UNIVERSITY OF PÉCS

FACULTY OF HEALTH SCIENCES

DOCTORAL SCHOOL OF HEALTH SCIENCES

Head of the Doctoral School: Prof. Dr. József Bódis MD, Ph.D., DSc.

Program leader: Prof. Dr. József Bódis MD, Ph.D., DSc.

Supervisor: Prof. Dr. József Bódis MD, Ph.D., DSc.

EFFECTS OF A SPECIAL PRENATAL DANCE METHOD ON FETAL AND POSTNATAL NEURODEVELOPMENT, MATERNAL PHYSICAL, PSYCHOLOGICAL, COGNITIVE, SOCIAL WELLBEING, AND CHILDBIRTH

Ph.D. Thesis Booklet

Beatrix Bánkyné Perjés

Pécs, 2022

Introduction

"Research is to see what everybody else has seen, and to think what nobody else has thought." /Albert Szent-Györgyi/

Personal background

I started my artistic work as a member of Hungarian professional ballet and contemporary dance companies. I graduated in dance education and have taught dance for all age groups from nursery to the elderly and given theoretical and practical lectures to university students. Since the beginnings, I have always been aware of the complex effects of dance physically, psychologically, cognitively, and socially as well. Consequently, my interest turned to the application of dance in health, I began giving dance classes for pregnant women, individuals with Parkinson's disease, Multiple Sclerosis, and psychiatric disorders and held presentations on the health benefits of dance in prevention, rehabilitation, and therapy internationally. My aim is to scientifically prove that what is a matter of course, an experiential knowledge for us dancers and an excursion full of magic for others, can have an important impact on everyone's health and it bears numerous hidden values, only a fraction of which researchers have begun to study. Since it can be useful for children and adults, why should we not start it as soon as possible, already in the uterus?

Based on all the above, I created a dance method specifically for this research to offer a complex health preventive and development opportunity for two subject groups at the same time, due to the special conditions: pregnant mothers and fetuses.

Dance from a wellbeing-focused perspective

Some studies have already shown the positive effects of physical activity (PA) on pregnancy outcomes and fetal brain development, but the impact of dance is under-researched in this area. Other research has examined the effects of dance on the brain, but not prenatally. In my thesis I aim to combine these scientific areas to approach dance from a completely new aspect with the help of a prenatal dance method I developed.

I propose dance to be investigated separately from PA since in addition to physical, it also bears cognitive, social, emotional, and artistic qualities. Why not try to use this branch of art for preventive purposes? Why not start all this as early as possible so that its positive qualities can improve fetal development from the beginning, and why not receive this support at the most important time in the life of the future mother, for the best of herself and her child?

Dance involves several brain functions at the same time: kinesthetic, logic, musical, and emotional. All kinds of dance have stress-reducing, cardiovascular benefits, and a positive sense of belonging to a group, but not all of them affect the development of cognitive skills in the same way.

Prenatal group dance is unique in the sense that as an artistic and PA, it is exercise, cognitive challenge, psychological recharging, and social interaction at the same time. It also bears a hidden factor, namely its impact on the fetus. Trials on the efficacy of dance on maternal cognitive abilities and fetal neurodevelopment is completely absent from scientific research. I aim to demonstrate that dance deserves more attention as a possible complementary therapy in prenatal care and may provide the basis for postnatal development as it offers all benefits

of the combination of physical exercise, cognitive and musical activity, with special interest on the developing brain.

When their parents are dancing, fetuses can feel the rhythmic and synchronized movements performed to music in various modes, directions, and levels in addition to the impact of physiological changes. Therefore, from a fetal neurological perspective, prenatal dance activity (PDA) may provide additional benefits over general PAs like sports, daily, household, or around-the-house activities, since the movements range on a wider scale, are never fixed, and are not simply performed with background music, but work in unison with the music. These all exert extra external stimuli on the fetus.

To the best of my knowledge, mine is the first controlled trial to examine the safety of dance during pregnancy and its effects on fetal and postnatal cognitive and motor development.

Aims

> "The brain is a world consisting of a number of unexplored continents and great stretches of unknown territory." /Santiago Ramon y Cajal/

The dissertation is structured along the elements of the so-called PrenaTánc (Prenatal Dance). This complex method offers dance classes for pregnant participants and aims to affect their wellbeing holistically, with a special emphasis on the cognitive functions, their fetuses' neurodevelopment, assuming its long-term impact.

The current trial was therefore set up to prove that dance is not valid only for entertainment purposes, but it also bears an essential role in health prevention, in the development of the brain, both in the case of the active participants and fetuses in the uterus. My objective was to prove that dance is not only a PA but an art form as well, therefore, it needs to be examined separately from that. I aimed to assess its compound impact on various subject groups and phases of development.

Specific aims

To prove that regular moderate-intensity prenatal dance intervention causes no adverse gestational, fetal, birth, or neonatal outcomes.

To assess its possible influence on maternal wellbeing.

To prove its impact on the brain.

To compare its effects with no activity and with PA.

To examine its impact on the mode of delivery.

To examine fetal and postnatal neurodevelopment.

To investigate toddler neurodevelopment.

Materials and methods

> "I bring you the dance." /Isadora Duncan/

A systematic literature review preceded the research in April 2017. Then a controlled, non-randomized, quasi-experimental, interventional study was conducted supplemented with follow-up research, using both quantitative and qualitative methods from August 2017 to March 2021 in Pécs, Hungary.

Systematic literature review

First, we conducted a systematic review of the literature on research on PA during pregnancy to examine whether, by choosing the right movement, exercise can contribute to the preparation for childbirth with its physical, psychological, and mental effects, namely, whether its positive impact on labor and delivery can be proven.

This review was performed according to the criteria of systematic analysis and meta-analysis, using keywords <<pregnancy AND physical activity AND normal>>, we selected English language studies published in the last 15 years.

The 1381 related studies were reviewed by two independent researchers, and after applying the exclusion criteria, results of 15 studies were examined in our quantitative synthesis to support the beneficial effect of PA on labor and delivery outcome without any negative consequences for the mother or the fetus.

Selection and description of participants

Clinically uncomplicated primipara and multipara individuals were recruited for the interventional study with age over 18 years, singleton pregnancy, 16th to 30th week of gestation, no mental disorders, no contraindication to PA.

All dancing group (DG) subjects needed to regularly attend a supervised group dance course until the 36th week of pregnancy. They did so with the mean attendance of 19.56±3.97 weeks, at the earliest from the 16th week of gestation. Participants' mean age was 30.38±6.46 years (n=16).

