancers have the lowest weight and body mass index and energy intake:

	Control	Dancers	Basketball	Skiers	ANOVA
Age (y)	16.7 ± 1.0	16.2 ± 2.0	17.2 ± 2.1	17.1 ± 2.9	NS
Weight (kg)	55.7 ± 6.7 ^{a,b,c}	49.5 ± 3.9 ^{a,d,e}	70.5 ± 11.02 ^{b,d,f}	59.7 ± 4.9 ^{c,e,f}	P < 0.001
Height (cm)	162.1 ± 6.2 ^b	162.8 ± 4.3 ^d	174.9 ± 8.0 ^{b,d,f}	163.7 ± 3.9 ^f	P < 0.001
BMI (kg/m ²)	21.2 ± 2.19 ^b	18.7 ± 1.1 ^{a,d,e}	23.0 ± 2.9 ^{b,d}	22.2 ± 1.34 ^e	P < 0.001
Age at menarche (years)	12.8 ± 1.03	13.3 ± 1.05	12.9 ± 1.6	12.3 ± 0.91	NS
Training (h/week)	0 ^{a,b,c}	25.2 ± 4.9 ^{a,d}	12.0 ± 2.3 ^{b,d,f}	24.1 ± 4.6 ^{d,f}	P < 0.001
<i>Dietetic parameters:</i>					
Consumption of milk products (g/day)	309.3 ± 165.8 ^a	434.5 ± 136.1 ^a	378.1 ± 176.6	290.5 ± 165.8	P < 0.01
Energy intake (kJ/day)	8489 ± 1674 ^b	7912 ± 1766 ^d	10 807 ± 2921 ^{b,d,f}	9272 ± 1799 ^f	P < 0.001
Protein intake (g/kg/day)	1.4 ± 0.33 ^a	1.7 ± 0.43 ^{a,d}	1.4 ± 0.41 ^d	1.5 ± 0.29	P < 0.05
Calcium intake (mg/day)	769.5 ± 262 ^{a,b}	1009 ± 273 ^a	1013 ± 412 ^b	824.2 ± 272	P < 0.001
Ca/P ratio	0.72 ± 0.20 ^a	0.90 ± 0.19 ^{a,d,e}	0.73 ± 0.17 ^d	0.71 ± 0.14 ^e	P < 0.001
Vitamin D intake (μg/day)	3.07 ± 3097	3.56 ± 2.70	4.04 ± 4.44	3.63 ± 4.15	NS

Ballet dancers have the lowest Bone Mineral Content (BMC) and lowest Bone Mineral Density (BMD).

