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Research Article

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Evaluation of Factors Affecting the Reduction in Postpartum Pelvic Floor Muscle Tension and The Therapeutic Effect

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Abstract

Purpose: *This study investigated the risk factors associated with reductions in postpartum pel-vic floor muscle tension and evaluated improvements in pelvic floor muscle tension with electrical stimulation combined with biofeedback technology and Kegel exercis-es.*

Methods: *We conducted a case-control study of 170 women with postpartum follow-up at Ningbo Li Huili Hospital from April 2019 to May 2020. According to the Oxford modified scale assessment(MOS), 94 and 76 women were included in the abnormal pelvic floor muscle tension group and control group, respectively. The two groups were trained by pelvic floor training. The changes in pelvic floor muscle tension before and after treatment in the two groups were analyzed to evaluate the effect of postpartum pelvic floor rehabilitation training.*

Results: *The EMG value of the fast muscle contraction stage was negatively correlated with age and neonatal weight ($P < 0.05$). The EMG values of slow muscle contraction and endurance were negatively correlated with weight gain during pregnancy but posi-tively correlated with age and BMI at delivery ($P < 0.05$). The muscle tension of the abnormal muscle tension group was significantly improved and significantly higher than that of the control group ($P < 0.05$) after the two groups received the intervention.*

Conclusion: *The factors affecting postpartum pelvic floor muscle tension include age, delivery times, BMI at delivery and neonatal weight. Electrical stimulation combined with the biofeedback technique and Kegel exercises in the early postpar-tum period are effec-tive means to reduce the incidence of Pelvic floor disorders.*

Keywords: Pelvic floor disorders, pelvic floor surface electromyography, electrical stimulation combined with biofeedback

Background

Pelvic floor dysfunction (PFD) refers to a group of diseases that seriously affect the quality of life for women, its clinical manifestations include defects and injuries to supportive tissues of the pelvic floor, resulting in conditions such as stress urinary in-continence and pelvic organ prolapse [1, 2]. The pathophysiological characteristics of PFD are relaxation and dysfunction of the main supportive pelvic floor muscle [3]. Enlargement of the fetus and uterus during pregnancy causes compression, pulls on the pelvic floor tissue and decreases the supportive function of the pelvic floor liga-ment muscle group [4]. Changes in hormone levels affect the metabolism of collagen in muscle groups and lead to relaxation of pelvic floor connective tissue and the birth canal. During vaginal delivery, the fetal head causes excessive compression of the pelvic floor, and the high tensile expansion directly and mechanically damages peri-neum muscles, nerves and blood vessels. The levator ANI plate ruptures from the tendon, reducing the elasticity and contractility of the pelvic floor muscles [5]. Muscle denervation and connective tissue separation and pelvic floor structural remodeling exacerbate the normal anatomical position and functional changes of pelvic organs, eventually leading to PFD [6][7]. Therefore, pregnancy and delivery are considered to be independent risk factors for PFD [8].

A string of studies has found that the level of pelvic floor muscle tension was gener-ally reduced after delivery, some women could recover to the prepregnancy state within 6–8 weeks postpartum, but pelvic floor muscle injuries are not fully repaired in most women [9]. For this reason, early implementation of pelvic floor rehabilitation exercises is emphasized both at home and abroad. The Glazer program can accurately and objectively evaluate pelvic floor muscle fibers [10]. Electrical stimulation com-bined with biofeedback technology directly stimulates the injured pelvic floor muscles, affects the neural pathways, and repairs the injured pelvic floor nerves and muscles by means of different frequencies, with the pulse widths and intensities determined ac-cording to the needs of different patients [11]. Pelvic floor muscle exercises mainly include Kegel exercises [12]. Feedback obtained by pelvic floor surface electromyog-raphy and vaginal systolic blood pressure measurements, which show the EMG or pressure curve, allow patients to clearly and intuitively understand the functional state of their pelvic floor muscles and participate in treatment [13, 14]. Electrical stimula-tion combined with biofeedback technology and Kegel exercises can restore the blood circulation and nerve function of pelvic floor muscle groups through active and pas-sive exercise of the pelvic floor muscle, thus enhancing pelvic floor muscle contraction to effectively prevent and treat PFD. The purpose of this study was to explore the factors affecting the reduction in pelvic floor muscle tension and to evaluate the im-provement in pelvic floor muscle function by means of pelvic floor rehabilitation techniques.