Members of the control group (CG) did not take part in the activities. Their mean age was 31.50±5.42 years (n=10).

Participants of pregnant gymnastics and maternity yoga classes were enrolled into the physical activity group (PAG). Members of the pregnant gymnastics attended a course held by a physiotherapist of the Clinical Center, participants of the maternity yoga classes attended a total of two studios in the city of Pécs, under the guidance of trained maternity yoga instructors. The mean age of these participants was 33,57±1,90 years (n=7).

All infants of the DG were born in due time and had no known abnormalities or developmental delay. Their mean calendar age was 37.88±2.78 days at the time of testing (n=16).

All infants of the CG were born in due time and had no known abnormalities or developmental delay. Their mean calendar age was 39.40±1.51 days at the time of testing (n=10).

Toddlers of the DG participating in the first phase of the follow-up research were 31.29±5.76 months of age (n=14). In the second phase their age was 33.46±1.95 months (n=13).

Assessment scales

Questionnaires

During the first meeting, each member of the DG received a questionnaire package that they completed locally.

The first, self-edited part asks for socio-demographic, lifestyle, and anthropometric data such as maternal height, weight, age, education, type of residence, place of work, economic status,

number of children, expected date of birth, preparation for pregnancy, pre- and during pregnancy medication, smoking, alcohol consumption, healthy eating and the environment. In the self-administered questionnaire on physical condition, subjects reported the frequency of various physical symptoms such as headache, low back, back pain, chest pressure, upset stomach, fatigue, shortness of breath, dizziness, loss of appetite, insomnia, edema, gestational diabetes, and the presence of high blood pressure. Among the psychological questionnaires, the 9-question version of the Beck's Depression Inventory was used, in which the responses that best described the mother's feelings from the week to the day before the survey were to be noted. The Satisfaction with Life Scale (SWLS-H) asked the degree of agreement with the listed statements. Using the Perceived Stress Scale, the frequency of the subject having a particular feeling or thought over the past month was examined. The 16-item version of the Ways of Coping Questionnaire asks to what extent the listed reactions to the events of the past two weeks occurred in the respondent. In the alternative Hungarian version of the Rosenberg Self Esteem Scale (RSES-H), the agreement with the given statements was needed to be indicated.

In the Social Support Questionnaire, which was based on the Brief Stress and Coping Inventory, the statement most relevant to the respondent was asked.

The self-compiled memory test in the cognitive study measured the recall of 15 non-meaningful, three-letter words after one minute of memorization immediately after one minute and then after one hour. This test was performed for DG before the start of the first dance session and then at the end of the dance session.

The same questionnaires were completed at the 36th week of pregnancy by the DG participants apart from the sociodemographic and lifestyle part.

The CG participants completed the sociodemographic, lifestyle, and anthropometric questionnaires with the memory tests at the 36th week of pregnancy.

The PAG participants completed the sociodemographic, lifestyle, and anthropometric questionnaires with the memory tests at the 36th week of pregnancy.

Medical measurements

For the DG each session began with resting heart rate and blood pressure measurements for the participants. Once a week it was followed by ultrasound monitoring of fetal heart rate (FHR), resistance index (RI), and pulsatility index (PI), performed by two obstetrician gynecologists.

During the activity we repeated heart rate and blood pressure measurements for the participants, plus once a week ultrasonographic monitoring of FHR, RI, and PI.

Gestational, birth, and neonatal measures

Information on gestation, childbirth and the neonatal data were collected from medical reports during the postpartum visit at DG and CG participants.

Infant testing

To analyze neurodevelopment of DG and CG infants, the Bayley Scales of Infant and Toddler Development (Bayley-III) was used when the children were 5 weeks old. It is an

individually administered instrument assessing developmental functioning from the age of one month. It evaluates five major areas of development: cognitive, communication (receptive and expressive), motor (fine and gross), social-emotional, and adaptive behavior. The latest one consists of conceptual (communication, self-direction), social (leisure, social skills), practical (health and safety, self-care), and motor composites.

Toddler in-depth interviews and videos

In-depth interviews were conducted with the DG parents when the children were around 2.5 years old to examine their neurodevelopment. In the interviews the questioner asked the parents to describe an ordinary day of their children, focusing on their favorite activities and games, their way of communication, their relationship with music, singing, dancing, and stories. They were also asked to tell the opinions of family health visitors and nursery caregivers about the behavior and communication of their children. Videos about the children were also analyzed while dancing, singing, or telling tales or rhymes.

Toddler testing

To quantitatively analyze neurodevelopment of DG toddlers, the Bayley-III was applied when the children were 33 months old with tasks of cognitive, communication, motor, social-emotional, and adaptive behavior scales relevant in their age.

Ethical approval

The research was approved by the University of Pécs Clinical Centre Regional Committee for the Research Ethics, Hungary (April 21, 2017), No: PTE/6618.

The applied dance method - PrenaTánc

The PDA examined in this study is called PrenaTánc. It was developed for this research by the author of this dissertation who is a trained dance educator. The sessions were held by two dance teachers and supervised by four obstetrician gynecologists. It is a unique dance method that combines various dance styles specifically selected for this population, including a wide range of movements, musical styles, and rhythms, as well as improvisation. Thus, it encompasses the broad spectrum of maternal and feminine energies to enhance self-confidence, strength, gracefulness, and joy at the same time. It was a 60-minute, twice-weekly, moderate-intensity dance activity, requiring a moderate amount of effort and noticeably accelerating the heart rate, without causing rapid breathing, as defined by the WHO. Participants' heart rate was monitored and the talk test was applied (the ability to converse with some slight effort) during the exercises. The active part of the sessions consisted of warm-ups with sitting and standing exercises, stretching, and then learning and performing steps and choreographies of the given dance styles. Participants were encouraged to apply the learned movements on their own and improvise. Cool-down terminated the classes with a low-intensity free dance when participants were asked to imagine themselves as if they were dancing with their babies in their arms.

This method, the so-called PrenaTánc, is a complex pregnant dance that simultaneously has physical, cognitive, psychological, social, and artistic characteristics for the participants. It also bears physical, cognitive, psychological attributes for the fetuses. This method

combines pregnant gymnastics with movement material of purposefully chosen dance styles, elements of free dance and imagination, cognitive exercises, relaxation, continuous positive feedback from the leader of the session, neurolinguistics, it builds social relationships, and encourages self-expression. It utilizes the benefits of PA, the combination of regularly recurring and alternating songs, movement to the rhythm, dancing in the community, memorizing steps, improvisation, positive reinforcements, concentration, attunement to each other. Therefore, it contributes holistically to the participants' fitness, body awareness, stress management strategies, conflict resolution skills, satisfaction with life, self-esteem, sense of social support, development of cognitive abilities (memory, creativity), reduction of depression, and supports fetal development and strengthens the parent-fetal relationship. Imaginative training is very suitable for preparing for childbirth, for imagining the wellbeing of the fetus, strengthening the expectant mother in positive feelings and activities, while neurolinguistic programming promotes internal positive reinforcement.

