Reliability and Validity of Chinese Version of MBIS and HerQles on Postpartum Women Who Have Diastasis Recti Abdominis

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Abstract

Background: The study aims to develop a tool with the Modified Body Self-Image Scale (MBIS) and Hernia-Related Quality-of-Life Survey (HerQles) and to analyze its reliability and validity among Chinese postpartum women. Method: Paper questionnaires were collected from 150 women who participated in the Postpartum Rehabilitation clinic to analyze the difference. Construct validity for MBIS was analyzed by factor analysis, HerQles was compared to SF-36. Results: 114 women with DRA and 36 without completed MBIS, HerQles, and SF-36. Age over 35-year-old was not a significant risk factor for DRA (P=0.056). Bodily pain of postpartum women without DRA had a significant increase compared to DRA ones (P=0.017). Kaiser-Meyer-Olkin (KMO) of MBIS was 0.897 (Bartlett's Test $\chi2$=777.841, df 36.000, P<0.05), and that of HerQles was 0.802 (Bartlett's Test $\chi2$=921.490, df 66.000, P<0.05). MBIS got a cumulative variance contribution rate of 62.439%, and HerQles 72.154%. Intra-class correlation coefficient (ICC) of MBIS was between 0.584-0.794 (Cronbach's α=0.913). ICC of HerQles was between 0.399-0.663 (Cronbach's α=0.872). The test-retest showed that the ICC of MBIS and HerQles was 0.834 (95%CI:0.778-0.877) and 0.758 (95%CI:0.681-0.819). Conclusion: Most women have DRA after childbirth, age over 35-year-old is a prevalent but not significant risk factor for DRA. Postpartum women with DRA have less bodily pain. The Chinese version of MBIS, HerQles are reliable and valid. Keywords: Modified Body Self-Image Scale (MBIS); Hernia-Related Quality-of-Life Survey (HerQles); Diastasis recti abdominis (DRA); Postpartum; Reliability; Validity

Background

Women undergo unusual physiological changes on their abdominis as to adapt pregnancy and childbirth processes. Diastasis Recti Abdominis (DRA) is one of these changes, which is manifested as a bulge or depression in the midline of the abdomen [1]. With a two-centimeter-width or even more extended Linea alba (LA) [2], abdominal muscles are weak [3–5] and obviously damaged [6]. Changes in fetal growth and hormone levels could result in DRA, and DRA could lead to loss of abdominal muscle elasticity, stretch marks, fat accumulation, sagging, and so forth, and the most concerned population among the patients is six-month postpartum women [7, 8].

Because of decreased physical condition, most DRA women are disappointed and some failed in daily activities, such as bending, squatting, and carrying heavy objects [9]. These negative changes gradually aggravate physical discomfort [4, 5, 10, 11] and cause psychological anxiety/depression [11, 12], lowing quality of Life (QoL) and even leading to self-rated disability [13]. Choosing an available clinical scale for DRA is challenging. At present, there exists rare studies evaluating postpartum women using specific scales, and quite a number of studies [13–15] use universal scales to evaluate without testing reliability and validity.

The first aim of the study was to develop a suitable abdominal evaluation tool combining Modified Body Self-Image Scale (MBIS) and Hernia-Related Quality-of-Life Survey (HerQles), and the second aim was to assess reliability and validity of MBIS and HerQles.

Methods

The subjects were postpartum women after 42 days participated from Sept.18th 2020 to Oct. 21st 2021. Women participants took part in the study by two steps. Firstly, they finished the questionnaire where contained their basic informations, Modified Body Self-Image Scale (MBIS), Hernia-Related Quality-of-Life Survey (HerQles) and the short form-36 health survey (SF-36). Secondly, they took clinical IRD examinations. The study procedure followed the CONSORT flow (see Fig. 1).

Inclusion and exclusion criteria

Inclusion criteria were women aged between 20–55 years old in postpartum period without any DRA treatment ever before or at present in any hospitals or institutions. Only women with conforming to the above criteria can be entered into this study.

