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Research article

Association between depressive symptoms and dynamic balance among young adults in the community

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ABSTRACT

Background: Detecting and addressing depression symptoms at their outset can reduce the burden on individuals and society; however, it has a limitation in that such evaluations mainly rely on self-reports. Several studies have demonstrated a strong association between motor symptoms and early depression. We aimed to associate body balance measured by the Lower Quarter Y Balance Test (YBT-LQ) with depressive symptoms among young adults in the community, to confirm the current evidence that depression negatively influences body balance.
Research question: Is the YBT-LQ an objective tool for measuring and evaluating young adults' depression risks, as well as assessing whether depression negatively influences body balance?
Methods: Our participants comprised 36 young adults. We assessed their depressive symptoms using the Center for Epidemiological Studies Depression Scale (CES-D) via a Google survey, measured their body balance with the YBT-LQ, and analyzed data with Spearman's rank-order correlation coefficient test, using SPSS version 27.0.
Results: We found that the right leg's anterior, posteromedial, and posterolateral scores— $Z = -2.129$, $p = .033$; $Z = -2.181$, $p = .029$; and $Z = -2.250$, $p = .024$, respectively—and composite scores—$Z = 73.00$, $p = .027$ —were significantly lower in the group with risk for clinical depression compared to the normal group. The CES-D total score had a negative association with all YBT-LQ scores, except for the anterior score of the left leg. Among the CES-D sub-factors, somatic and retarded activity showed negative correlations with all the YBT-LQ scores.
Significance: Our findings revealed that depressive symptoms have a negative association with balance, and that the YBT-LQ can be a reliable tool for measuring motor symptoms of depression, specifically among young adults.

1. Introduction

Detecting and addressing depression earlier on can reduce the burden on individuals and society [1,2]. Several studies have also demonstrated a strong association between motor symptoms and early depression [3,4]. For example, Kvæl et al. reported that stroke patients' balance and physical ability decreased as the severity of their depression increased [3]. In particular, the "no depression" and

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"mild depression" groups had the most significant differences in the relationship between their balance and degree of depression [3].

Motor symptoms specific to depression include slowness of movement and gait, motor stagnation, or reduced balance [5]. Neurobiology and pathophysiology of depression support that gait and postural performance are directly and indirectly controlled by the dopaminergic pathways and neuronal circuits of the prefrontal cortex and basal ganglia [6]. The dopamine pathways' dysregulation synergistically impacts movement, affection, and cognition [7], which leads to multidimensional depressive symptoms.

In general, depressive symptoms are evaluated from their onset to the end of treatment [8] in clinical settings, based on self-report questionnaires. In particular, the primary approach at patient intake is to conduct a clinical interview, which may not address the full scope of the key depressive symptoms [9]. Evaluation of the motor symptoms of depression is also based on clinicians' subjective judgments and patients' recalled behaviors [8,10]. In current practice, for mood disorders [11,12], which are invasive and/or involve complicated processes, a few objective measures such as blood tests or brain imaging are available only in specific types of clinical settings. However, motor symptoms are still underrepresented in assessing depression.

In recent years, studies have attempted to use objective instruments that can evaluate the motor symptoms of depression [8]. For example, when the Berg Balance Scale [3] and force platform [13] were used, individuals with depression showed lower performance on balance. Studies among adults with newer technologies, such as photogrammetry and 3D motion capture, presented depressive symptoms related to head and shoulder inclination and forward head and shoulder protrusion [14]; reduced walking speeds, arm swings, and vertical head movements, but increased body sways and slumped postures [15]. However, these new technologies may not be feasible or applicable in current clinical settings because of the high costs of complex equipment and systems, complicated procedures, and ceiling effect of tools, and so on. Additionally, studies with these balance assessment tools had mostly focused on older adults or those with other medical conditions in addition to depression, and their approach for measuring balance had limitations in economic feasibility, objectivity, and accuracy. Therefore, a non-invasive and cost-effective clinical approach for evaluating motor functions is necessary for detecting early signs of depression.