The sessions support a positive experience of pregnancy, preparation for the birth of the child, confidence, a good physical condition and balanced state of mind, aiming for a smooth course of childbirth and a more spiritual experience.

An important element is that the facilitator works with the participants as dancers and not as patients, paying attention to the group dynamics. Tasks include guided and free exercises, they are interactive, enjoyable, and are simultaneously physical activities and artistic creative activities. The facilitator is in a circle with the participants and carries out the activity among them, not in front of the group.

Through its physical attributes, this method improves the condition of the lungs, heart, blood circulation, muscles, joints, digestion, posture, endurance, balance, fetal blood circulation, oxygen and nutrient supply.

Its cognitive quality is that learning choreographies improves memory, improvisation increases creativity and self-expression. It improves concentration, focus, reaction speed, leaves no place for negative thoughts while dancing. The nervous system of the fetus is exposed to extra stimuli through the synchronization of music and special movements, thus supporting its development.

Its psychological part improves self-esteem, body image, mood, reduces distress, depression. It develops self-discipline, self-confidence, stress management, endurance, it proves that we can control our bodies. It brings you to a changed state of consciousness, can help you achieve a sense of flow and arousal more easily by eliminating unnecessary, negative thoughts. It supports a more complex experience of femininity. It strengthens the parent-fetal relationship, attachment, and communication.

Through its social factors, it contributes to the growth of the feeling of social support, acceptance, understanding, empathy, and the experience of common experiences. Moving and working together helps to overcome fatigue and inhibitions.

As an artistic activity, it provides the positive feeling of creation.

A fetus can develop ideally in the uterus if the mother's physical and mental health is satisfactory. This special pregnant dance program strengthens the feminine energies: it combines the elements of the progenitress (belly dance), femininity (salsa), strength,

determination (flamenco), grace (classical ballet), freedom (funky), strictly adhering to the protocols for PA that can be performed by expectant mothers.

My dance method PrenaTánc - a holistic dance method for pregnant mothers was registered by the National Office of Intellectual Property as an own scientific work.

Data analysis

In the basic research and in the second phase of the follow-up research we applied the IBM SPSS Statistics 25.0 and 27.0 for Mac (SPSS Inc., Chicago, IL, USA). Based on the results of the normality tests (Kolmogorov-Smirnov tests), we conducted a Mann-Whitney U-test, paired t tests, and non-parametric tests (Wilcoxon) to detect statistical differences. In the second phase of the research, we conducted the statistical analysis with Excel 2019 program and applied a two-sample t-test. In the research, quantitative variables are described with mean±standard deviation (SD). Qualitative variables are presented with the number (n) and percentage (%) of participants. Statistical significance was accepted at $p < 0.050$.

In the first phase of the follow-up research, qualitative content analysis of the in-depth interviews was conducted.

Results

<div align="center">"The world of dance is a charmed place." /Dame Margot Fonteyn/</div>

Systematic review of the literature on research on physical activity during pregnancy

In the selected studies of the systematic literature review, only healthy, singular pregnancies were examined, and their subjects were of different ages, gestational ages, and body mass indices, primiparous and multiparous, for whom exercise was not contraindicated. Members of the intervention group performed some form of exercise at least once a week, occasionally for at least 30 minutes, for a minimum of 10 weeks. Members of the control group did not participate in any such sessions. The type of exercise was aerobic and resistance training, walking, aquatic aerobics, and flexibility development. Studies evaluating the ratio of Cesarean sections among members of the intervention and control groups were examined.

The total number of participants was 5,966 (intervention group: 2,988, control group: 2,978). The mean length of exercise was 23.43±7.32 weeks, duration of sessions 47.83±9.77 minutes, frequency of sessions 3.13±1.06 weekly. Due to differences in the length of exercise, as well as duration and frequency of sessions, there were significant differences in the total time spent exercising.

In all cases, the relative risk of Cesarean delivery was lower in the intervention groups compared to the control ones. In the 15 studies, the mean relative risk of Cesarean delivery was significantly lower in the intervention group (20.59±14.92) than in the control group (27.82±16.36) (p=0.039).

Basic research

Descriptive analysis of the safety of PrenaTánc

The two populations of the interventional study's pregnant participants appeared homogeneous regarding sociodemographic, lifestyle, and anthropometric measures. We found no statistically significant differences between them in age, marital status, type of

residence, education, employment status, preparation for pregnancy, number of children already living in the household, monthly family income, or lifestyle factors including smoking or alcohol consumption during pregnancy, living in a physically and emotionally healthy environment, following a vitamin-rich and balanced diet, gestational weight gain, and initial body mass index (BMI). The only statistically significant difference was detected in the 36th week BMI of the groups.

As a primary outcome, we demonstrated the safety of the activity. Our own measurements during the sessions and medical reports on birth and neonatal variables did not show any parental, fetal, or neonatal disorders among the participants in the DG. Our measurements show that FHR, PI and RI increased in a safe interval during the activity. A significant difference was observed between mean FHR values at rest (141.14±6.32) and during activity (146.13±6.14) (p=0.010). The differences between the impedance indices were not significant.

No significant difference was found in gestational, birth, or neonatal measures between the DG and CG, such as preeclampsia, placental insufficiency, length of pregnancy, weakening of fetal heart sound or oxygen deficiency, complications during labor or childbirth, weakening of contractions, prolonged labor, surgical delivery, newborns' birth weight and length, head and chest circumference, Apgar scores, number of days spent in hospital after birth, and their calendar age at testing.

Comparative analysis of pre- and post-activity psychological and social wellbeing in the dancing group

As a secondary outcome, investigating the difference between the DG's (n=16) pre- and post-activity psychological and social wellbeing we found better results after the intervention regarding perceived stress, coping, body awareness, and social support, worse ones in the levels of depression, while the value of self-esteem remained the same. Significant difference (p=0.012) was detected in the case of satisfaction with life: the pre-activity value being 27.06±2.98 while the post-activity one 28.60±2.80. We did not analyze values of one of the participants in depression, satisfaction with life and perceived stress questionnaires since in the weeks for which the questions referred to she was hospitalized and in constant worry due to the presumed developmental delay of her fetus that turned out to be a mistake. During this period of time, she was allowed to attend the classes.