Exclusion criteria were women suspected or diagnosed with severe spinal lesions (such as spinal fractures, metastases, inflammatory or infectious diseases, cauda equina syndrome/widespread neurological disease) and neurological injury; or whoever had motor contraindications or severe infectious diseases such as fractures, hypertension, severe heart disease, cancer; whatever the above shall be excluded.

DRA diagnosis with cut-off value

The measurement took place in a standard supine position with the abdomen exposed. During expiration, subjects contracted abdominal muscles contraction to slightly flex the upper body to keep the shoulder blades just lifted off the bed. Based on the study of Sperstad, J. B. and etc [2], DRA was confirmed if inter recti distance (IRD) was recognized as ≥ 2 cm by palpation at the umbilics level. The measurement method was based on Van de Water's research [16], and demonstrated with intra-rater and inter-rater reliability [17].

Questionnaire description

MBIS

The original 10-item Body image scale (BIS) [18] was considered suitable for any group experiencing body image problems [19]. It was firstly used for women with breast cancer [18], and verified as useful by clinical trial [20]. It was improved into MBIS by Eric Jelovsek [21] for pelvic organ prolapse (POP) patients and concluded with its importance on measuring QoL in gynecology field. The Chinese version of MBIS was derived from the doctoral dissertation of Xiaoqian Wang [22]. It was subsequently applied to Chinese POP patients with good reliability (Cranach's α = 0.926, ICC of each item = 0.554–0.963, $P < 0.01$) and validity (one principal component factor, accounting for 66.604% of the variance) [22].This study added a question to the existing Chinese version, the change in the appearance of abdomen (the second item of MBIS). This additional question was mainly used for comparing the proprioception of the patient with the IRD measured by the physiotherapist. Thus, the new MBIS composed nine items with a total score of 27, and each item contained four answers representing different levels (0/not at all, 1/mild, 2/middle, 3/severe). Each question should be answered based on the situation in one past week [22]. Select the only one answer which was closest to the real situation according to personal situation. If two or more options were checked, the questionnaire shall be invalid. The higher the score was, the more bothering the body-image was.

HerQles

The original HerQles contained 16 questions, it was adapted to the current HerQles-12 with one latent construct [23]. HerQles-12 was firstly acted on disease-specific QoL evaluating the abdominal wall function and was verified as useful by multiple parties [24–26]. The Chinese version of the questionnaire [27] came from Professor Yonggang Huang, and we contacted Professor Huang by e-mail, solicited the right to use the Chinese version and got approved. It was divided into 12 questions, each contained six options (1/strongly disagree, 2/moderate disagree, 3/mild disagree, 4/ mild agree, 5/moderate agree, 6/strongly agree). The time set was the same as MBIS. The total score was 72, and the higher the score was, the more serious the abdominal wall problem was, and vice versa. Criteria for judging the validness of a questionnaire was the same as MBIS.

SF-36

With its advantages of simplicity and self-evaluation, SF-36 is the universal standard one among QoL assessment questionnaire [10, 28, 29]. It consists of eight indicators as follow: Physiological Function (PF), Role-Physical (RP), Bodily Pain (RP), General Health (GH), Vitality (VT), Social Function (SF), Role-Emotional (EF) and Mental Health (MH). The Chinese version was formulated by Zhejiang University, with good reliability and validity (Cranach's α = 0.838, the Spearman-Brown coefficient = 0.828) [30]. The total calculated score of statistics corresponded to the total score of eight dimensions respectively, instead of the whole questionnaire. The converted scoring method was based on the formula below: (the difference between the actual score and the lowest possible score in this aspect)/ (the difference between the highest possible score and the lowest score in the same aspect) * 100. The time set was within past one month. The higher the score was, the better the health condition was. Criteria for judging the validness of a questionnaire was as same as MBIS.

Statistical analyses

SPSS 25.0 software (SPSS, Inc., Chicago, IL, USA) and SPSSAU 21.0 software [31] were used in the study. The general information and scores of the scale were calculated by SPSS 25.0, and reliability and validity of scales by SPSSAU 21.0.