Methods

This case-control study was conducted between April 2019 and May 2020 at Ningbo Li Huili Hospital. A total of 170 parturients with clean lochia who were 6–8 weeks postpartum were selected from the postpartum follow-up clinic. According to the MOS assessment, they were divided into the abnormal muscle tension group (94 cases) and the control group (76 cases). After informed consent was obtained from the partu-rients, the two groups were treated with electrical stimulation therapy and biofeedback therapy using a pelvic floor electromyography biofeedback meter (SA9804 and SA9800) host machine from TT Company of Canada and a pelvic floor electromyography biofeedback meter workbench from Nanjing Best Medical Co., Ltd. An appropriate amount of vaginal lubricant was applied to the vaginal electrode probe and placed in the vagina of the subject 2–3 times per week, 30 min each time, 15 times as a course of treatment. The therapeutic effect of treatment in the two groups was evaluated after 1 course of treatment.

The inclusion criteria were as follows: informed consent, voluntary participation, and voluntary acceptance of pelvic floor function testing. The exclusion criteria were the presence of a urinary system abnormality, organic disease or other basic disease. Patients complicated by neuromuscular disease, cough, diabetes, constipation, history of urogenital surgery, history of pelvic organ prolapse and history of urinary incontinence were also excluded.

The MOS evaluation criteria were as follows: the middle finger and index finger were placed in the patient's vagina, and the contraction of the puborectalis and vaginal muscle was palpated (the score ranged from 0–5, where ≤ 3 indicated abnormal pelvic floor muscle tension and 4–5 indicated normal tension) [15]. Grading was performed as follows: Grade 0, no muscle contraction; Grade 1, muscle flutter; Grade 2, weak vaginal contraction, lasting for 2 s in two measurements; Grade 3, vaginal contraction, lasting for 3 s in 3 measurements; Grade 4: good vaginal contraction, lasting for 4 s in 4 measurements, with slight resistance; and Grade 5, strong vaginal contraction lasting for 5 s in 5 measurements, with continuous resistance.

The Glazer evaluation criteria were as follows: 2–4 μV before and after the resting stage, with > 4 μV indicating pelvic floor muscle hyperactivity; a 5-times higher rapid contraction stage of 35–45 μV, with < 35 μV indicating a decrease in fast muscle ten-sion; and continuous contraction of 30–40 μV for 10 s, with < 30 μV indicating de-creased muscle tension of slow muscles [16]. The continuous contraction stage at 60 s was 25–335 μV, with < 25 μV indicating a decrease in slow muscle endurance.

Statistical analysis was performed using SPSS 19.0 software. Measurement data are expressed as the ±s, and an independent samples t test was used for comparisons between two groups. A nonparametric rank-sum test was used for measurement data and grade data that did not meet the conditions of two independent samples t tests and analysis of variance. The correlation was analyzed by GraphPad Prism 8.0 Pearson correlation and Spearman correlation. Multivariate analysis was performed using the GraphPad Prism 8.0 multiple linear regression analysis tool. $P < 0.05$ was considered statistically significant.

Results

There were statistically significant differences in age, delivery times, BMI at delivery and neonatal weight between the two groups ($P < 0.05$), as shown in Table 1.

Table 1: Comparison of basic clinical features between the two groups (□x±s)

Scale	Age	Gravidity	Delivery times	BMI at delivery	Weight gain during pregnancy	Neonatal weight	Delivery mode
Abnormal muscle tension group	31.71±3.36	2.00 (1.00–3.00)	1.00 (1.00–2.00)	26.10 (24.66–28.42)	12.00 (10.00–15.00)	3475.00 (3187.50–3800.00)	1.00 (1.00–1.00)
Control group	29.57±4.14	1.00 (1.00–2.00)	1.00 (1.00–2.00)	24.80 (23.62–26.64)	13.00 (11.00–16.00)	3250.00 (3050.00–3437.50)	1.00 (1.00–1.00)
t/Z value	-3.65	-1.50	-2.14	-2.98	-0.93	-3.86	-0.76
P value	0.00	>0.05	<0.05	<0.05	>0.05	0.00	>0.05

The EMG values of the two groups in the pretesting stage, fast muscle contraction, slow muscle contraction, slow muscle endurance and post testing stage were com-pared, and the differences were statistically significant (Table 2). This indicated that the Glazer assessment was consistent with the results of the pelvic floor strength as-sessment of clinical vaginal palpation and could objectively reflect the level of pelvic floor muscle strength.