Comparative analysis of pre- and post-activity cognitive wellbeing in the dancing group

We detected increase in the results of memory. I examined it before starting the activity (pre-activity), before the beginning of the very first dance class (pre-class test) and at its end (post-class test), while second time at the 36th week of pregnancy (post-activity) in the same manner. Both pre- and post-class test results were higher in the post-activity questionnaires. Significant increase was found in the case of the memory test right after the dance session, the pre-activity value being 5.19±2.51, post-activity: 6.75±3.17 (p=0.018).

Comparative analysis of pre- and post-activity physical wellbeing in the dancing group
The third outcome of the study revealed the change in physical condition. There was a significant difference between the pre- (10.69±5.39) and post-activity (15.53±6.96) values of the participants that showed a decline in their condition (p=0.044).

Comparative analysis of cognitive wellbeing in the dancing and control groups
As fourth outcome we found a significant difference between the cognitive test results of the DG (n=16) and the CG (n=10) at the 36th week of gestation. Both pre- and post-class memory test values were lower in the case of the CG than in the DG, with a significant difference in the DG results. Their pre-class memory test result was 7.75±2.70 and the post-class one was 6.75±3.17 (p=0.010). In the case of the CG, it meant a one-hour difference between the two tests of theirs during which they filled out the other questionnaires.

Comparative analysis of mode of delivery in the dancing and control groups
The incidence of surgical delivery was lower in the DG (50%) compared to the CG (70%), but we could not detect significant difference in the case of this fifth outcome between the two groups.

Comparative analysis of infant development in the dancing and control groups
As sixth outcome of the research we examined the efficacy of the activity and detected a significant difference between the DG (n=16) and CG (n=10) infants in all subtests. Children in the DG performed better than those in the CG on all scales: cognitive, receptive and expressive communication, fine and gross motor, social-emotional, and adaptive behavior. The developmental ages were 2.5-1.6 times (DG) and 1.1-0.7 times (CG) their calendar ages. The mean calendar age of the infants was 37.88±2.78 days in the DG and 39.40±1.51 in the CG at the time of testing (p=0.182).
For cognitive, communication, and motor skills we determined mean developmental ages in days based on scaled and composite scores (Figure 1).
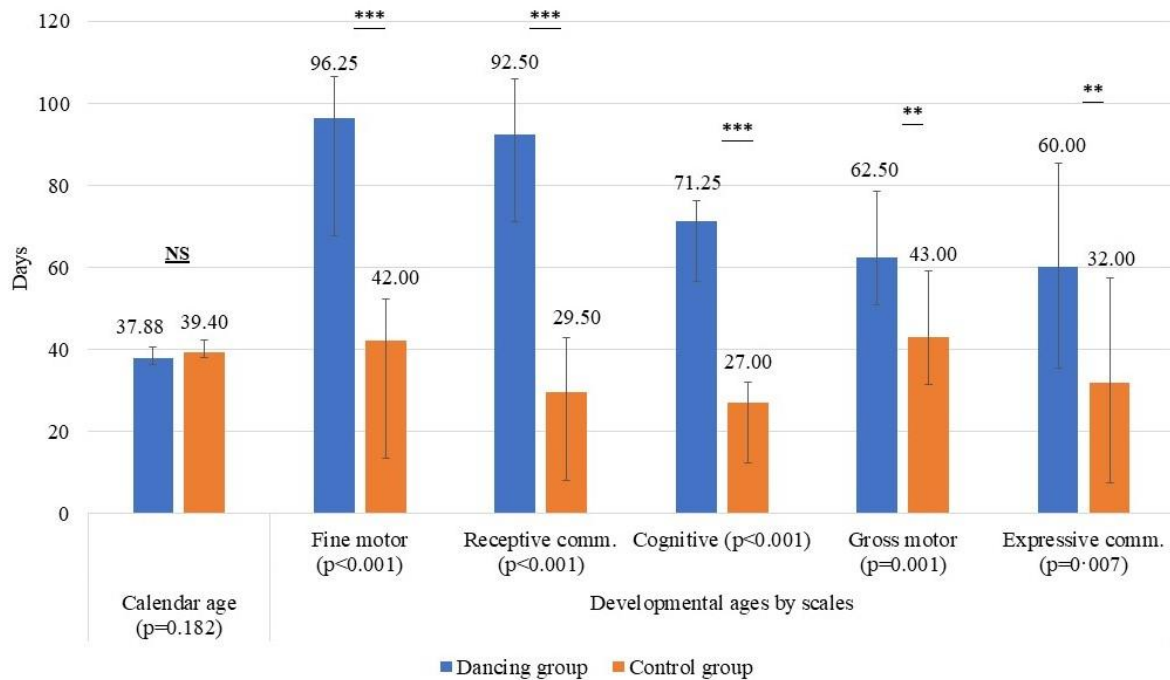
Figure 1. Mean Bayley-III infant test results representing developmental ages by scales compared
with calendar age in the dancing (n=16) and the control (n=10) groups
Notes: NS=not statistically significant, * p<0.05, ** p<0.01, *** p<0.001