General information

Quantitative data was expressed in terms of Mean ± SD (Median), 95% CI, Max and Min. Qualitative data was expressed in N (%). Normally distributed data was analyzed by two-sample T Test, and comparison between subgroups and grade/skewed distribution data were calculated by two-sample Rank Sum Test and Mann-Whitney U test. $P < 0.05$ was considered as statistically significant.

MBIS

Validity analysis was used for rationality of quantitative data. Exploratory and confirmatory sample sizes cannot be the same data, the sample (Sample 1) should be randomly divided into half and then analyzed. Firstly Sample 1-A was calculated by exploratory factor analysis (EFA) with poorly relevant items being deleted, and then the left half (Sample 1-B) was used to verify if the model conformed to confirmatory factor analysis (CFA). Kaiser-Meyer-Olkin (KMO) and Bartlett's Test were used to judge effectiveness of extracted data. KMO value and its representative meaning were defined as below: KMO > 0.8/an excellent suitable information extraction, 0.7 < KMO < 0.8/a more suitable extraction, 0.6 < KMO < 0.7/a suitable extraction, KMO < 0.6/an unsuitable extraction. Items were remained only if the standard loading factor > 0.4 [32]. Bartlett's Test $P < 0.05$ was significant. The total variance interpretation was used to measure the amount of information extracted by the factor. The higher the index, the more information that can be extracted, generally the indicator shall be higher than 0.5. Discriminant validity was performed by average variance extraction (AVE) and combined reliability (CR). Normally, AVE > 0.5 and CR > 0.7 was considered as good. Cronbach's α was used for measuring intra-class correlation coefficient (ICC) of items in one scale. The higher the score was, the more consistent it would be, with the range from 0 to 1. Reliability measured by Cronbach's α was divided into four reliability levels, Cronbach's α ≥ 0.7/a high reliability, 0.5 < Cronbach's α < 0.7/medium, 0.2 < Cronbach's α < 0.5/common, Cronbach's α ≤ 0.2/low. Test-retest reliability was expressed by r (Two-way Random Effect Model Absolute Agreement Definition), and the time set was two weeks after the first filling-out of the questionnaire. If r > 0.75, it indicated an excellent retest, 0.40 < r < 0.75 was a good one, and r < 0.40 meant a bad one.

HerQles and SF-36

Total variance explained, discriminant validity, and reliability analysis were the same as MBIS. Correlation analysis could be used for scales with similar structures, as described in the previous literature of the Lithuanian and the Dutch CCS versions [33, 34]. HerQles and SF-36 were estimated by Spearman's rank. The key indicator was Spearman's rank correlation coefficient (r) with three levels ($r > 0.50$/strong correlation, $0.35 < r < 0.50$/moderate correlation, $r < 0.35$/weak correlation).

Results

General information

Table 1 showed basic description and total scale scores of 150 postpartum women. The completion rate was 100%. The overall basic information of 150 samples were analyzed by descriptive statistics, such as age (age > 35 years old), days after childbirth (> one year), disease history (Yes/No), medicine history (Yes/No), allergy history (Yes/No), educational background, occupation, twins birth history (Yes/No) and whether this delivery was twins (Yes/No). The comparison of general information between the two groups showed no statistical significance ($P > 0.05$). 114 women were with DRA, and 36 without DRA. Among women of DRA, 98 only had DRA within one year after delivery, and 16 still had DRA after one year. 35-year-old was certainly correlated with DRA but there was no significant difference ($P = 0.056$). Bodily pain of postpartum women without DRA had significant increase comparing to DRA ones ($Z = -2.387$, $P = 0.017$). Other total scores of HerQles and SF-36 were not statistically significant ($P > 0.05$).