	Control	Ballet	Baloncesto	ESQUÍ	
<i>BMC and BMD for lumbar spine:</i>					
L2 BMC (g)	11.5 ± 2.3 ^{b,c}	11.8 ± 2.2 ^{d,e}	16.1 ± 2.1 ^{b,d}	15.0 ± 2.0 ^{c,e}	P < 0.001
BMD (g/cm ²)	0.96 ± 0.10 ^{b,c}	0.98 ± 0.11 ^{d,e}	1.1 ± 0.11 ^{b,d}	1.1 ± 0.13 ^{c,e}	P < 0.001
L3 BMC (g)	13.8 ± 2.5 ^{b,c}	13.7 ± 2.1 ^{d,e}	18.9 ± 2.2 ^{b,d}	17.9 ± 2.7 ^{c,e}	P < 0.001
BMD (g/cm ²)	1.02 ± 0.10 ^{b,c}	1.03 ± 0.10 ^{d,e}	1.16 ± 0.10 ^{b,d}	1.2 ± 0.12 ^{c,e}	P < 0.001
L4 BMC (g)	15.4 ± 2.5 ^{b,c}	15.7 ± 2.4 ^{d,e}	20.7 ± 2.6 ^{b,d}	19.6 ± 3.6 ^{c,e}	P < 0.001
BMD (g/cm ²)	1.04 ± 0.11 ^{b,c}	1.03 ± 0.10 ^{d,e}	1.2 ± 0.10 ^{b,d}	1.2 ± 0.13 ^{c,e}	P < 0.001
TOTAL BMC (g)	40.8 ± 7.1 ^{b,c}	41.2 ± 6.4 ^{d,e}	55.8 ± 6.7 ^{b,d}	52.5 ± 8.1 ^{c,e}	P < 0.001
BMD (g/cm ²)	1.01 ± 0.10 ^{b,c}	1.02 ± 0.10 ^{d,e}	1.2 ± 0.10 ^{b,d}	1.2 ± 0.12 ^{c,e}	P < 0.001
<i>BMC and BMD for Right hip:</i>					
Neck BMC (g)	4.4 ± 0.52 ^{b,c}	4.6 ± 0.63 ^{d,e}	6.0 ± 0.72 ^{b,d}	5.6 ± 0.78 ^{c,e}	P < 0.001
BMD (g/cm ²)	0.89 ± 0.10 ^{b,c}	0.93 ± 0.09 ^{d,e}	1.1 ± 0.12 ^{b,d}	1.1 ± 0.15 ^{c,e}	P < 0.001
Trochanter BMC (g)	6.1 ± 1.4 ^{b,c}	6.4 ± 1.1 ^{d,e}	9.0 ± 1.9 ^{b,d,f}	7.7 ± 1.3 ^{c,e,f}	P < 0.001
BMD (g/cm ²)	0.72 ± 0.08 ^{a,b,c}	0.77 ± 0.08 ^{a,d,e}	0.86 ± 0.10 ^{b,d}	0.84 ± 0.12 ^{c,e}	P < 0.001
Intertrochanter BMC (g)	20.3 ± 3.4 ^{b,c}	21.1 ± 3.7 ^{d,e}	28.9 ± 4.8 ^{b,d}	26.7 ± 4.2 ^{c,e}	P < 0.001
BMD (g/cm ²)	1.07 ± 0.12 ^{b,c}	1.07 ± 0.11 ^{d,e}	1.2 ± 0.12 ^{b,d}	1.2 ± 0.15 ^{c,e}	P < 0.001
Total BMC (g)	30.8 ± 4.9 ^{b,c}	32.1 ± 4.9 ^{d,e}	44.0 ± 6.4 ^{b,d}	39.9 ± 5.7 ^{c,e}	P < 0.001
BMD (g/cm ²)	0.95 ± 0.10 ^{b,c}	0.97 ± 0.09 ^{d,e}	1.1 ± 0.11 ^{b,d}	1.1 ± 0.14 ^{c,e}	P < 0.001
Ward's triangle BMC (g)	0.90 ± 0.16 ^{b,c}	0.97 ± 0.14 ^d	1.1 ± 0.20 ^{b,d}	1.1 ± 0.18 ^c	P < 0.001
BMD (g/cm ²)	0.83 ± 0.11 ^{b,c}	0.86 ± 0.10 ^{d,e}	1.0 ± 0.13 ^{b,d}	0.99 ± 0.13 ^{c,e}	P < 0.001
<i>BMC and BMD for right forearm:</i>					
Neck BMC (g)	2.1 ± 0.30 ^{b,c}	2.3 ± 0.33 ^{d,e}	2.6 ± 0.44 ^{b,d}	2.6 ± 0.44 ^{c,e}	P < 0.001
BMD (g/cm ²)	0.63 ± 0.04 ^{a,c}	0.61 ± 0.04 ^{a,e}	0.63 ± 0.04 ^f	0.69 ± 0.05 ^{c,e,f}	P < 0.001
Trochanter BMC (g)	2.7 ± 0.33 ^{a,c}	2.2 ± 0.33 ^{a,d,e}	2.5 ± 0.37 ^d	3.3 ± 0.44 ^{c,e,f}	P < 0.001
BMD (g/cm ²)	0.53 ± 0.03 ^{a,c}	0.51 ± 0.05 ^{a,d,e}	0.54 ± 0.04 ^{d,f}	0.61 ± 0.05 ^{c,e,f}	P < 0.001
Intertrochanter BMC (g)	1.4 ± 0.19 ^{b,c}	1.3 ± 0.19 ^{d,e}	1.7 ± 0.25 ^{b,d,f}	1.8 ± 0.25 ^{c,e,f}	P < 0.001
BMD (g/cm ²)	0.42 ± 0.04 ^{b,c}	0.41 ± 0.05 ^{d,e}	0.45 ± 0.05 ^{b,d,f}	0.52 ± 0.06 ^{c,e,f}	P < 0.001
Total BMC (g)	36.2 ± 0.75 ^{a,b,c}	5.8 ± 0.61 ^{a,d,e}	6.8 ± 0.87 ^{b,d,f}	7.7 ± 0.77 ^{c,e,f}	P < 0.001
BMD (g/cm ²)	0.53 ± 0.03 ^c	0.51 ± 0.04 ^{d,e}	0.54 ± 0.04 ^{d,f}	0.60 ± 0.05 ^{c,e,f}	P < 0.001