We calculated composite scores for social-emotional and adaptive behavior scales (Figure 2). The previous result was significantly higher in the case of the DG infants, whose value can be classified as very superior, compared to the average value of the CG infants. The result of the adaptive behavior test was also significantly higher in the case of the DG compared to the CG, both of which can be classified as average.
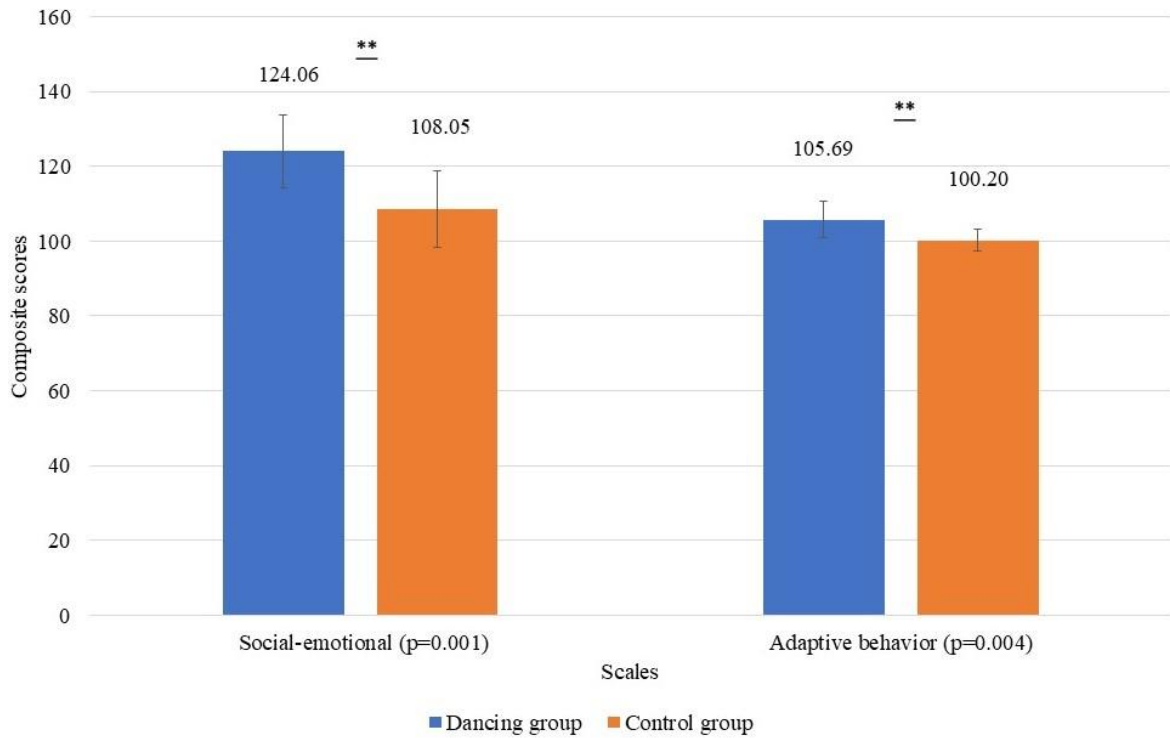
Figure 2. Mean Bayley-III test results representing composite scores in the dancing (n=16) and the control (n=10) groups
Notes: NS=not statistically significant, * p<0.05, ** p<0.01, *** p<0.001

Second phase of the research

In the second phase of the research, we compared two activity groups: the DG (n=16) and the PAG (n=7). In terms of their socio-demographic and lifestyle data, the two samples showed noticeable differences in the number of their children, medication, and significant difference in the monthly income of the family.

Comparative analysis of physical, psychological, and social wellbeing in the dancing and physical activity groups

The results of the wellbeing questionnaires were divided between the two groups. We found no significant differences in physical condition, depression, perceived stress, satisfaction with life, coping, social support, and self-esteem.

Results of the PAG participants were found to be better than the DG group regarding physical conditions, levels of depression, perceived stress, and body awareness.

Results of the DG participants were found to be better than the PAG group regarding satisfaction with life, field of coping, self-esteem, and social support.

Comparative analysis of cognitive wellbeing in the dancing and physical activity groups

There was a significant difference in memory tests. The mean scores in the DG group were higher than in the PAG. In the case of pre-class memory test DG value was 7.75 ± 2.70, while PAG result was 4.57 ± 1.51 (p=0.004). Post-class memory test results were the following: DG 6.75 ± 3.17, PAG 3.86 ± 3.24 (p=0.029).

Follow-up research

Qualitative analysis of toddler development in the dancing group

In the follow-up research first, I conducted parental in-depth interviews with the DG parents and assessed the behavior of 14 toddlers at the age of 31.29±5.76 months. Every parent highlighted the essential role of music, dancing, singing, and storytelling or rhymes in their toddlers' daily routine and that they practiced them at a higher level than their peers. Their vocabulary and sense of rhythm were outstanding. Most of them used eclectic wording and put together puzzles corresponding to a higher age. Parental statements were claimed by family health visitors and nursery caregivers.

The videos I was provided showed the children dancing either freestyle or in a dance class, singing with or without music, telling stories while watching a book, or rhymes by themselves.

Quantitative analysis of toddler development in the dancing group

The Bayley-III was applied in the DG when the children's mean calendar age was 33.46±2.03 months (n=13). Mean developmental ages were significantly higher than their calendar age on all subscales. Children in all areas of development were 9 to 7 months before their age. The following order could be set up from highest to lowest: expressive communication, gross motor, receptive communication, fine motor, and cognitive skills, as shown in Figure 3.
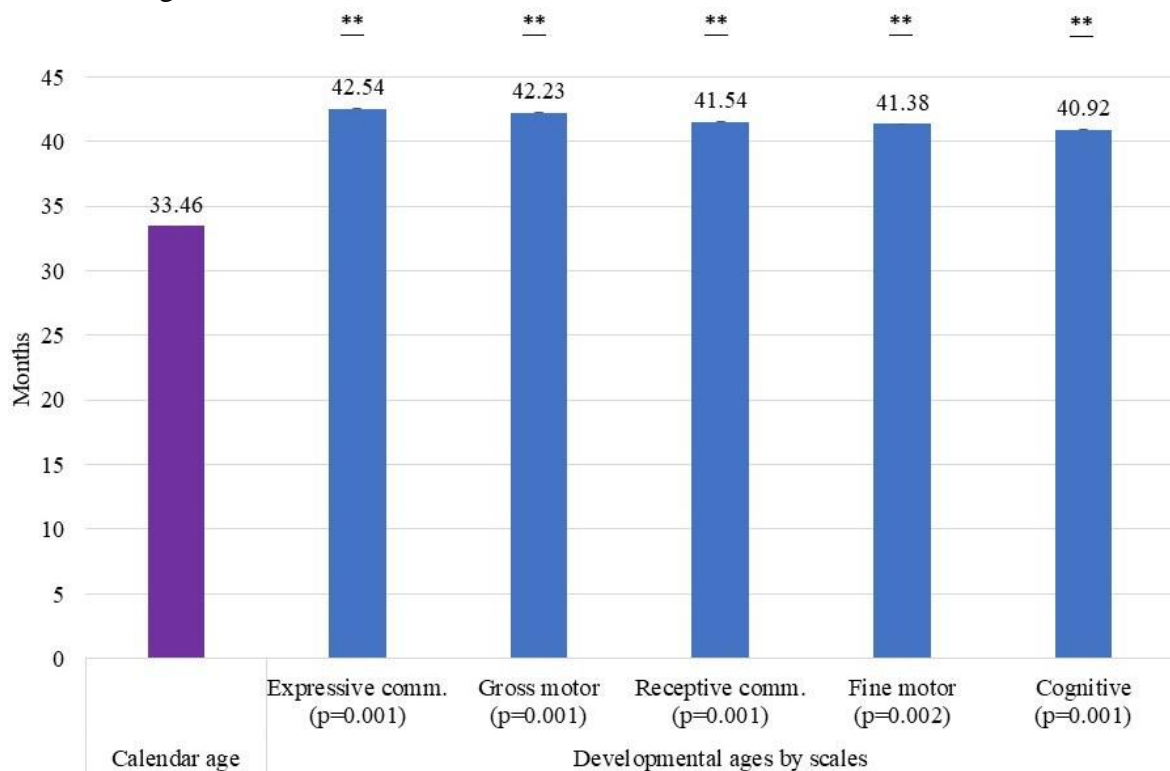
Figure 3. Mean Bayley-III toddler test results representing developmental ages by scales compared with calendar age in the dancing (n=13) group
Notes: NS=not statistically significant, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Conclusions