Table 1
Basic Description and Scale Score of 150 Females

Title	Total	DRA	Without DRA	*Z*	*P*	Mann-Whitney U test	95%CI		Max	Min
							Lower	Upper		
Age, Mean ± SD(Median)	32.04 ± 3.97(31.75)	32.50 ± 4.12(32.61)	30.59 ± 3.08(29.63)	-1.911	*0.056*	1755.00	31.40	32.68	41.60	22.95
≤ 35 years old	121(80.67%)	88(77.20%)	33(91.70%)							
> 35 years old	29(19.33%)	26(22.80%)	3(8.30%)							
Days after birth, Mean ± SD(Median)	271.94 ± 501.60(100.50)	290.92 ± 550.70(101.00)	211.83 ± 295.07(98.50)	-0.022	0.982	2049.00	191.01	352.87	3708.00	42.00
≤ 1 year	129(86.00%)	98(86.00%)	31(81.60%)							
> 1 year	21(14.00%)	16(14.00%)	5(13.90%)							
Other disease				-0.022	0.982	2049.00				
No	129(86.00%)	98(86.00%)	31(81.60%)							
Yes	21(14.00%)	16(14.00%)	5(13.90%)							
Medicine history				-0.022	0.982	1947.00				
No	129(86.00%)	98(86.00%)	31(81.60%)							
Yes	21(14.00%)	16(14.00%)	5(13.90%)							
Allery history				-0.891	0.373	1950.00				
No	136(90.70%)	102(89.50%)	34(94.40%)							
Yes	14(9.30%)	12(10.50%)	2(5.60%)							
Education background				-0.985	0.325	1848.50				
Phd	2(1.30%)	1(0.90%)	1(2.80%)							
Master	21(14.00%)	16(14.00%)	5(13.90%)							
Undergraduate	82(54.70%)	61(53.50%)	21(58.30%)							
High school/high vocational school	28(18.70%)	20(17.50%)	8(22.20%)							
Junior high school/ technical secondary school	8(5.30%)	7(6.10%)	1(2.80%)							
Primary school	6(4.00%)	6(5.30%)	0(0.00%)							
Illiteracy	3(2.00%)	3(2.60%)	0(0.00%)							
Occupation				-0.580	0.562	1925.00				
Civil servants	7(4.70%)	5(4.40%)	2(5.60%)							
Professional skill worker	46(30.70%)	34(29.80%)	12(33.30%)							
Staff	51(34.00%)	40(35.10%)	11(30.60%)							
Business personnel	6(4.00%)	3(2.60%)	3(8.30%)							
Service personnel of the tertiary industry	23(15.30%)	17(14.90%)	6(16.70%)							
Industrial worker	0(0.00%)	0(0.00%)	0(0.00%)							