The low energy intake of ballet dancers can have a devastating effect on their bodies. Not only do they lose bone structure, but they can also lose their reproductive functions. Despite the benefits of exercise, female athletes are still susceptible to amenorrhea, disordered eating behaviors, and osteoporosis. This

constellation of disorders can result in short- and long-term side effects, including stress fractures, irreversible bone loss, infertility, and osteoporosis. (Lo et al., 2003)

Scarce metabolic fuels consumed while training is unavailable for critical physiological functions such as:

- immune function,
- growth and maintenance functions such as tissue turnover,
- reproductive development and function.

Adolescent kids deposit their 30-50% bone mass during their peak growth. Energy deficiency reduces the rate of bone formation by suppressing growth factors and increases the rate of bone resorption by suppressing reproductive hormones. The result is skeletal demineralization. While girls should be accumulating their peak bone mass, they follow an unhealthy lifestyle, which leads to some amenorrhoeic athletes having the bone densities of 60-year-old women. Osteoporosis for a 20-year-old athlete is a considerable risk. Osteopenia is a disaster waiting to happen. Accordingly, the American College of Sports Medicine has published a Position Stand on the Female Athlete Triad is a syndrome requiring prompt intervention to prevent chronic under-nutrition from inducing reproductive disorders and skeletal demineralization. (Loucks, 2004)

3.5. The Female Athlete Triad

The Female Athlete Triad refers to a constellation of 3 clinical entities: menstrual dysfunction, low energy availability (with or without an eating disorder), and decreased Bone Mineral Density (BMD). The American College of Sports Medicine coined this complex disorder in 1992 after many experts in the field had noticed a pattern among adolescent and young adult female athlete patients. (Nazem, 2012)

Adolescence is a time in development that a positive energy balance is crucial for puberty, menarche, and regular menstruation. Eating disorders are the third most common chronic illness and start during puberty. High-level athletes, specifically young girls participating in ballet, running, gymnastics, and figure skating, are at risk of developing from excessive exercise and inability to meet the body's energy needs:

- functional hypothalamic amenorrhea (menstrual dysfunction),
- low weight,
- high-stress levels.

Dysfunction of the hypothalamic-pituitary-ovarian axis leads to a hypoestrogenic state. Low estrogen levels harm bone health, sexual maturation, sexual function, and fertility. Puberty has the highest rate of bone accrual in a female's life. Adequate nutrition, physical activity, and estrogen are crucial for bone development and the prevention of osteoporosis. Recognition and early intervention are necessary to limit the irreversibility of some of these effects. (Huhmann, 2020)

4. Hypothesis

4.1. Research questions and hypothesis

From the literature, we see a tendency of ballet dancers to have lower than average anthropometric data and bone density data. Our research wanted to find differences between ballet dancers and contemporary dancers among Hungarian artists. Our main question is:

- Are there anthropometric, bone structure, and bone composition differences between ballet and contemporary dancers?

In Budapest, there are two major institutions to study dance professionally. One is the Hungarian Dance University, where they teach ballet professionally, and the other is the Budapest Contemporary Dance Academy, where they teach contemporary dance professionally. It is common among professionals that ballet culture requires adolescent dancers to consume few calories, and teachers and fellow dancers encourage each other to follow a special diet. In contemporary dance schools, teachers and directors promote healthy eating.

Our hypothesis is:

- We hypothesize that the anthropometric data and the Bone Mineral Density data will differ between ballet dancers and contemporary dancers.
- We hypothesize that ballet dancers have lower weight and Body Mass Index and lower Bone Mineral Density.

5. Methods

5.1. Place and the supervisor of the project

The research took place at the University of Physical Education in Budapest. The research supervisor was Dr. Irina Kalabiska, who researches Medical Anthropology, Radiology, and Sports Medicine. We applied to the Research Ethics Committee of the University of Physical Education in Budapest for the Research Ethics Approval. We received the approval on February 24, 2021. We took the measurements from 22-26. February 2021.