The Y Balance Test Lower Quarter (YBT-LQ)—a portable and low-case tool—has been modified from the Star Excursion Balance Test (SEBT), for improving the test reliability and application of dynamic postural-control assessments in clinical settings [16,17]. It uses only the most reliable three-reach directions compared to SEBT's [16] eight-reach directions. Its reliability and testing speed have been improved using a standardized approach via a testing kit and revised protocol [18]. It was initially used to evaluate injury potential, assess deficiencies following injuries, and monitor the rehabilitation progress of athletes in sports settings [17]. Recently, its use has increased and expanded to diverse clinical populations for accurately measuring dynamic neuromuscular control [19]. For example, the body balance of patients with patellofemoral pain evaluated using the YBT-LQ was found to be related to functional levels of the cortical structure, measured by quantitative electroencephalography [20]. Alshehre et al. demonstrated that the YBT-LQ was useful as a dynamic balance assessment for patients with chronic low back pain [16].

We aimed to associate body balance measured by the YBT-LQ directly with depressive symptoms in young adults in the community, which can confirm the current evidence that depression negatively influences body balance. Our findings can also provide evidence of the clinical utility and application of the YBT-LQ in early detection for potential clinical depression.

2. Materials and methods

2.1. Study design and sample

Our study was descriptive and exploratory with a cross-sectional design. It was approved by the institutional review board at the University of Nevada, Las Vegas (UNLV) (IRB# UNLV-2021-198), and advertised via social media, including Twitter, Reddit.com, and the university's electronic news for local communities. Voluntary participants were recruited from the UNLV campus and surrounding community. All potential participants, who accessed the advertisement and were interested in the study, directly contacted the research team. Each potential participant was pre-screened using the specific eligibility criteria. Inclusion criteria were healthy adults in Las Vegas, both males and females, aged 18–39 years, and any ethnic background. Exclusion criteria were an active diagnosis of a medical or psychiatric disorder and taking prescribed medications. Those found eligible were invited to the Brain Injury Translational Research (BITR) laboratories at UNLV School of Nursing (PI: H.L.) for a 1-h-long data collection. Before collecting data, each participant reviewed the informed consent form with the research team for their full understanding of the study's purpose, procedures, risks, and benefits. After they agreed and signed the informed consent form, data collection began. A community-based sample of 36 adults from Las Vegas, Nevada, who voluntarily agreed, were recruited between April and July 2022. Based on Cohen's post hoc power analysis using G-power program [21], this sample size of 36, with alpha error = .05 and correlation pH1(alternative hypothesis that there is a non-zero correlation between the variables) = 0.498 (average of the coefficients of CES-D and YBT-LQ in this study), achieved a power of 0.889.

2.2. Measurements

2.2.1. Depressive symptoms

We used the Center for Epidemiological Studies Depression Scale (CES-D)—a self-report scale—for measuring symptoms associated with depression over the past week in the general population [22]. It consists of 20 items with a four-point Likert scale ranging from 0 (rarely or never) to 3 (all the time), and has four sub-factors: depressed affect, positive affect, somatic and retarded activity, and interpersonal functioning [22]. Its total score ranges from 0 to 60, with higher scores indicating increased severity of depressive symptoms. A cut-off score of 16 or greater reflects individuals at risk for clinical depression [22]. Its Cronbach's α was 0.84 in our study, which confirms its reliability.

2.2.2. Dynamic balance

We assessed body balance using the YBT-LQ based on a published protocol [23] [Fig. 1]. Each participant first watched a demonstration of the YBT-LQ's three-reach directions—anterior (ANT), posteromedial (PM), and posterolateral (PL)—followed by performing six consecutive practice trials for each of the three directions, so that they could familiarize themselves with the main assessment process. Their leg lengths were measured with cloth ruler from anterior superior iliac spine (ASIS) and until most distal portion of the medial malleolus in supine position.