Table 2: The EMG values of the pelvic floor surface before treatment were compared between the two groups

Scale	EMG value in the preresting stage	EMG value of fast muscle contraction	EMG value of slow muscle contraction	EMG value of slow muscle endurance	EMG value in the postresting stage
Abnormal muscle tension group	3.59 (1.88–5.39)	27.93 (19.26–34.41)	18.71 (12.35–24.44)	18.39 (13.16–25.56)	4.63 (2.67–7.24)
Control group	5.15 (2.36–8.33)	30.47 (21.78–38.28)	20.02 (15.47–27.23)	20.86 (16.28–27.10)	5.11 (3.23–8.21)
Z value	-2.34	-11.07	-3.40	-2.26	-9.53
P value	<0.05	0.00	<0.05	<0.05	<0.05

The correlation analysis of the two groups showed that the EMG value of the fast muscle contraction stage was negatively correlated with age and neonatal weight. The EMG values of slow muscle contraction and endurance were negatively correlated with weight gain during pregnancy but positively correlated with age and BMI at de-livery. The EMG value of the postresting stage was positively correlated with age, BMI at delivery and neonatal weight (P < 0.05) (Table 3).

Table 3: Correlation analysis of pelvic floor surface EMG values and various factors

Scale	EMG value in the preresting stage		EMG value of fast muscle contraction		EMG value of slow muscle contraction		EMG value of slow mus-cle endur-ance		EMG value in the postresting stage	
	r value	P value	r value	P value	r value	P value	r value	P value	r value	P value
Age	-0.13	>0.05	-0.16	<0.05	0.20	<0.05	0.08	>0.05	0.20	<0.05
Gravidity	-0.09	>0.05	0.00	>0.05	0.11	>0.05	0.03	>0.05	0.10	>0.05
Delivery times	-0.12	>0.05	-0.09	>0.05	0.08	>0.05	-0.01	>0.05	0.10	<0.05
BMI at delivery	0.09	>0.05	-0.14	>0.05	0.20	<0.05	0.11	>0.05	0.27	0.00
Weight gain during pregnancy	-0.05	>0.05	-0.08	>0.05	-0.15	<0.05	-0.16	<0.05	-0.10	>0.05
Neonatal weight	-1.12	>0.05	-0.24	<0.05	0.06	>0.05	-0.03	>0.05	0.15	<0.05
Delivery mode	0.04	>0.05	0.08	>0.05	0.09	>0.05	0.06	>0.05	0.05	>0.05

Multivariate linear analysis showed that weight gain during pregnancy was negatively correlated with the EMG value of slow muscle contraction (P <0.05). BMI at delivery was positively correlated with the EMG value of the slow muscle contraction and postresting stage (P < 0.05). There was a positive correlation between age and EMG in the resting stage (P < 0.05) (Table 4, 5, 6).

Table 4: Correlation analysis between the EMG value of fast muscle contraction and other factors

Variate	B	β	t value	P value
Age	-0.65	-0.14	-1.81	>0.05
BMI at delivery	-0.70	-0.11	-1.39	>0.05

Table 5: Correlation analysis between the EMG value of slow muscle contraction and other factors

Variate	B	β	t value	P value
Age	0.45	0.14	1.82	>0.05
BMI at delivery	0.87	0.20	2.12	<0.05
Weight gain during pregnancy	-0.42	-0.21	-2.76	<0.05

Table 6: Correlation analysis between EMG value and other factors in the resting stage

Variate	B	β	t value	P value
Age	0.42	0.16	2.11	<0.05
BMI at delivery	0.81	0.22	2.83	<0.05
Neonatal weight	0.00	0.10	1.39	>0.05

The comparison of the pretreatment and posttreatment EMG values for the preresting stage and postresting stage in the abnormal muscle tension group showed the EMG values of fast muscle contraction, slow muscle contraction and muscle endurance were significantly different ($P < 0.05$). In the comparison of the pre- and posttreatment EMG values in the control group, the results showed that the EMG value in the preresting stage was significantly different ($P < 0.05$). There was no significant dif-ference in any of the other indicators ($P > 0.05$), as shown in Fig. 1 and Fig. 2.