Title	Total	DRA	Without DRA	*Z*	*P*	Mann-Whitney U test	95%CI		Max	Min
							Lower	Upper		
Workers engaged in agriculture, forestry, animal husbandry and fishery	0(0.00%)	0(0.00%)	0(0.00%)							
Housewife	3(2.00%)	3(2.60%)	0(0.00%)							
Student	2(1.30%)	2(1.80%)	0(0.00%)							
Private business owner	5(3.30%)	5(4.40%)	0(0.00%)							
Unemployment	3(2.00%)	2(1.80%)	1(2.80%)							
Retirees	0(0.00%)	0(0.00%)	0(0.00%)							
Others	4(2.70%)	3(2.60%)	1(2.80%)							
Operation history				-1.160	0.246	1824.00				
No	79(52.70%)	57(50.00%)	22(61.10%)							
Yes	71(47.30%)	57(50.00%)	14(38.90%)							
Twins birth history				-1.135	0.256	1980.00				
No	146(97.33%)	110(96.49%)	36(100.00%)							
Yes	4(2.67%)	4(3.51%)	0(0.00%)							
Whether this delivery was twins				-0.797	0.425	2016.00				
No	148(98.70%)	112(98.20%)	36(100.00%)							
Yes	2(1.30%)	2(1.80%)	0(0.00%)							
IRD, Mean ± SD(Median)	2.53 ± 0.86(2.50)	2.83 ± 0.76(2.90)	1.58 ± 0.20(1.50)	-9.050	1.432	39.50	2.39	2.67	6.00	1.50
MBIS, Mean ± SD(Median)	7.55 ± 5.49(7.00)	7.97 ± 5.80(7.00)	6.25 ± 4.16(6.00)	-1.310	0.190	1755.00	6.67	8.44	26.00	0.00
HerQles, Mean ± SD(Median)	19.27 ± 8.82(16.00)	19.68 ± 9.13(16.00)	18.00 ± 7.73(15.50)	-0.726	0.468	1891.00	17.85	20.70	44.00	12.00
SF-36, Mean ± SD(Median)										
PF	79.00 ± 21.18(85.71)	78.38 ± 21.70(85.71)	80.95 ± 19.62(85.71)	-0.365	0.715	1970.00	75.58	82.42	100.00	0.00
RP	70.00 ± 39.50(100.00)	68.64 ± 41.25(100.00)	74.31 ± 33.53(100.00)	-0.224	0.823	2006.00	63.63	76.37	100.00	0.00
BP	22.17 ± 27.26(0.00)	24.56 ± 27.37(31.25)	14.58 ± 25.83(0.00)	-2.387	*0.017*	1554.00	17.77	26.57	100.00	0.00
GH	59.04 ± 23.81(61.11)	59.97 ± 23.78(62.22)	56.08 ± 23.99(50.00)	-0.912	0.362	1845.00	55.20	62.88	100.00	0.00
VT	63.49 ± 19.53(64.71)	64.50 ± 19.64(64.71)	60.29 ± 19.10(58.82)	-1.298	0.194	1758.50	60.34	66.64	100.00	0.00
SF	67.73 ± 15.10(71.43)	66.93 ± 15.69(71.43)	70.24 ± 12.95(71.43)	-1.060	0.289	1833.00	65.29	70.16	100.00	0.00
RE	67.56 ± 39.75(100.00)	66.67 ± 40.16(83.33)	70.37 ± 38.86(100.00)	-0.545	0.586	1938.00	61.14	73.97	100.00	0.00
MH	59.09 ± 23.95(63.16)	60.39 ± 24.01(63.16)	54.97 ± 23.62(55.26)	-1.329	0.184	1751.00	55.22	62.95	100.00	0.00

Validity and reliability analysis

Table 2 showed validity analysis of MBIS and HerQles.

Table 2
Validity Analysis of MBIS and HerQles

Title	KMO	Bartlett's Test		
		Chi - Squared Approximation	Degree of Freedom	*P*
MBIS	0.897	777.841	36.000	0.000
HerQles	0.802	921.49	66	0.000

Table 3 showed EFA of MBIS based on the Sample 1-A (N = 67). Nine questions were divided into one dimension, item No.8 (Do you avoid contacting with others because of your appearance?) was deleted since the load factor < 0.4 and the load difference between any two factors > 0.2 [32], and seven items (M1-7 + M9) remained.

Table 3
MBIS EFA Component 1 of MBIS (Rotated) Sample1-A (N = 67)

Before adjustment	Component	After adjustment	Component
	1		1
M1	0.609	M1	0.669
M2	0.646	M2	0.689
M3	0.812	M3	0.851
M4	0.833	M4	0.849
M5	0.840	M5	0.849
M6	0.791	M6	0.776
M7	0.802	M7	0.823
M8	0.496	M9	0.793
M9	0.771		

Table 4 showed CFA of MBIS (Sample 1-B (N = 83)).

Table 4
MBIS CFA Loading Factors of MBIS Sample1-B (N = 83)

Factor	Measurement Variables	Coef.	Std. Error	*Z* (CR)	*P*	Std. Estimate
Factor1	M1	1	-	-	-	0.648
Factor1	M2	1.176	0.222	5.287	0	0.65
Factor1	M3	1.817	0.276	6.58	0	0.851
Factor1	M4	1.565	0.24	6.526	0	0.842
Factor1	M5	1.727	0.263	6.564	0	0.849
Factor1	M6	1.343	0.226	5.934	0	0.747
Factor1	M7	1.425	0.222	6.423	0	0.825
Factor1	M9	1.415	0.23	6.153	0	0.781

Table 5 showed total Variance explained of MBIS (Sample 1-A (N = 67) and HerQles.