Participants were then invited to the main body balance assessment, where they were instructed to reach their one foot as far as possible, push the reach indicator block, and then return their foot to the starting point, while simultaneously maintaining their balance on the stance leg. The assessment was completed in the order of right anterior (ANT-R), left anterior (ANT-L), right posteromedial (PM-R), left posteromedial (PM-L), right posterolateral (PL-R), and left posterolateral (PL-L). The reach distance was recorded to the nearest 0.5 cm as the point at which the reach indicator block was pushed closest to the central footplate. Each of the six reach distances was measured thrice and the longest reach distance score was used, following the published YBT-LQ protocol. For normalization, each of the six reach distance scores was first divided by the participant's leg length (LL)—the distance between the anterior superior iliac spine and the medial malleolus—and then multiplied by 100. For each leg's normalized composite score of three reach distances—ANT, PM, and PL—their individual scores were first summed, then divided by three times LL, and multiplied by 100. The longer the reach distance, the better the balance in that reach direction. A difference of more than 4 cm between the reach distances of the right and left legs indicates lower limb imbalance, based on Phillip et al. [6].

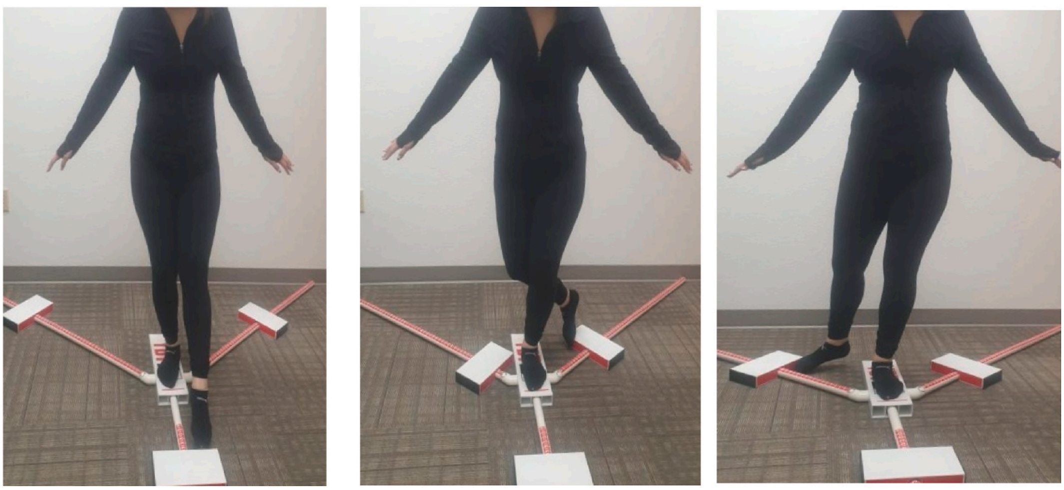
2.3. Data analysis

We analyzed collected data using the IBM SPSS version 27 (Armonk, NY, USA); assessed the frequency, percentage, mean, and standard deviation of participants' general characteristics and variables using descriptive statistics; determined the differences between groups using the nonparametric Mann-Whitney test; and assessed the correlations among variables using the nonparametric Spearman's rank-order correlation coefficient test. *P*-values less than 0.05 were considered significant.

3. Results

3.1. Participants' demographic and clinical characteristics

The demographic and clinical characteristics of the 36 participants are listed in Table 1. Their mean age was 26.33 (standard deviation = 6.11) years, over two-thirds (69.4 %) were between 18 and 29 years, and more than half (55.6 %) were Asian Americans. According to the CES-D's cut-off criterion of 16 points [22], the participants were divided into the 1) *Risk for clinical depression group,* with 11 (30.6 %) participants who scored 16 or higher; and 2) *Normal group,* with 25 (69.4 %) participants who scored lower than 16. Both groups showed statistically significant differences in gender ($\chi^2 = 4.134$, $p = .042$), level of education ($\chi^2 = 7.375$, $p = .007$), and total depression scores (z = −4.731, $p = .000$).



Anterior Posteromedial Posterolateral

Fig. 1. Lower Quarter Y balance test composed of three directions (anterior, posteromedial, and posterolateral).

Table 1
Demographic and clinical characteristics of participants (N = 36).