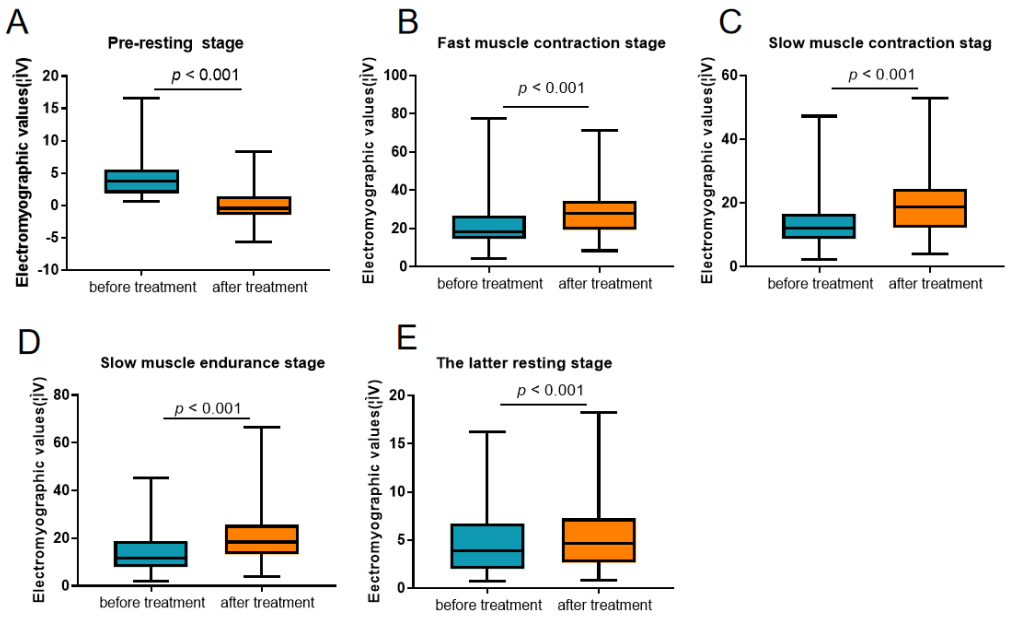

Figure 1: The comparison of the pretreatment and posttreatment EMG values in the abnormal muscle tension group
A. EMG value in the preresting stage was significantly lower after treatment ($P < 0.05$).
B, C, D. EMG values of fast muscle contraction, slow muscle contraction and muscle endurance were significantly higher after treatment ($P < 0.05$).
E. EMG value in the postresting stage was significantly lower after treatment ($P < 0.05$).

