Mathematical modeling of the "mother-newborn" system in acupuncture

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Mathematical modeling of the "mother-newborn" system by using acupuncture

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SUMMARY

The aim of this study was to study the structure of the factor load of a newborn with cerebral ischemia in the living system "mother-child" during acupuncture. A statistical model of the dyad involving a woman suffering from postpartum depression was calculated. The factorial models of the dyad at the end of the late neonatal period are presented, depending on the treatment option. The models show 5 indicators that determine the factor weight by 71.1–72.6%. Significant factors are the activity of the autonomic nervous system and cerebral blood flow of the newborn, maternal factors of intrapersonal conflict, psychoemotional state and electrocutaneous conduction. Postpartum factors form 28.4–50.1% of the total cumulative weight with a strong correlation in the dyad. Taking into account the identified patterns and correcting the psychoemotional state of a mother with postpartum depression leads to an improvement in the infant's outcomes. The mathematical model made it possible to develop a methodology for preventing the negative consequences of postpartum depression in the “mother-child” system.

Key words: factor analysis, newborn, mother-child system, postpartum woman,acupuncture.

RESUME

The objective of this study was to examine the structure of the factor loadings of newborns with cerebral ischemia in a living system "mother-child" by using acupuncture. The statistical model of the dyad with women suffering from postpartum depression was calculated. Factor models of the dyad at the end of the late neonatal period depending on the treatment option are given. In the models five indicators that lead to weight factor for 71.1–72.6% were presented. The valuable factors are the autonomic nervous system activity and cerebral blood flow in the newborn, maternal factors of interpersonal conflict, emotional state and electrocutaneous conductivity. Puerperal factors constitute 28.4–50.1% of the cumulative weight with a strong correlation in the dyad. The account of the revealed laws and correction of mental and emotional state of the mother with postpartum depression leads to improved outcomes of the baby.

Keywords: factor analysis, newborn, "mother-child" system, puerpera, acupuncture.

INTRODUCTION

Hypoxic ischemic encephalopathy is associated with high mortality and morbidity in newborns. The effectiveness of standard treatment methods is limited [14], therefore, the Cochrane systematic review substantiated the need to study such an alternative method of treatment as acupuncture [18]. Acupuncture of a newborn at the second stage of nursing has a positive effect on the physical, nervous and mental state, cerebral hemodynamics, autonomic homeostasis, and a decrease in the incidence of infants in the first year of life [3]. Coexistence of a mother and a child determines the physiological and behavioral advantages of a mother-child couple. However, up to 80% of women in childbirth are in postnatal depression of varying severity. The influence of the psychoemotional state of the mother on the dynamics of the functional state of the newborn during adaptation to hypoxic ischemic injury was confirmed. The severity of the detected changes in children is consistent with the degree of deviations in the psychological state of the mother, corresponding to the severity of the lesion. The revealed relationship between the state of the newborn and the degree of violations of the psychological status of the mother serves as an objective test of the severity of the child's condition, opens up an opportunity to assess the compensatory abilities of the newborn and the effectiveness of rehabilitation [12].

The questions remain, what factor load is borne by a newborn with a mother suffering from postpartum depression, what is the structure of factors that determine the nature of changes in the parameters of the functional systems of a newborn with cerebral ischemia in the self-regulating union "mother-child" under the influence of reflexotherapy. Is it possible to influence the factors and prevent the loss of the benefits of living together, creating a healthier parent-child relationship in the dyad. Does the factor loading change, and if it does, how. What options of reflexological influence for a couple are most effective in changing the factorial weight of the mother. A holistic assessment of the structure of interconnections of a living system is possible by using multidimensional statistical methods,

The aim of the study was factorial modeling of a “mother-child” pair - a postpartum woman with postpartum depression and a newborn with cerebral ischemia and the structuring of factor loads during reflexotherapy.

MATERIAL AND METHODS

We examined 137 pairs of newborns with perinatal pathology of the nervous system and mothers in the late neonatal period. Taking into account the variant of influence, the group is divided into 3 subgroups. Against the background of standard treatment in the first subgroup, acupuncture was performed both for the mother (mean age 25.3 ± 0.6 years) and for the child - 52 couples; in the second subgroup, acupuncture was performed only in 36 puerperas (mean age 26.0 ± 0.7 years); and in subgroup 3 (average age of mothers 26.4 ± 0.6 years), a course of reflexology was carried out only for children - 49 newborns.