5.2. Research subjects

The study involved 49 dancers: 24 male and 25 female, 24 ballet and 25 contemporary dancers. We divided the participants into four groups:

- 11 male ballet dancers,
- 13 female ballet dancers,
- 13 male contemporary dancers,
- 12 female contemporary dancers.

The ballet dancers participating in the study graduated from the Hungarian Dance University, the contemporary dancers studied in the Budapest Contemporary Dance Academy.

Participants in the research had to meet the following criteria:

- professional dance studies,
- for ballet dancers: a minimum of four years of daily ballet training six times a week,
- for contemporary dancers: a minimum of four years of daily contemporary dance training five times a week,
- After their studies, they are still active dancers.

Exclusion criteria from the research were:

- Of a bodyweight exceeding 136 kg,
- test person with orthopedic metallic devices,
- the presence of X-ray contrast in the body,
- the presence of a radiating isotope in the body,

- pregnancy.

5.3. Methods for examining anthropometric factors

We analyzed the anthropometric characteristics of the dancers by descriptive statistical method. We calculated the mean, standard deviation of age, height, body weight, and body mass index. The examined indicators were by four different comparisons:

- Gender: averages of male and female dancers.
- Divided into dance styles: averages of ballet and contemporary dancers.
- Divided by dance styles and gender: averages of male ballet and male contemporary dancers.
- Divided by dance styles and gender: averages of female ballet and female contemporary dancers.

5.4. Body composition analysis



DEXA (Dual-Energy X-ray Absorptiometry) is a scanning device using x-ray technology to measure body composition. The machine determines the distribution of bone, muscle, fat, and water content of the body. DEXA is the gold standard in tissue determination because it gives accurate results. DEXA measures:

- bone mass,

- muscle mass,
- fat mass,
- fat percentage,
- bone mineral density,
- bone mineral content
- visceral fat tissue (central abdominal fat).

It can measure the tissue content of the total body and body parts: left and right side of the trunk, left and right side of the legs, and the arms.

DEXA most often is used for Bone Densitometry measurements, identifying osteoporosis. T score is the Bone Mineral Density compared to young adults of the same gender in peak health:

- normal score: -1 and above,
- osteopenia: -1 to -2.5,
- osteoporosis: below -2.5.

For this research, we used the DEXA data of BMI (Body Mass Index) and BMD data (Bone Mineral Density) in four body regions: Legs, arms, trunk, and hips.

6. Results and discussion

6.1. Results of anthropometric measurements

We prepared descriptive statistical tables to observe differences in age, height, body weight, and body mass index between sexes, between dance styles, between male ballet and male contemporary dancers, and between female ballet and female contemporary dancers.

6.1.1. Differences between the 49 dancers by gender

Gender								
	Age		Height		Weight		BMI	
	Male	Female	Male	Female	Male	Female	Male	Female
n	24	25	24	25	24	25	24	25
Average	27.333	25.760	177.767	165.684	70.875	56.064	22.429	20.392
Deviation	5.561	3.689	6.772	4.174	6.634	6.891	1.731	2.127
Minimum	19.000	20.000	160.000	157.500	60.900	43.700	19.900	17.300
Maximum	38.000	32.000	191.800	171.900	85.500	71.800	25.600	26.300

The average age of male dancers is 27.3 ± 5.5 years; average height 177.7 ± 6.7 cm; average body weight 70.8 ± 6.6 kg; and a mean body mass index of 22.4 ± 1.7 kg / m².

The average age of female dancers is 25.7 ± 3.6 years; average height 165.7 ± 14.2 cm; average body weight 56.1 ± 6.9 kg; and a mean body mass index of 20.4 ± 2.1 kg / m².

6.1.2. Differences between dancers according to dance style

Ballet and contemporary dancers								
	Age		Height		Weight		BMI	
	ballet	cont	ballet	cont	ballet	cont	ballet	cont
n	24	25	24	25	24	25	24	25
Average	24.625	28.360	169.829	173.304	60.167	66.344	20.762	21.992
Deviation	4.030	4.672	8.539	7.734	9.406	9.865	2.040	2.180
Minimum	19.000	21.000	157.500	158.900	46.900	43.700	17.300	17.300
Maximum	35.000	38.000	191.800	190.000	81.100	85.500	25.600	26.300

The average age of ballet dancers is 24.6 ± 4 years; average height 169.8 ± 8.5 cm; average body weight 60.1 ± 9.4 kg; and an average body mass index of 20.7 ± 2 kg / m².