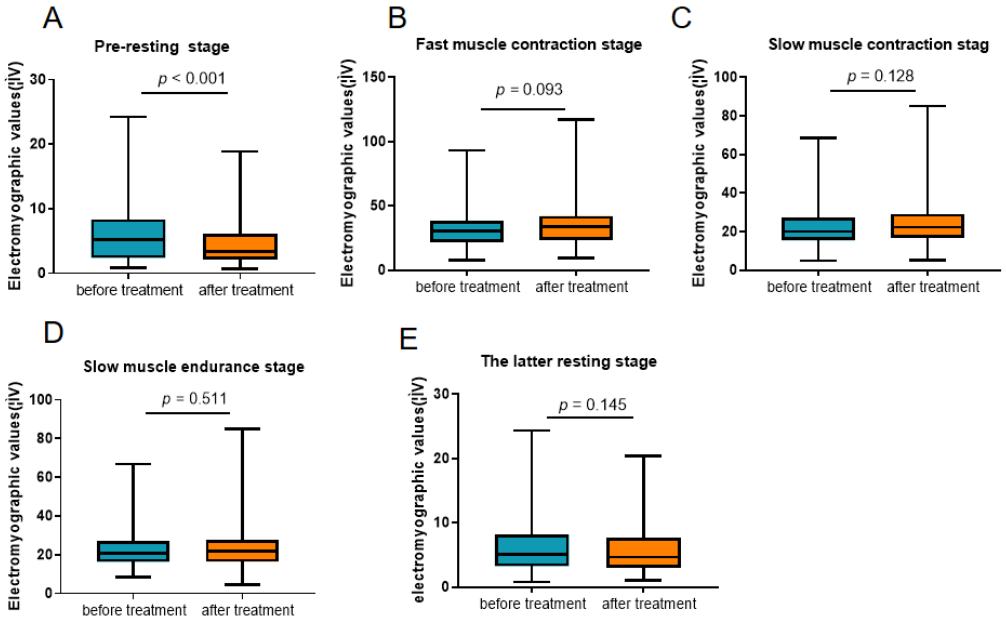

Figure 2: The comparison of the pretreatment and posttreatment EMG values in the control group
A. EMG value in the preresting stage was significantly lower after treatment (P < 0.05).
B, C, D. EMG values of fast muscle contraction, slow muscle contraction and muscle endurance were no significant after treatment(P > 0.05).
E. EMG value in the postresting stage was no significant after treatment (P > 0.05).

In the comparison of the pelvic floor surface EMG values of the two groups after treatment, the results showed that the EMG values of the two groups were statistically significant (P < 0.05), as shown in Table 7.

Table 7: Comparison of pelvic floor surface EMG values between the two groups after treatment

Scale	EMG value in the preresting stage	EMG value of fast muscle contraction	EMG value of slow muscle contraction	EMG value of slow muscle endurance	EMG value in the postresting stage
Abnormal muscle tension group	-0.47 (-1.51–1.36)	6.19 (1.23–12.34)	5.35 (1.30–8.32)	4.41 (1.18–10.60)	0.56 (-0.72–2.19)
Control group	3.40 (2.15–6.12)	33.68 (23.32–43.35)	22.20 (16.82–29.15)	21.85 (16.41–27.66)	4.66 (3.01–7.68)
Z value	-10.99	-6.60	-6.97	-6.36	0.85
P value	0.00	0.00	0.00	0.00	<0.05

Discussion

According to the function of the muscle fibers, pelvic floor muscles can be divided into slow muscles (type I muscle fibers) and fast muscles (type II muscle fibers). The slow muscle includes the levator ANI muscle group (pubovaginalis, puborectalis, pubococcygeus, iliac coccygeus), which is characterized by a long and lasting con-traction time and is not easily fatigued. Fast muscles include the perineal muscle group (superficial transversalis perinealis, deep transversalis perinealis, bulbous cavernosal muscle), and these muscles are characterized by rapid contraction and are easily fatigued [17,18]. The earliest injury to pelvic floor muscle tension manifests as electromyologic changes, including changes in muscle potential, muscle tension and muscle fatigue, which can be used as indicators for early diagnosis of the injury [19, 20]. The pelvic floor surface EMG assessment refers to the evaluation of the bioelec-trical signal sent by recording neuromuscular activity through electrodes on the human surface or cavity, quantitatively reflecting the local fatigue degree of muscle activity, the excitation conduction velocity of the motor unit and the muscle tension level [21]. In this study, the Glazer assessment results were consistent with the results of the clinical pelvic floor muscle tension assessment by vaginal palpation, indicating that it could objectively on stage was negatively correlated with age and neonatal weight.

The EMG values of slow muscle contraction and endurance were negatively corre-lated with weight gain during pregnancy but positively correlated with age and BMI at delivery. The EMG value of the postresting stage was positively correlated with age, BMI at

delivery and neonatal weight (P < 0.05). Multivariate linear analysis showed that weight gain during pregnancy was negatively correlated with the EMG value of slow muscle contraction and slow muscle endurance. BMI at delivery was positively correlated with the EMG value of the slow muscle contraction and postresting stage. There was a positive correlation between age and EMG in the resting stage (P <0.05). These results mean that the higher the weight gai during pregnancy is, the lower the BMI and lower pelvic floor muscle tension will be. Hola V L et al. found that pelvic floor tissues would be damaged to varying degrees during pregnancy due to the effect of gravity [22]. During vaginal labor, perineal tearing and lateral resection could lead to extreme stretching and dilation of muscles and nerves around the vagina, as well as damage to the pelvic floor and surrounding urethral tissues and changes in the position and range of activity of the bladder neck [23]. In particular, a prolonged second stage of labor is the main factor associated with pelvic floor tissue injury, and for-ceps-assisted delivery assisted aggravates the pelvic floor muscle injury [24-26]. Moreover, the higher the number of deliveries, the more serious the pelvic floor tissue damage would be, which is consistent with the results of this study [27, 28].