Table 5
Total Variance Explained of MBIS and HerQles

	Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
		Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
MBIS after adjustment	1	4.995	62.439	62.439	4.995	62.439	62.439			
sample1-A(N = 67)	2	0.801	10.008	72.447						
	3	0.667	8.334	80.781						
	4	0.433	5.406	86.187						
	5	0.372	4.654	90.841						
	6	0.270	3.374	94.215						
	7	0.257	3.214	97.429						
	8	0.206	2.571	100.000						
HerQles	1	5.250	43.754	43.754	5.250	43.754	43.754	2.903	24.193	24.193
	2	1.283	10.690	54.443	1.283	10.690	54.443	2.094	17.449	41.642
	3	1.086	9.054	63.497	1.086	9.054	63.497	2.058	17.152	58.793
	4	1.039	8.657	72.154	1.039	8.657	72.154	1.603	13.361	72.154
	5	0.803	6.692	78.846						
	6	0.667	5.561	84.408						
	7	0.530	4.414	88.821						
	8	0.463	3.862	92.683						
	9	0.331	2.761	95.444						
	10	0.261	2.171	97.615						
	11	0.176	1.464	99.080						
	12	0.110	0.920	100.000						

Table 6 showed AVE and CR of MBIS and HerQles.

Table 6
Discrimination Validity of MBIS and HerQles

Title	Factor	AVE	CR
MBIS after adjustment sample1-A(N = 67)	Factor1	0.621	0.927
HerQles	Factor1	0.424	0.844

Table 7 showed correlation between HerQles and SF-36.

Table 7
Correlation Between HerQles and SF-36

Title		HerQles	PF	RP	GH	VT	SF	RE	MH	BP
HerQles	ρ	1.000	-0.070	-0.036	-0.064	-0.021	-0.042	0.043	0.040	.199*
	Sig.		0.395	0.659	0.440	0.800	0.609	0.600	0.623	*0.015*
PF	ρ	-0.070	1.000	.636**	.453**	.420**	.245**	.270**	.338**	− .671**
	Sig.	0.395		0.000	0.000	0.000	0.002	0.001	0.000	0.000
RP	ρ	-0.036	.636**	1.000	.493**	.528**	.295**	.460**	.402**	− .354**
	Sig.	0.659	0.000		0.000	0.000	0.000	0.000	0.000	0.000
GH	ρ	-0.064	.453**	.493**	1.000	.621**	.323**	.400**	.477**	− .289**
	Sig.	0.440	0.000	0.000		0.000	0.000	0.000	0.000	0.000
VT	ρ	-0.021	.420**	.528**	.621**	1.000	.202*	.500**	.724**	− .168*
	Sig.	0.800	0.000	0.000	0.000		0.013	0.000	0.000	0.040
SF	ρ	-0.042	.245**	.295**	.323**	.202*	1.000	0.054	.174*	− .223**
	Sig.	0.609	0.002	0.000	0.000	0.013		0.514	0.034	0.006
RE	ρ	0.043	.270**	.460**	.400**	.500**	0.054	1.000	.493**	-0.145
	Sig.	0.600	0.001	0.000	0.000	0.000	0.514		0.000	0.078
MH	ρ	0.040	.338**	.402**	.477**	.724**	.174*	.493**	1.000	-0.026
	Sig.	0.623	0.000	0.000	0.000	0.000	0.034	0.000		0.752
BP	ρ	.199*	− .671**	− .354**	− .289**	− .168*	− .223**	-0.145	-0.026	1.000
	Sig.	*0.015*	0.000	0.000	0.000	0.040	0.006	0.078	0.752	

*Correlation is significant, $P < 0.05$ ** Correlation is significant, $P < 0.001$.

Table 8 showed ICC of MBIS and HerQles.