> "The body says what words cannot." /Martha Graham/

Of my eleven hypotheses our results confirmed eight, two partially, and one could not be confirmed. The fundamental aim was to prove that this activity is safe which was completely met. The main focus of my research was on the impact dance can have on maternal, fetal, neonatal, and toddler brain. Our findings supported all of my assumptions in connection with this field: maternal memory improved during the PDA, dancing participants' memory was better than the CG and the PAG, infant neurodevelopment was better in the DG than the CG, toddler neurodevelopment was better in the DG compared to their peers. I believe that these attributes are valuable enough to convince expectant mothers that apart from engaging in a fun activity, it is also worth it for the sake of their children.

The results obtained shed light on the usefulness of prenatal exercise in pregnancy care. Such and similar studies may also be essential to enable the widest possible range of health professionals to learn about the different forms and to support and promote expert-led activities among their patients, provided that there is no contraindication to exercise. The wider the range they can choose from, the more likely they are to find the one that suits them best, which could increase PA in this population as well. Although pregnant DVDs and online videos are easily accessible nowadays, I would like to stress the importance of competent supervision.

My mission is to inform parents about our achievements and encourage them to choose this activity as they can have a significant impact on the quality of future life of their children already in the uterus.

Clinical implications

> "I see dance being used as communication between body and soul." /Ruth St. Denis/

This method is completely applicable in clinical practice and may contribute to a new approach to dance in pre- and postnatal neurodevelopment and its application as complementary therapy in prenatal care. Interpreting the results and benefits without any harms and considering other relevant evidence can help make prenatal dance a safe and joyful, novel, forward-looking, and innovative initiative.

Summary of novel findings

> "Dance first. Think later. It's the natural order." /Samuel Beckett/

The findings were supported by short and long-term follow-up, quantitative and qualitative measurements as well.

1/ I demonstrated the important role of dance activity during pregnancy,

2/ I demonstrated the importance of separate research on PA and art-physical activity,

3/ I used FHR and impedance indices measurements to detect fetal activity during sessions,

4/ I outlined the relationship between prenatal dance and fetal neurodevelopment,

5/ I developed a complex prenatal dance method,

6/ I registered my dance method as my own scientific work under the registration number 009520 of the National Intellectual Property Office on March 25, 2021, under the title PrenaTánc - a holistic dance method for pregnant individuals,

7/ I demonstrated that prenatal dance had a positive effect on the psychological and social wellbeing of expectant mothers, with an outstanding effect on their cognitive wellbeing,

8/ I demonstrated that prenatal dance had a positive effect on fetal neurodevelopment,

9/ I demonstrated the long-term effect of prenatal dance on children.

My research bears several strengths. First, I examined an area that has not yet been researched. The activity applied is a unique, novel, and innovative initiative. Second, the dance activity was not self-monitored but supervised, ensuring regularity, the same intensity and duration, standardized measures, and identical content for each DG member. Expert supervision was also essential for proper execution of movements, hydration, appropriate clothing, venue, and group dynamics. Pregnant gymnastics and maternal yoga were also supervised. Third, there were no statistically significant differences between the DG and the CG populations in terms of sociodemographic, lifestyle, and anthropometric measures, birth and neonatal data, and a difference was found only in the 36th week BMI values. Fourth, we analyzed medical reports, resting and in-activity ultrasound measurements, and validated tests to detect safety, maternal wellbeing, infant and toddler development. Fifth, almost 3 years after birth, I conducted a follow-up research to investigate the long-term effects of the activity. Sixth, the same person led the testing with all participants to ensure standardization of the experimental protocol. Seventh, I combined quantitative and qualitative measurements to be able to capture individual experiences as well.

Nevertheless, the best way to prove the joy, the artistic and transformative factor together with the beneficial fetal effects for every pregnant mother is to experience dance for themselves. Therefore, I may modify the quotation of José Limón who said that dance, "this great power of expression is ours from the day we are born to the hour of our death." Mine goes like "dancing is here for everyone from the womb to the tomb."

Acknowledgments

List of publications

Articles underlying the thesis

Bánkyné Perjés B, Mátrai G, Nagy B, Erdei D, Makai A, Prémusz V, Kovács KA, Bódis J. *Prenatal dance activity enhances foetal and postnatal cognitive and motor development*. Physiology International 2022 (IF: 1.697)

Prémusz V, Makai A, <u>Bánkyné Perjés B</u>, Máté O, Hock M, Ács P, Koppán M, Bódis J, Várnagy Á, Lampek K. *Multicausal analysis on psychosocial and lifestyle factors among patients undergoing assisted reproductive therapy – with special regard to self-reported and objective measures of pre-treatment habitual physical activity,* BMC PUBLIC HEALTH 2021; 21(Suppl 1):1480. (IF: 4.135/10=0.413)

Bánkyné Perjés B, Mátrai G, Nagy B, Makai A, Prémusz V, Bódis J. *Egy speciális prenatális táncmódszer, mint művészeti-fizikai aktivitás, valamint a várandós torna és kismamajóga hatásának összehasonlítása várandós nők jóllétére vonatkozóan.* Sport- és Egészségtudományi Füzetek 2020; 4(3):3-17.

Csavajda E, <u>Bánkyné Perjés B</u>, Makai A, Járomi M. *Tánc sportterápiás mozgásprogram hatékonyságának vizsgálata Parkinson-kóros betegek járás minőségének fejlesztésére.* Fizioterápia 2019; 28(2):3-8.