We found that older age is a high-risk factor for resting-state strength, and the lack of estrogen may damage the vaginal epithelium and lamina propria during smooth muscle contraction, decrease the uterine ligament collagen fiber ratio, reduce vaginal area perfusion, and decrease the resilience of the pelvic floor muscle [29]. QI X et al. found that an increased BMI during pregnancy is an independent risk factor for post-partum stress urinary incontinence [30]. Urbankova I et al. also showed that over-weight or obese patients have more waist and abdominal adipose tissue, resulting in higher intra-abdominal pressure [31]. Continued abdominal pressure directly acts on the stretching and deformation of the pelvic floor tissue in the direction of stress, weakening the pelvic floor muscle, which is consistent with the results of this study [32]. Excessive fetal weight leads to an increased pelvic floor muscle load and chang-es in the shape and function of the pelvic floor muscles, leading to PFD [33]. In other studies, the size of the fetal head circumference was considered an independent risk factor. When the fetal head circumference was greater than 35.5 cm, the incidence of levator ANI injury increased by 3.34 times [34]. In a sample of patients with vaginal wall prolapse, Kerkhof M H et al. found that pelvic floor muscle fibers were sparsely aligned, with a reduced density and decreased number of nerves [35]. The pelvic floor muscles are filled with abundant fibrous connective tissue and infiltrated with in-flammatory cells. Lenis et al. found that the expression of CCL7 and CD195 was up-regulated in the urethral epithelium in a vaginal wall traction model of rat stress uri-nary incontinence and thus affected tissue repair [36]. Due to the small sample size included in this study, only the pelvic floor data of primiparous women who were 6–8 weeks postpartum were collected, and long-term follow-up and basic experiments were not conducted. Multivariate analysis did not confirm relevant conclusions, and further studies are needed in the later stage.

By means of electrical stimulation combined with biofeedback technology in this study, the Kegel exercise intervention dramatically and obviously improved the resting pressure, fast muscle tension, slow muscle tension and endurance in the abnormal pelvic floor muscle group, and these outcomes occurred earlier and were significantly better than those in the control group. This shows that physiological electrical stimu-lation treatment in the early postpartum period is effective and can maximize pelvic floor muscle flexibility and muscle tension for a quick recovery. This intervention can also improve pelvic floor muscle tension in terms of compressive ability and promote the maternal pelvic floor structure to the maximum extent of recovery. However, Le-on-Larios F et al. proposed that daily perineal massage and pelvic floor exercise from 32 weeks of pregnancy could significantly reduce perineal injury and the lateral re-section rate [37]. Additionally, water delivery can reduce the perineal lateral resection rate and reduce damage to pelvic floor muscle [38].

Conclusion

In summary, the factors affecting the pelvic floor muscle tension of women are com-plex and varied. Interventions such as education and management during pregnancy, adjustments to dietary structure, weight and growth speed control during pregnancy, proper exercise, and free position delivery during childbirth, and individualized pelvic floor rehabilitation training in the early postpartum period can reduce the incidence of PFD and ensure the quality of life of women.

Abbreviations

PFD Pelvic floor dysfunction
MOS Oxford modified scale
BMI Body Mass Index
EMG Electromyogram

Declaration

Ethical approval and consent to participants: All procedures performed in studies in-volving human participants were in accordance with the ethical standards of the insti-tutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

All experimental protocols were approved by ethical licensing Committee of Ningbo Medical Center Lihuili Hospital (YJZ2021SL050) and consent to participant's section.

A written informed consent was obtained from all the study participants.

No additional administrative permissions or licenses were acquired for this study.

Consent to publication

Not applicable.

Data availability

All data generated or analysed during this study are included in this published article [original data].

Author contribution

Author contributions Jinghui Zou—project management, manuscript writing, data collection, data analysis; YanLiu—data collection; Xiaohuan Sun—data collection; Aijiao Xue—data collection; Yisheng Zhang—project man-agement, manuscript editing All authors reviewed the manuscript

Conflict of interest

The authors declare that they have no conflicts of interest.

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