The average age of contemporary dancers is 28.3 ± 4.6 years; average height 173.3 ± 7.7 cm; average body weight 66.3 ± 9.8 kg; and a mean body mass index of 21.9 ± 2.1 kg / m².

6.1.3. Differences of male dancers by dance style

Male ballet and contemporary dancers

	Age		Height		Weight		BMI	
	ballet	cont	ballet	cont	ballet	cont	ballet	cont
n	11	13	11	13	11	13	11	13
Average	24.636	29.615	176.036	179.231	68.509	72.877	22.136	22.677
Deviation	4.632	5.393	8.078	5.334	6.028	6.678	1.874	1.635
Minimum	19.000	21.000	160.000	168.000	62.200	60.900	19.900	20.400
Maximum	35.000	38.000	191.800	190.000	81.100	85.500	25.600	25.000

The average age of male ballet dancers is 24.6 ± 4.6 years; average height 176 ± 8 cm; average body weight 68.5 ± 6 kg; and a mean body mass index of 22.1 ± 1.8 kg / m².

The average age of male contemporary dancers is 29.6 ± 5.3 years; average height 179.2 ± 5.3 cm; average body weight 72.8 ± 9.8 kg; and a mean body mass index of 22.6 ± 1.6 kg / m².

6.1.4. Differences of female dancers by dance style

Female ballet and contemporary dancers

	Age		Height		Weight		BMI	
	ballet	cont	ballet	cont	ballet	cont	ballet	cont
n	13	12	13	12	13	12	13	12
Average	24.615	27.000	164.577	166.883	53.108	59.267	19.600	21.250
Deviation	3.641	3.464	4.493	3.602	4.639	7.655	1.362	2.510
Minimum	20.000	21.000	157.500	158.900	46.900	43.700	17.300	17.300
Maximum	31.000	32.000	170.000	171.900	60.700	71.800	21.700	26.300

The average age of female ballet dancers is 24.6 ± 3.6 years; average height 164.5 ± 4.4 cm; average body weight 53.1 ± 4.6 kg; and an average body mass index of 19.6 ± 1.3 kg / m².

The average age of female contemporary dancers is 27 ± 3.4 years; average height 166.8 ± 3.6 cm; average body weight 79.2 ± 7.6 kg; and an average body mass index of 21.2 ± 2.5 kg / m².