Table 8
ICC of MBIS and HerQles

Title	Item	CITC	Item deleted Cronbach's α	Cronbach's α
MBIS				0.913
	M1	0.584	0.912	
	M2	0.608	0.911	
	M3	0.794	0.894	
	M4	0.787	0.895	
	M5	0.785	0.895	
	M6	0.697	0.903	
	M7	0.756	0.898	
	M9	0.718	0.901	
HerQles				0.872
	H1	0.607	0.861	
	H2	0.510	0.865	
	H3	0.661	0.857	
	H4	0.663	0.855	
	H5	0.596	0.864	
	H6	0.399	0.874	
	H7	0.597	0.862	
	H8	0.409	0.870	
	H9	0.616	0.859	
	H10	0.642	0.858	
	H11	0.614	0.859	
	H12	0.596	0.860	

Table 9 showed test-retest reliability of MBIS and HerQles.

Table 9
Test-Retest Reliability of MBIS and HerQles (Two-Way Random Effect Model Absolute Agreement Definition)

Title	ICC	95% CI
MBIS	0.834	0.778–0.877
HerQles	0.758	0.681–0.819

Discussion

DRA is receiving increasing attention since it is influenced by social values [35], occupation stress [36], and relationship with partners [37]. However, recovery is hard because of the damaged A/B type muscle [38, 39]. At present, a suitable scale is important for clinical research [40] but it is still inconclusive by far. It is believed that a combined use of scales can meet full requirements of a clinical trial [41, 42]. Our research is of exploratory significance by accomplishing three research purposes. It's the first study to evaluate body-image, abdominal situation and QoL in Chinese version among postpartum DRA women as well as the first study to measure the reliability and validity of MBIS and HerQles. Comparing to other figure scales, body cognition can be predicted by the original BIS [43]. SF-36, as a general tool, is recognized as a golden standard among QoL scales, and as for HerQles, it owns specific characteristics such as moderate-length, specific-dimension and its easiness to be understood. Comparing to SF-36, HerQles provides a more aimed and popular understanding among postpartum women. The study is prepared for further DRA RCT trial [44].

DRA situation and its evaluation

150 postpartum women from 42 days to 10 years participated the study and all filled out the complete questionnaires. 29 were over 35 years old (excluding 35 years old), in which 26 still had DRA. Some studies [45, 46] found that age over 35-year-old was a risk factor for DRA, but some [2, 15, 47] also thought age was a protective factor. It's mainly for the different level of observed groups [48]. Our research suggests that age has some certain correlation but it is not significant, indicating that further study should pay attention to a unified definition and classification [48].

The trend of data shows that postpartum women almost all have at least mild dissatisfaction of QoL or functional limitation in body image and the abdominal wall, and DRA women have higher dissatisfaction or functional limitation, and the conclusions are consistent with previous studies, indicating that the adverse effects of DRA should be highly regarded by experts. It's interesting that both retest scores of MBIS and HerQles are lower than the first time, and the three reasons we analyze and summarize are as follows. Firstly, some uncomfortable symptoms will disappear themselves as time goes by. Secondly, some patients will search disease information after the initial test. Thirdly, although the participants receive no prescription or treatment, placebo effect could happen.

Construct validity and item-correlation

Both reliability and validity of MBIS show professional expectations [21, 22, 49]. KMO > 0.6 indicates that MBIS is suitable for principal component analysis (PCA), and the correlation between MBIS items indicates the relation between item No.8 and other items is weak. When the item was deleted, the relationship between the questionnaire items got closer, indicating that the construct validity of the questionnaire was improved. The validated questionnaire showed that more effective information can be extracted (more than 50%), and both of MBIS and HerQles got high extraction. Discrimination analysis suggested that both questionnaires were in a good degree of convergence. Items in new MBIS including eight questions reflected a self-perception of postpartum women on their own abdominal image and the level of satisfaction on social connections and self-confidence. At the same time, the questionnaire is suitable for women without DRA to learn the awareness.