Prémusz V, Makai A, Melczer Cs, <u>Bánkyné Perjés B</u>, Ács P, Bódis J, Lampek K, Várnagy Á. *Habituális fizikai aktivitás és életminőség összefüggése várandósság alatt a WHO Global Physical Activity Questionnaire alapján.* Magyar Nőorvosok Lapja 2018; 81(6):343-50.

Bánkyné Perjés B, Prémusz V, Nagy Á, Várnagy Á, Bódis J. *Szülésfelkészítő tréning? A várandósság alatt végzett rendszeres testedzés hatása a szülés kimenetelére – irodalmi áttekintés.* Sport- és Egészségtudományi Füzetek 2017; 1(2):3-17.

Csavajda E, <u>Bánkyné Perjés B</u>, Makai A, Járomi M. *Tánc sportterápia alkalmazási lehetőségei Parkinson-kóros betegek körében.* EGÉSZSÉG-AKADÉMIA 2017; 8(4):197-203.

Articles related to the thesis

L. Nagy Á, Prémusz V, <u>Bánkyné Perjés B</u>, A, Duberg, Hegyi G. *Dance as Moderate Intensity Activity in the Stress Management among Teenage Girls.* Health Education and Public Health 2019; 2(2):181-6.

Prémusz V, Makai A, <u>Bánkyné Perjés B</u>, Kerner Á, Melczer Cs, Lampek K, Várnagy Á, Ács P. *A habituális fizikai aktivitás hatása a reprodukciós potenciálra asszisztált reprodukciós kezelés esetén.* Magyar Sporttudományi Szemle Különszám 2019; 82(5):62.

Prémusz V, Makai A, Nagy Á, <u>Bánkyné Perjés B</u>, Ács P, Lampek K., Várnagy Á. *Szisztematikus irodalmi áttekintés kvalitatív szintézise a fizikai aktivitás méréséről az asszisztált reprodukcióval összefüggésben.* Sport- és Egészségtudományi Füzetek 2019; 3(4):1-13.

Prémusz V, Makai A, Gács B, Nagy Á, <u>Bánkyné Perjés B</u>, Ács P, Lampek K, Várnagy Á. *Preliminary study on pre-treatment physical activity and quality of life in infertility.* Exercise and Quality of Life: Journal of Science in Sports 2019; 11(2):5-17.

Additional articles

Bánkyné Perjés B. *Tánccal a befogadásért – A PTE Táncoló Egyetem projekt bemutatása.* In: Vitéz (szerk.): Befogadó Egyetem - itt és most. Pécs, Magyarország: PTE BTK Neveléstudományi Intézet; 2021:111-21.

Baumann P, Sági A, <u>Bánkyné Perjés B</u>, Ács P, Prémusz V, Marada Gy, Kovács N, Radnai M. *Temporomandibular joint disorder in patients with Parkinson's disease - a pilot study.* Health Problems of Civilization 2020; 14(3):235-41.

Abstracts and oral presentations underlying the thesis

Bánkyné Perjés B. *Long-term effects of prenatal dance intervention on neurodevelopment – a follow-up research.* In: Program book of International Association for Dance Medicine & Science 31st Annual Conference, Denver, USA (virtual) pp.1-1. 2021.10.21-24.

Bánkyné Perjés B, Mátrai G, Nagy B, Erdei D, Makai A, Prémusz V, Kovács KA, Bódis J. *The Significance of Dance During Pregnancy in Pre- and Postnatal Neurodevelopment.* Columbia's Zuckerman Institute and Mount Sinai's Friedman Brain Institute virtual Symposium In: Innovators in Neuroscience: From Molecules to Mind: Abstract Book, New York, USA pp. 29-30. 2021.05.25-26.

Bánkyné Perjés B. *Let's dance – the role of dance in health promotion and well-being.* World Leisure Organization World Leisure Day online event, São Paulo, Brazil. 2021.04.16.

Bánkyné Perjés B, Mátrai G, Nagy B, Erdei D, Makai A, Prémusz V, Koppán M, Bódis J. *The impact of prenatal dance on neurodevelopment in infants and toddlers.* In: Betlehem J, Musch J, Bánfai-Csonka H, Almádi Zs, Rippl K (szerk.): Lifelong Health and Wellbeing: Seminar Programme and Abstract Book - EDUC WP9, Pécs: Pécsi Tudományegyetem, Hungary pp. 13-4. (ISBN: 9789634296409) 2021.03.19.

Bánkyné Perjés B. *Tánc és egészség – Várandósságtól a demenciáig.* EgészségTudomány Közérthetően series of lectures, Pécs: Pécsi Tudományegyetem Egészségtudományi Kar, Hungary. 2020.09.30.

Bánkyné Perjés B. *Várandósan is aktívan - kismamatorna-, jóga- és táncfoglalkozások hatása a résztvevők jóllétére.* Online event, Pécs: Pécsi Tudományegyetem, Hungary: 2020.06.29.

Bánkyné Perjés B. *Egy speciális prenatális táncmódszer, mint művészeti-fizikai aktivitás, valamint a várandós torna és kismamajóga hatásának összehasonlítása várandós nők jóllétére vonatkozóan.* Új Nemzeti Kiválóság Program Intézményi Konferencia, Pécs: Pécsi Tudományegyetem, Hungary. 2020.05.20.

Bánkyné Perjés B, Mátrai G, Nagy B, Erdei D, Prémusz V, Bódis J. *Effects of Dance Intervention During Pregnancy on Fetal and Neonatal Development.* In: Abstract book of International Association for Dance Medicine & Science 29th Annual Conference, Montréal, Canada pp. 62-62. 2019.10.24-27.

Bánkyné Perjés B, Prémusz V, Nagy Á, Várnagy Á, Bódis J. *Childbirth Preparation Training? Effects of Regular Physical Activity During Pregnancy on Delivery – Systematic Review.* In: Ács K, Bódog F, Mechler M, Mészáros O (szerk.): Book of Abstracts: Interdisciplinary Doctoral Conference 2017. Pécs, Hungary p. 187. (ISBN:978-963-429-113-8) 2017.05.19-21.

Abstracts and oral presentations related to the thesis

Birkás Gy, <u>Bánkyné Perjés B</u>. *Mindenki tud táncolni? Táncterápia lehetősége Parkinson kórral élők rehabilitációjában.* Magyar Rehabilitációs Társaság XL. Vándorgyűlése, Szeged, Hungary. 2021.10.07-09.

Bánkyné Perjés B. *Milyen hatással van ránk a tánc idősebb korban?* Duna Televízió, Almárium TV program, Budapest, Hungary. 2021.04.15.