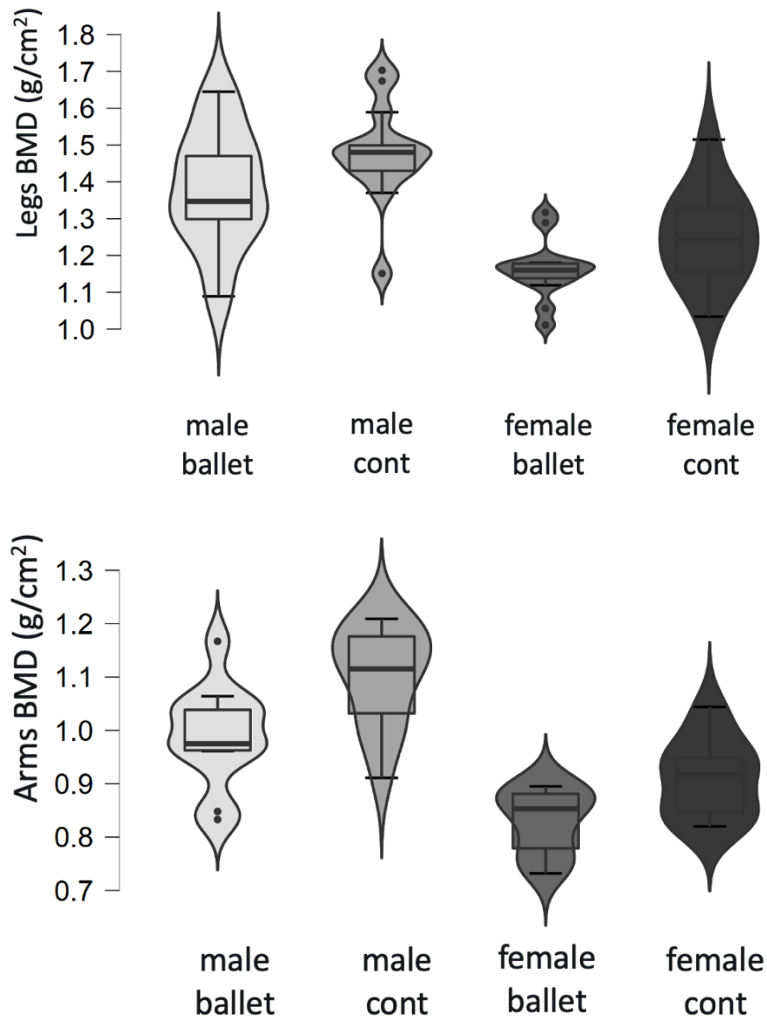
6.2. Bone Density differences

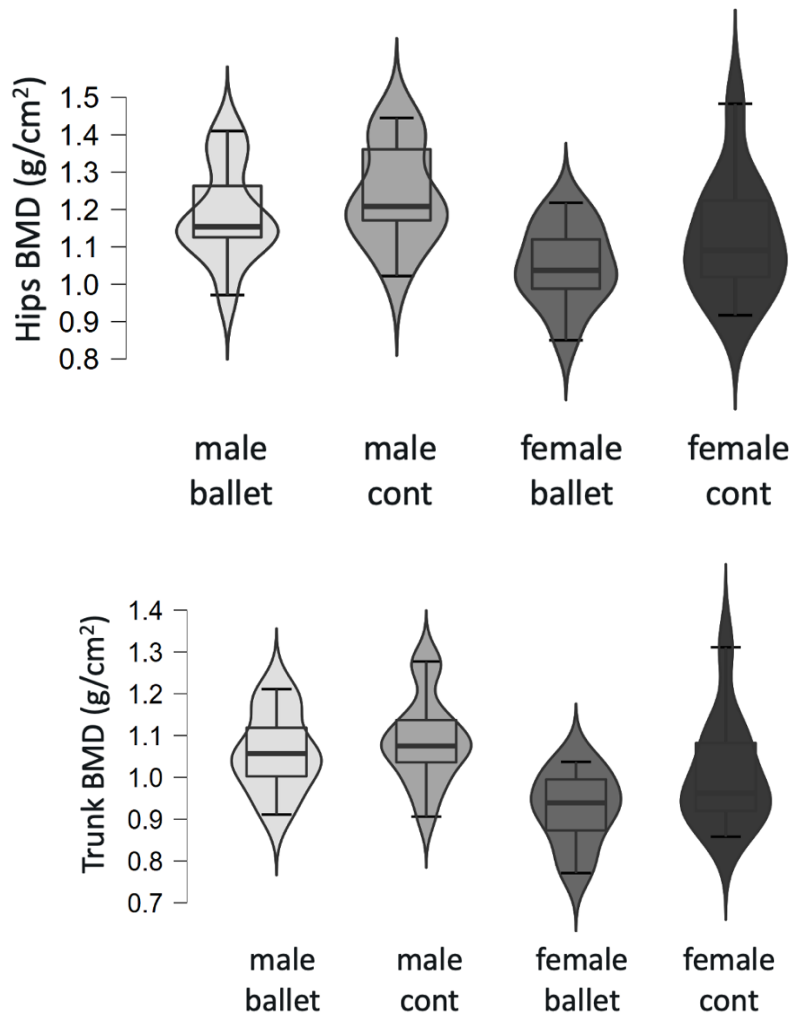
We prepared descriptive statistical analysis to observe differences in Bone Mineral Density in the legs, arms, trunk, and hips. The four groups were male ballet dancers, male contemporary dancers, female ballet dancers, and female contemporary dancers.

Bone Mineral Density Data (g/cm²)

	Male ballet		Male contemp		Female ballet		Female contemp	
	lowest	highest	lowest	highest	lowest	highest	lowest	highest
Legs	1.089	1.645	1.151	1.703	1.011	1.317	1.034	1.515
Arms	0.833	1.167	0.911	1.209	0.732	0.895	0.820	1.044
Trunk	0.911	1.211	0.906	1.277	0.771	1.037	0.858	1.311
Hips	0.971	1.410	1.022	1.445	0.850	1.218	0.917	1.483

Visual analysis of Bone Mineral Density:





From the figures, we can conclude: female ballet dancers have the lowest Bone Mineral Density in the four major body regions.