The initial age of children of the first subgroup was 11.1 ± 0.9 days, boys - 28, girls - 24, body weight 3358–3543 g; the second - 8.5 ± 0.3 days, boys - 19, girls - 17, body weight 33813432 g; the third - 12.8 ± 2.3 days, boys - 22, girls - 27, body weight 3474-3778 g. By the end of the course therapy, the age of children of the first subgroup is 31.1 ± 1.4 days, body weight is 3960 ± 71, 6 g; the second - 27.2 ± 0.7 days, body weight 3922 ± 70.4 g; third - 31.3 ± 2.5 days, body weight 4068 ± 115.4 g. Subgroups are identical in the main characteristics of newborns: feeding, age, sex, gestational age, weight, body length, head and breast circumference at birth, clinical syndromes , the severity of the lesion, concomitant diseases and protocol therapy, as well as mothers - the course of pregnancy, age, number of births, complications.

The assessment of physical development, clinical, neurological examination with the assessment of unconditioned reflexes, rheoencephalography, cardiointervalography, immunological reactivity of newborns was carried out; psychological testing of puerperas to determine the level of neurotization and psychopathization, indicators of the Spielberger-Khanin scales, mini-cartoon, Pishaud's depression, Luscher's color choice; electrocutaneous conduction in pairs by Ryodoraku method according to Y. Nakatani points of representation of both sides. Reflexotherapy effect according to F. Mann's inhibitory prescription and stimulation of the group Lo-point. The duration of the procedure is up to 60 minutes after the morning feeding, exclusively during the child's sleep. Disposable needles "SuJok Acupuncturae Needles Sterilized by Gama-ray" from Subal were used. Acupuncture course 5 sessions.

Statistical processing was performed by parametric methods with the calculation of the mean, standard error of the mean. The significance of differences for absolute and relative values was assessed by Student's t-test and Pearson χ^2 test. To reduce the dimension, and to identify in the entire set of signs that affect the change in dependent variables, we used factor analysis of the principal components with quadrimax rotation at a significance level of $p < 0.01$. The prognostic role of maternal parameters of psychoemotional state was assessed by multiple regression analysis. The data were analyzed using the StatSoft Statistica 5.0 software package.

RESULTS AND DISCUSSION

Previously, we presented the dynamics of indicators of the postpartum psychoemotional state of the postpartum woman [11] and the clinical manifestations of the newborn [8] during the course of standard therapy. The initial and final factor loadings are characterized by a significant proportion of maternal participation, amounting to 43.5–56.6% of the cumulative weight against the background of altered personal and psychoemotional state of the postpartum woman suffering from postpartum depression.

At the end of reflexotherapy treatment, the factor analysis program transformed 74 studied parameters into 5 factors that determine 71.1–72.6% of the variance of a single “mother-child” system with a structure that differs in subgroups. The leading factor of the first subgroup, with its own

value of 6.3, and the highest loads on variables, is associated with indicators of humoral regulation of the autonomic nervous system of the newborn - a fashion that explains 26.4% of the total variance. The second factor - with indicators reflecting the state of cerebral hemodynamics of the newborn. The third factor load is represented by indicators of a woman's psychoemotional state - neurotic manifestations, personal anxiety, depression. The fourth (eigenvalue 2.2) - the state of the central conflict of the intrapersonal plan of the postpartum woman - with maternal anxiety, which contributes to the development of compensation and the state of her electrocutaneous conduction. The fifth is an indicator of the neonatal cervical hemodynamics (eigenvalue 1.6). Factor load and its contribution to the total variance are reflected in table. 1.

Table 1

Factorial model of the first subgroup of the mother-child dyad at the end of the late neonatal period, p <0.01

Фактор и его признак	Собственное значение	Факторная нагрузка	Вклад в общую дисперсию, %	Кумулят., %
1. Гуморальная регуляция автономной нервной системы новорожденного:	6,3		26,4	26,4
мода		0,83		
2. Церебральный кровоток новорожденного:	4,3		18,0	44,4
внутренняя сонная артерия слева		-0,91		
внутренняя сонная артерия справа		-0,81		
3. Психоэмоциональное состояние матери:	2,6		10,9	55,3
стрессовоустойчивость (невроз)		-0,92		
личностная тревожность		0,77		
депрессия		0,76		
4. Внутриличностный конфликт и состояние системы акупунктурных каналов матери:	2,2		9,3	64,6
тревога		0,86		
электрокожная проводимость		0,76		
5. Цервикальный кровоток новорожденного:	1,6		6,1	71,1
позвоночная артерия справа		0,90		
позвоночная артерия слева		0,81		