Bánkyné Perjés B, Birkás Gy, Sárvári E. *Könnyű agyunkat táncba vinni? - a tánc szerepéről Parkinson-kór esetén szóban és mozgással.* Agykutatás Hete, Pécs, Hungary. 2021.03.17.

Prémusz V, Makai A, Meszlényi-Lenhart E, Oláh A, Betlehem J, <u>Bánkyné Perjés B</u>, Ács P, Várnagy B, Lampek K. *Physical Activity or Exercise During Pregnancy in Relation with Self-Reported Health and Quality of Life.* In: Salonna F (szerk.): Abstract book for the ISBNPA 2019 Annual Meeting in Prague, Czech Republic: International Society of Behavioral Nutrition and Physical Activity, Prague, Czech Republic pp. 1122-1122.

Prémusz V, Makai A, <u>Bánkyné Perjés B</u>, Kerner Á, Melczer Cs, Lampek K, Várnagy Á, Ács P. *A habituális fizikai aktivitás hatása a reprodukciós potenciálra asszisztált reprodukciós kezelés esetén.* Magyar Sporttudományi Szemle Különszám 2019; 82(5):62.

Prémusz V, Makai A, Bánkyné Perjés B, Pálvölgyi Á, Bodor A. L, Onchonga D. O, Ács P, Lampek K, Várnagy Á. *Fizikai aktivitási ajánlások összefüggése az életminőséggel és egészségi állapottal, keresztmetszeti vizsgálat a női reprodukció vonatkozásában*. In: Németh, Katalin (szerk.): Tavaszi Szél Konferencia 2019: Nemzetközi Multidiszciplináris Konferencia: Absztraktkötet, Budapest, Hungary: Doktoranduszok Országos Szövetsége p. 571.

Bánkyné Perjés B, Prémusz V, Hegyi G, Moller M, Nagy A, Duberg A. *How can dance intervention become a way of stressmanagement between young girls?* 10th EFSMA Congress 2017. Cascais, Portugal: 16-18.11.2017. The European Journal of Sports Medicine 2017; 5(1):85-6.

Bánkyné Perjés B. *Parkinson-kór és életminőség – a tánc szerepe a rehabilitációban.* PTE ETK Egészségtudományi Doktori Iskola és az MTA TAB Egészségtudományi Munkabizottság VII. Tudományos Fóruma, Pécs, Hungary. 2017.11.10.

Bánkyné Perjés B. *A tánc szerepe Parkinson-kórral élő páciensek életében.* In: Bódog F, Csiszár B, Hegyi D, Pónusz R (szerk.): DKK17- Doktoranduszok a Klinikai Kutatásokban absztraktkötet p. 89. (ISBN:978-963-429-160-2) Pécs, Hungary. 2017.10.28.10.

Bánkyné Perjés B, Cselik B. *Health Education and Development in Practice.* Pécs Debate Academy, Summer School and Culture Week. 'University Education and Student Life in the 21st Century', Pécs, Hungary. 2017.07.31.

Bánkyné Perjés B. *A tánc, mint kreatív terápiás lehetőség alkalmazása időskorú páciensek körében, különös tekintettel a demenciában és Parkinson-kórban szenvedőkre.* Magyar Sporttudományi Szemle 70:28-29. XIV. Országos Sporttudományi Kongresszus. Pécs: 2017.06.01-03.

Prémusz V, Makai A, Gács B, Bánkyné Perjés B, Ács P, Lampek K, Várnagy Á. *Measurement of Physical Activity in Association with Assisted Reproduction.* 5th International Scientific Conference on Civilization Diseases and Lifestyle, Janów Podlaski, Poland. 2017.05.19-20.

Bánkyné Perjés B. *Táncterápiás lehetőség Parkinson-kórral élők számára.* Pécsi Parkinson Világnap 2017, Parkinson Betegek Egyesülete, Pécs, Hungary. 2017.04.22.

Bánkyné Perjés B. *Először táncolj! Utána gondolkozz! – A tánc megközelítése az Alzheimer-kór vonatkozásában.* A Pécsi Alzheimer Egyesület Workshopja, Pécs, Hungary. 2016.11.11.

Additional abstracts and oral presentations

Bánkyné Perjés B. *Táncoló Egyetemek – Összegyetemi táncprojekt bemutatása*. Magyar Egyetemi-Főiskolai Sportszövetség II. Sportirodák Országos Találkozója, Pécs, Hungary. 2021.09.23-24.

Bánkyné Perjés B. *Let's Dance for Inclusion – The Complex Program of the PTE Dancing University*. In: Arató F, Németh T, Varga A (szerk.): Inclusive Excellence and Inclusive Universities: How to Increase Academic Excellence Through Diversity and Inclusion for Enhancing Social Inclusion in Higher Education Pécs: Pécsi Tudományegyetem, Hungary p. 38. (ISBN: 9789634297130) 2021.06.10-11.

Bánkyné Perjés B, Prókai J. *PTE Dance Parade: Leisuretime activity video for the World Leisure Organization.* 2021

Bánkyné Perjés B. *Táncközelben - Tánctörténetről középiskolásoknak.* Pécsi Balett series of events, Pécs, Hungary. 2019.10.07.

Bánkyné Perjés B. *A Successful Recreational Program of the University of Pécs.* PTE Természettudományi Kar, Pécs, Hungary. 2014.10.25.

Bánkyné Perjés B. *Why Dance?* PTE Általános Orvostudományi Kar, Pécs, Hungary. 2013.09.01.

Bánkyné Perjés B. *„Tömegtánc", avagy szabadidős táncoktatás az oktatási intézményekben.* In: Bencéné dr. Fekete A (ed.): I. Kárpát-medencei Nemzetközi Módszertani Konferencia Absztraktfüzet p.67 (ISBN 978-963-9541-12-2) I. Kárpát-medencei Nemzetközi Módszertani Konferencia, Kaposvári Egyetem, Kaposvár Hungary. 2010.10.08.

Awards related to the thesis

Third Prize, Compostela Group of Universities IV Research Pitches Contest. 2020

Marjorie Moore Student Poster Award, International Association for Dance Medicine & Science 29th Annual Conference, Montréal, Canada. 2019

New National Excellence Program Scholarship, Hungary. 2019

Own scientific works

PrenaTánc - a holistic dance method for pregnant individuals - National Intellectual Property Office, registration number: 009520 (25.03.2021)

Creative Parkinson dance – a complex dance method for individuals living with Parkinson's disease - National Intellectual Property Office, registration number: 009522 (26.03.2021)