6.3. Discussion

One of the basic tenets of our hypothesis is that there is a difference between ballet and contemporary dancers because the two art forms differ in esthetics. The results clearly show the differences:

- Differences by gender: Male dancers were older, taller, heavier, and had higher Body Mass Index (BMI).
- Differences between ballet and contemporary dancers: contemporary dancers were older, taller, heavier, and had higher Body Mass Index (BMI).

- Differences between male ballet and contemporary dancers: contemporary dancers were older, taller, heavier, and had higher Body Mass Index (BMI).
- Differences between female ballet and contemporary dancers: contemporary dancers were older, taller, heavier, and had higher Body Mass Index (BMI).

We also see in the anthropometric data that the differences between the male ballet and male contemporary dancers are not at a significant level. The difference in weight and BMI between female ballet and female contemporary dancers is significant.

We can confirm the other hypothesis as well. From the results of the Bone Mineral Density (BMD) measurements, we can conclude those female ballet dancers have significantly lower BMD than the other three groups: female contemporary, male contemporary, and male ballet dancers.

Unfortunately, we found many ballet dancers with deficient Bone Mineral Density, especially the lumbar spine. The average Bone Mineral Density is between 1 to -1 g/cm². From 11 female ballet dancers, we found three 20 years old with severe osteoporosis. The worst score was -3.2 g/cm² in the lumbar spine. The result is like a 70–80-year-old woman who must be extremely careful not to fall because she risks breaking her bones. The best score was a female contemporary dancer who scored 4.8 g/cm² in the lumbar spine in the same region. It is an extremely high score.

From 13 female ballet dancers, we found five malnourished (Body Mass Index less than 18 kg/m²). From 12 female contemporary dancers, we found one malnourished. We found no malnourished male dancers.

7. Conclusions

The body composition of athletes and dancers depends on what the sport or the esthetics of the art form requires. There is a rigorous selection process for high-level athletes and professional ballet dancers before puberty. The body type required for ballet is particular because ballet is a highly aestheticized art form. The traditional female ballet role model is a lightweight creature from the romantic era.

In ballet, low-calorie intake is a big problem. I have already mentioned in the literature review that low Body Mass Index (BMI) is a high-risk factor for injuries. (Kenny et al., 2016) Unfortunately, it has also appeared among contemporary dancers in recent years. It is not typical in Hungary, but the 'Female Athlete Triad' appears in more and more contemporary dancers in Western dance schools. The Triad refers to a constellation of three clinical signs: menstrual dysfunction, low energy supply (with or without an eating disorder), and decreased Bone Mineral Density (BMD). (Nazem, 2012).

It is necessary to look for connections between dance styles to establish the conditions for selecting future talent and compile training plans on a scientific basis.

The prevalence of menstrual irregularities, disordered eating, and low Bone Mineral Density (BMD) varies widely in the general and athletic communities. In women who participate in sports that emphasize aesthetics or leanness, such as ballet or running, the prevalence of secondary amenorrhea can be as high as 69%, compared with 2% to 5% in the general population.

Energy availability is the amount of dietary energy for all physiologic functions after accounting for energy expenditure from exercise. Low energy availability may result from an eating disorder but can also occur without a psychiatric diagnosis such as AN (Anorexia Nervosa) or BN (Bulimia Nervosa). Dancers may have disordered eating simply by unknowingly failing to attain their energy requirements secondary to time constraints or lack of nutritional knowledge. Some studies have also found that athletes often lack the appetite to promote food intake as compensation for energy expenditure from intense exercise regimens.

Female athletes are at risk of developing eating disorders due to pressure to maintain low body weight and poor nutrition guidance and weight loss from the athletic community. Many have blamed the coach, who often fails to teach athletes about healthy dieting or cultivates an environment where weight loss is encouraged regardless of the methods employed to attain it. Disordered eating and amenorrhea are most common among sports that emphasize leanness, aesthetics, a weight class, or endurance, including gymnastics, ballet, figure skating, lightweight rowing, and running. (Nazem et al., 2012)

8. Summary

Introduction: One of the basic tenets of the hypothesis is that there is a difference between ballet and contemporary dancers because the two art forms differ in esthetics. Female ballet dancers' figures must be slim with long lines. Male ballet dancers are more muscular than female ballet dancers but still have long lines. Female and male contemporary dancers represent a more robust esthetic; they can be more varied and individual. The dancers of the two dance styles often look different.