The signs are presented according to the decrease in the factor load, which is the correlation coefficient of the variable with the factor. The largest positive (or the smallest negative) value of the factor indicates the predominant manifestation of the variable included in the factor. In particular, the mode strongly correlates with the first factor (0.83), the blood flow of the left internal carotid artery with the second factor (-0.91), stress resistance (-0.92) with the third. The maternal part is 28.4% of the total cumulative factorial weight of the loads, taken as 100%. The introduction of other variables did not change the structure of the factor model. In the second subgroup, 5 factors determine 72.6% of the variance in the indicators of the mother-child dyad. Factors and their signs are presented in table. 2.

table 2

The factorial model of the second subgroup of the mother-child dyad at the end of the late neonatal period, p <0.01

Фактор и его признак	Собственное значение	Факторная нагрузка	Вклад в общую дисперсию, %	Кумулят., %
1. Активность и центральная регуляция автономной нервной системы ребенка:	6,7		28,0	28,0
вариационный размах		0,83		
показатель ритма		-0,91		
амплитуда моды		-0,92		
активность процессов регуляции		-0,92		
индекс вегетативной реактивности		-0,94		
индекс напряжения		-0,96		
2. Мозговой кровоток новорожденного:	3,6		15,1	43,1
внутренняя сонная артерия справа		0,86		
позвоночная артерия слева		0,84		
позвоночная артерия справа		0,81		
внутренняя сонная артерия слева		0,76		
3. Внутриличностный конфликт матери:	2,9		12,0	55,0
компенсация		0,96		
вегетативный баланс		-0,93		
4. Психоэмоциональное состояние матери:	2,8		11,6	66,6
стрессовоустойчивость (невроз)		0,89		
личностная тревожность		-0,72		
депрессия		-0,86		
5. Характерологические черты матери:	1,4		6,0	72,6
акцентуация характера (психопатия)		0,87		

These are the activity and nervous regulation of the autonomic nervous system of the newborn (eigenvalue 6.7), cerebral blood flow of the newborn, intrapersonal conflict, psychoemotional state of the mother (eigenvalue 2.8) and characterological characteristics of the mother. The share of maternal participation is 40.7% of the cumulative weight. In the third subgroup, 71.9% of the variance of indicators of the mother-child dyad is represented by five factors. The factor load of the third subgroup is due, firstly, to the activity and nervous regulation of the child's autonomic nervous system, secondly, the psychoemotional state of the mother, thirdly, the cerebral blood flow of the newborn, fourthly, the intrapersonal conflict of the mother and, fifthly, the mother's anxiety represented by an independent factor (eigenvalue 1.5). The weight of the maternal contribution is 50.1% (tab.

Table 3

The factorial model of the third subgroup of the mother-child dyad at the end of the late neonatal period, $p < 0.01$

Фактор и его признак	Собственное значение	Факторная нагрузка	Вклад в общую дисперсию, %	Кумулят., %
1. Активность и центральная регуляция автономной нервной системы ребенка:	6,7		28,0	28,0
вариационный размах		0,83		
показатель ритма		-0,91		
амплитуда моды		-0,92		
активность процессов регуляции		-0,92		
индекс вегетативной реактивности		-0,94		
индекс напряжения		-0,96		
2. Мозговой кровоток новорожденного:	3,6		15,1	43,1
внутренняя сонная артерия справа		0,86		
позвоночная артерия слева		0,84		
позвоночная артерия справа		0,81		
внутренняя сонная артерия слева		0,76		
3. Внутриличностный конфликт матери:	2,9		12,0	55,0
компенсация		0,96		
вегетативный баланс		-0,93		
4. Психоэмоциональное состояние матери:	2,8		11,6	66,6
стрессовоустойчивость (невроз)		0,89		
личностная тревожность		-0,72		
депрессия		-0,86		
5. Характерологические черты матери:	1,4		6,0	72,6
акцентуация характера (психопатия)		0,87		