Comparing to SF-36, HerQles has a significant correlation with SF-36 in the field of bodily pain, which is consistent with the original study, and has no significant correlation with other fields in SF-36. Therefore, HerQles is not suitable for evaluating the whole quality of life other than bodily pain, which is consistent with previous study [50]. DRA women have higher total scores on bodily pain, general health, vitality and mental health indicating that they are more tolerant of the above symptoms. We consider that it is possibly because of the reduced stress from companions, families and partners as they know that the participants are suffering from illness. Hence, we recommend a combined use of two scales in further studies for a full-dimension evaluation.

Reliability, test-retest reliability

The internal consistency of MBIS after deletion is 0.913, and HerQles 0.872, indicating items in each scale are quite reliable. If item No.6 in HerQles is deleted, the internal consistency will be adjusted to 0.874. However, since current ICC are good enough, and our sample size is not wide or large enough, we choose to keep all the items. We also find that the second test score is slightly different and with no statistical significance, suggesting that the scales can truly reflect women's objective psychology, rather than their impulsive choice. Moreover, the additional problem (M2) in MBIS is more sensitive compared to the actual IRD. We recommend that postpartum women should firstly self-assess the MBIS, once the total score is higher than 0, they had better go for measurement or treatment.

Limitations

Although with new discoveries, there are some certain limitations in the study. As for QoL, we excluded the assessments of posture, lung function, back muscles, and urinary incontinence that were related to abdomen [10]. Besides, due to practical reasons of collecting questionnaires, postpartum time for women varied quite a lot in the study. Future researches should pay attention to controlling the time-set within a certain range to reduce the possibility of bias. Though reliable [17], palpation is considered as a shortcoming for being not objective and detailed enough [16]. We support to explore more details of DRA by performing ultrasound [17]. The last, the sample should be expanded in future experiments to reduce sample bias.

Conclusion

In summary, women after childbirth should pay attention to DRA problems in time. Age over 35-year-old is a prevalent but not significant risk factor for DRA. Postpartum DRA women have less bodily pain. The Chinese version of MBIS and HerQles have good reliability and validity when assessing Chinese postpartum women.

Adverse events reporting and safety monitoring

No adverse events (AE), side effectiveness (SE) such as falls, joint sprains happened during the measurement.

Abbreviations

Diastasis Recti Abdominis (DRA); Linea Alba (LA); Quality Of Life (QoL); Modified Body Self-Image Scale (MBIS); Hernia-Related Quality-Of-Life Survey (HerQles); Inter Recti Distance (IRD); Kaiser-Meyer-Olkin (KMO); Average Variance Extraction (AVE); Combined Reliability (CR); Intra-Class Correlation Coefficient (ICC); Body Image Scale (BIS); Pelvic Organ Prolapse (POP); Physiological Function (PF); Role-Physical (RP); Bodily Pain (RP); General Health (GH); Vitality (VT); Social Function (SF); Role-Emotional (EF); Mental Health (MH); Exploratory Factor Analysis (EFA); Confirmatory Factor Analysis (CFA); principal component analysis (PCA); Adverse Events (AE); Side Effectiveness (SE)

Declarations

Ethics approval and consent to participate: The Ethics Committee of Hangzhou Hospital of Traditional Chinese Medicine reviewed this study protocol and gave its approval and consent (approval code 2020KY082, the reference named *Ethics statement* in related file). All procedures performed in studies involving human participants were by the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All authors agree with the accordance statement (the reference named *Accordance statement* in the related file)). Informed consent was obtained from all individual participants before their inclusion in the study (the reference named *DRA informed consent* in the related file).

Consent for publication: Not applicable.

Availability of data and materials: All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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Author contributions: Ying Zhu: data analyses, figure preparation, and manuscript preparation. Yan Liu: questionnaire evaluation. Liyuan Jiang: responsible for the design of randomization, project funding, and study initiation. Li Sun: responsible for manual data measurement. Lijuan Xiao: responsible for the design of randomization. Jiayu Chen, Ting Wang: responsible for data entry. Yinghua Ren, Hongjun Xu, Huihui Zhao, Xiaozhen Mao, Tiantian Shen: responsible for recruitment. All authors approved the final version of the manuscript.

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