In this research, we looked at those differences and measured the body composition of the dancers, their anthropometric qualities and their bone structure:

- Height,
- Weight,
- Age,
- Body Mass Index (BMI),
- Bone Mineral Density (BMD).

Material and method: We measure 49 dancers between the ages of 20-36 years old. We divided the participants into four groups:

- 11 male ballet dancers,
- 13 female ballet dancers,
- 13 male contemporary dancers,
- 12 female contemporary dancers.

We used descriptive statistical analysis to see the average age, weight, height, and Body Mass Index of:

- Male and female,
- Ballet and contemporary,
- Male ballet and contemporary,
- Female ballet and contemporary.

We prepared a visual analysis of the Bone Mineral Density results of four groups:

- 11 male ballet dancers,
- 13 female ballet dancers,
- 13 male contemporary dancers,
- 12 female contemporary dancers.

Results: Female ballet dancers had the lowest age, height, weight, Body Mass Index, and Bone Mineral Density. There were no significant differences between male ballet and male contemporary dancers.

Conclusion: Professional ballet requires a slim figure. That is why female ballet dancers often restrict their calory intake. Female ballet dancers have a high risk of osteoporosis at a young age because of it. Our research concludes that the Body Mass Index and the Bone Mineral Density of female ballet dancers in the Hungarian dance scene are lower than other dancers. Because of their condition, they can develop the Female Athlete Triad, which will reduce their physical and artistic capacity.

9. The artistic practice

9.1. Personal experiences

After the scientific research findings, the next phase of the dissertation is the performance based on the research subjects. We rarely hear the voice of a dancer. Their personal life is hardly ever the topic of performance. Through this scientific research, we found the dancers suffering from the unhealthy habits of their dance practice, and the artistic phase of this dissertation will allow them to share their experiences with us. They are such disciplined individuals, but we only see the surface of their existence. In the performance "Bone Soup and Poppy Seeds," we focus on the dancers' life, not their movements and bodies. We can finally hear the stories of their diligent day-to-day work and the reality of what it takes to become a dancer.

Many dancers had unhealthy habits, such as eating ten pieces of nuts for lunch and smoking after each class to overcome the feeling of hunger. Some dancers experienced emotional abuse during their studies and in their work environment. Listening to their stories, we realize how teachers, choreographers, fellow dancers treated them wrongly just because the result justifies the means.

While talking about their stories, the dancers and the audience can enjoy a cup of warm bone soup, and the dancers can prepare a very simple poppy seeds desert: the Hungarian "Mákosguba" (poppy seed dough). These foods help rebuild bone and nurture the body with the proper nutrition to develop a healthy bone structure. Many dancers will never cook bone soup because it takes 48-72 hours. They have no time in their daily training to take care of themselves properly. Bone soup would be the most crucial food for them.

Poppy seeds are another source of nutritional food for bone development, but poppy seeds are not part of the diet in some cultures. Hungarian cuisine has plenty of poppy seeds recipes. The dancers will prepare one in a couple of minutes while listening to their everyday lives.

It would be essential in dance institutions to provide dancers with the proper nutrition to develop resilient dancers. The culture of food is a missing topic in many institutions.

The performance "Bone Soup and Poppy Seeds" attempts to shed light on the toxic culture surrounding professional dance by scientifically proving the damaging effect of promoting an unhealthy lifestyle and pointing towards real personal consequences.

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Annex

Research Ethics Approval



TESTNEVELÉSI EGYETEM

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KUTATÁSETIKAI ENGEDÉLY

Téma: „A balett és kortárs táncosok csípőgeometriájának vizsgálata DEXA és DynaKnee mozgáselemző módszerrel”

Témavezető: Dr. Kalabaska Irina, PhD

Kérelem benyújtója: Rózsavölgyi Zsuzsanna

Kutatásetikai vélemény:

A kérelem benyújtói vagy tapasztalt szakemberek, vagy azok felügyelete alatt állnak, a vizsgálati személyek részére készült tájékoztató teljes körű, a vizsgálat kockázatát nem hordoz magában, így a kutatás etikai engedélyezését támogatom.

Engedélyszám: TE-KEB/14/2021

Záradék: A vizsgálatok során a hatósági járványügyi intézkedések mindenkor betartása a kutató felelőssége"

Budapest, 2021. február 24.

Dr. habil. Szelid Zsolt
a KEB elnöke



ISO 9001 minőségirányítási rendszer szerint tanúsítva