The values of the beta coefficients allowed us to compare the relative contribution of each independent maternal variable to the prediction of the dependent variable of the newborn with a significance level of $p < 0.05$. In newborns of the first subgroup, the standardized beta regression coefficient, reflecting the measure of the influence of the mother's personal anxiety on the blood flow of the left carotid artery, has a significant value - 0.557, depression in the right carotid artery - -0.65. In the second subgroup, the corresponding indices of vasodilation of the internal carotid arteries are determined by the parameters of maternal compensation and are equal to 1.04 and 1.35, respectively. In the third subgroup, the standardized regression coefficients of cerebral blood flow are determined by maternal compensation with the value
- - 1.8. A decrease in maternal psychoemotional severity leads to an increase in cerebral blood flow in the newborn. Psychoemotional parameters of the postpartum woman, as independent variables, make a great contribution to the prediction of predictors associated with autonomic homeostasis of the newborn. The increased level of stress resistance of the mother is reflected by a decrease in the nervous regulation of the autonomic system of the newborn by the value of the standardized regression coefficient - -0.75, and the prevalence of the activity of the parasympathetic division - by the value of 0.703. A decrease in the activity of the sympathetic division is predicted by the beta regression coefficient of the autonomic balance of the mother - -1.4 (in the first subgroup) and character accentuation - -0.45 (in the second). The analysis made it possible to identify changes in the stability of the mother-child system in child-mother relations as a result of taking measures to optimize them using rehabilitation therapy methods. The assessment of the reflexotherapy formation of the functional systems of newborns with cerebral ischemia revealed that the main factors are presented as indicators of the autonomic nervous system, cerebral blood flow of the child, and the psychoemotional state of the mother. The most significant factor load falls on the indicators of the functioning of the autonomic nervous system of the newborn, which is realized by the transition to the vagotonic variant of reactivity, an increase in the threshold of pain sensitivity, improved sleep, and the absence of anxiety [2]. Optimization of the formation of autonomic regulation of the newborn, with the location of the mode and stress index in the first factor,

Autonomic dysfunctions and cerebral hypoperfusion are significant elements of the thanatogenesis of cerebral ischemia of the newborn [6]. Normalization of cervical blood flow, due to parasympathicotonic vegetative orientation, forms the restoration of reflexes of spinal automatism with an increase in the conductivity of the segmental level [7], disappearance of cerebral symptoms, optimal oxygen tension in the pool, stimulation of the formation of cerebral structures, restored blood circulation of the internal carotid artery.

In the living "mother-child" system, maternal parameters form the third and fourth factors. The process of "scree" of indicators begins with them. The restoration of the prefrontal dorsomedial activity of the cortex, the hypothalamic-pituitary-adrenocortical axis, cytokines and neurotrophins in postnatal women with postnatal depression results in a normalized hormonal composition of plasma and, as a consequence, human milk [5]. A decrease in the degree of manifestation of a woman's internal personal conflict with the presence of compensation, autonomic homeostasis of a cholinergic orientation, high stress resistance, the absence of postpartum depression, leveled reactive and personal anxiety seem to be factors that determine the harmonization of physical development, restoration of the unconditioned reflex sphere of oral and spinal automatism [9], the formation of immunological reactivity [15], a high health index and a decrease in morbidity in infancy. Correction of cervical hemodynamics, carried out in the course of joint reflexology, ranked this factor in the fifth position. More significant is the mother's electrocutaneous conduction, represented by the fourth factor, which, in the presence of discriminant ability and close correlation with the parameters of the newborn, causes positive changes in the electrical action potential, neuromuscular conduction of the child and the advantages of personalized rehabilitation [10]. Referred to the fourth (in the first subgroup) and to the seventh (in the second and third subgroups) in terms of significance, electrocutaneous conduction reflects the importance of electrogenetic processes with persisting maternal autonomic dysfunction. The character traits inherent in the accentuation of the postpartum woman in the relationship with the child, giving rise to coldness of interpersonal relationships, emotional poverty of communication in the dyad, delay in the formation of the "revival" complex, delay in neuropsychic development, have lost their relevance and are attributed to the fifth factor in the second subgroup. The mother's anxiety, which was an emotional source of stress and aggravated a woman's personal conflict [13], does not have a factor load after a course of reflexology.

In the course of the reflexotherapy, the dynamics of the factor load and the weight of each subgroup was noted. The model of the third subgroup is different from the first and second. The dominance of maternal participation in the formation of the functional systems of the newborn in the third subgroup remains. The second factor is still maternal. These are depression and neurosis, reflecting the significance of deviations in the emotional sphere, for which the subcortical structures are responsible. The weight of the second factor determines the need for additional interpersonal therapy of the postpartum woman [4]. Comparison of the presented results of factor analysis showed that the method of joint influence turned out to be the most effective, reducing the maternal factor load by 71.6%, the second - reflexotherapy of the mother (by 59.3%), and the third - reflexology of the child (by 49.9%).

The data of this study completely coincide with the recently published results of the effect of acupuncture on the level of depression in women [16], the efficacy and safety of use in newborns [17].

CONCLUSIONS

The assumptions were confirmed that maternal postpartum depression is associated with the state of the newborn and is a factor that forms the state of the functional systems of the child. With a decrease in the psychoemotional manifestations of the postpartum woman, under the influence of reflexotherapy [1], the state of the functional systems of the newborn improves. The necessity of maternal participation in the correction of the condition of the newborn is mathematically substantiated. A decrease in the weight of maternal factor loads on a newborn with cerebral ischemia and their inversion in the course of restorative treatment were revealed. The maternal weight of the factors reaches half of the factor loadings of the newborn, remaining during the neonatal period.

Thus, the statistical model made it possible to identify and take into account the impact of specific psychoemotional and personal maternal factors on a newborn with cerebral ischemia and to develop a method of reflexotherapy rehabilitation of the “mother-child” dyad. The obtained indicators are informative and significant in assessing the level of maternal dependence of a newborn in the “mother-child” system, and can serve as a basis for organizing therapeutic and preventive work with women in childbirth.

LITERATURE

1. Golenkov A.V., Filonenko A.V. Organization of care for women with postpartum depression (by results of a survey of medical students) // Russian medical journal. - 2012. - No. 5. - P.8-11.

2. Filonenko A.V. Autonomic dysfunctions of newborns with perinatal involvement nervous system in the early recovery period and reflexology // Bulletin of recovery medicine. - 2009. - No. 3. - pp. 81–84.

3. Filonenko A.V. Acupuncture in the rehabilitation of newborns // Traditional medicine. - 2010. - No. 2 - P.14–20.

4. Filonenko A.V. Non-drug methods in the treatment of postpartum depression // Traditional medicine. - 2012. - No. 31. - pp. 30–37.

5. Filonenko A.V. Consequences of the influence of postpartum depression in postpartum women on psychosomatic indicators of infant health // Russian Bulletin of Perinatology and Pediatrics. - 2012. - No. 4. - P.37–43.

6. Filonenko A.V. Reflexodiagnostic characteristics of electrogenesis indicators newborns with perinatal lesions of the nervous system // Bulletin of restorative medicine. - 2012. - No. 2. - P.53–56.

7. Filonenko A.V. Reflexology and unconditioned reflexes of newborns with perinatal damage to the nervous system in the early recovery period // Reflexotherapy. - 2005. - No. 3. - P.55–58.

8. Filonenko A.V. Reflexology: the psychoemotional sphere of the mother and its relationship with severity of morpho-functional abnormalities in a newborn with perinatal damage to the nervous system in the late neonatal period // Reflexotherapy. - 2007. - No. 4. - pp. 40–44.

9. Filonenko A.V. Physical development of newborns with perinatal nerve damage systems in the early recovery period and reflexotherapy // Kazan Medical Journal. - 2009. - No. 6. - pp. 812–817.

10. Filonenko A.V., Gartfelder D.V. Discriminant functions of electrocutaneous conduction couples "mother-newborn" in acupuncture // Traditional medicine. - 2013. - No. 2. - P.20-24.

11. Filonenko A.V., Golenkov A.V. Impact of postpartum depression on the family // Psychic health. - 2011. - No. 6. - P.71–76.

12. Filonenko A.V., Golenkov A.V. Early somatic effects of postpartum depression parturient women in a newborn with breastfeeding // Questions of children's dietology. - 2012. - No. 3. - pp. 31–38.

13. Filonenko A.V., Golenkov A.V. Color preferences of women with postpartum depression // Traditional medicine. - 2011. - No. 4. - P.35–43.

14. Filonenko A.V., Kirillov A.G. Homeopathy in Clinical Pediatrics // Traditional Medicine. - 2012. - No. 3 - P.16-24.

15. Filonenko A.V., Sergeeva A.I., Guryanova E.A. Reflexotherapy in the regulation of immunological reactivity of newborns with perinatal damage to the nervous system // Traditional medicine. - 2011. - No. 1. - pp.21-28.

16. Macpherson H., Richmond S., Bland M. et al. Acupuncture and Counseling for Depression in Primary Care: A Randomized Controlled Trial // PLoS Med. - 2013. - Vol.10, No. 9. - e.1001518.

17. Raith W., Urlesberger B., Schmölzer GM Efficacy and safety of acupuncture in preterm and term infants // Evid. Based Complement. Alternat. Med. - 2013. - No. 2013. - 739414.

18. Wong V., Cheuk DK, Chu V. Acupuncture for hypoxic ischemic encephalopathy in neonates // Cochrane Database Syst. Rev. - 2013. - No. 1. - CD.007968.

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