Variables	Categories	All (n = 36)	Risk for clinical depression (*n* = 11)	Normal (*n* = 25)	*t/z*	χ^2	*P*-value
		n (%) or Median (IQR)	n (%) or Median (IQR) [Mean rank]				
Age (years) +		25.00 (9.00)	23.00 (7.00) [13.95]	26.00 (10.00) [20.50]	−1.721		.085
Sex	Men	19 (52.8)	3 (27.3)	16 (64.0)		4.134	.042
	Women	17 (47.2)	8 (72.7)	9 (36.0)			
Race†	Hispanic	5 (13.9)	3 (27.3)	2 (8.0)		5.856	.178
	European American	8 (22.2)	2 (18.2)	6 (24.0)			
	Asian American	20 (55.6)	4 (36.4)	16 (64.0)			
	African American	1 (2.8)	1 (9.1)	0 (0.0)			
	Others	2 (5.6)	1 (9.1)	1 (4.0)			
Marital status	Married	9 (25.0)	2 (18.2)	7 (28.0)		.393	.531
	Single	27 (75.0)	9 (81.8)	18 (72.0)			
Education	≤ High school	9 (25.0?)	6 (54.5)	3 (12.0)		7.375	.007
	≥ College	27 (75.0)	5 (45.5)	22 (88.0)			
Employment Status†	Student	15 (41.7)	4 (36.4)	11 (44.0)		.539	.891
	Unemployed	5 (13.9)	2 (18.2)	3 (12.0)			
	Employed	16 (44.4)	5 (45.4)	11 (44.0)			
Income†	< $50,000	18 (50.0)	8 (80.0)	10 (50.0)		2.241	.417
	$50,000 > x< $100,000	7 (19.4)	1 (10.0)	6 (30.0)			
	> $100 k	5 (13.9)	1 (10.0)	4 (20.0)			
BMI†					−1.733		.093
	Normal	15 (41.7)	3 (27.3)	12 (50.0)		2.073	.344
	overweight	14 (38.9)	5 (45.5)	9 (37.5)			
	Obese	6 (16.7)	3 (27.3)	3 (12.5)			
CES-D+		12.17 ± 7.37	20.82 ± 6.03 [31.00]	7.00 (8.00) [13.00]	−4.731		.000

Note. Risk for clinical depression: CES-D ≥ 16; IQR= Interquartile; BMI = Body mass index; CES-D = Center for epidemiological studies depression scale; +Mann Whitney test; †Fisher's exact test.

Table 2
Comparison of dynamic balance between the Risk for clinical depression and normal groups (N=36).

YBT scores	Overall	Risk for clinical depression (*n* = 11)	Normal (*n* = 25)	*Z*	*p*
	Median (IQR)	[Mean Rank] Median (IQR)			
ANT (R) (% LL)	68.71 (13.73)	[12.86] 60.42 (12.55)	[20.98] 70.79 (10.92)	−2.129	.033*
PM (R) (% LL)	94.17 (19.49)	[12.73] 86.90 (15.64)	[21.04] 101.14 (24.55)	−2.181	.029*
PL (R) (% LL)	99.48 (12.99)	[12.55] 98.78 ± 9.07)	[21.12] 103.16 (15.28)	−2.250	.024*
ANT (L) (% LL)	65.16 (9.46)	[14.95] 62.50 (12.25)	[20.06] 67.05 (11.92)	−1.340	.180
PM (L) (% LL)	99.43 (18.25)	[13.36] 92.42 (12.09)	[20.76] 104.55 (23.10)	−1.940	.052
PL (L) (% LL)	102.91 (19.30)	[13.86] 95.46 (15.60)	[20.54] 105.56 (21.46)	−1.752	.080
Difference_ANT (cm)	3.00 (4.00)	[14.13] 2.00 (2.00)	[20.42] 3.00 (3.00)	−1.678	.093
Difference_PM (cm)	4.00 (5.00)	[18.00] 4.00 (4.00)	[18.72] 4.00 (5.50)	−.191	.849
Difference_PL (cm)	3.00 (5.00)	[21.50] 5.00 (7.00)	[17.18] 2.00 (4.00)	−1.143	.253
Composite score (R) (% LL)	86.78 (16.52)	[12.64] 82.94 (10.82)	[21.08] 92.05 (16.09)	73.00	.027*
Composite score (L) (% LL)	88.02 (16.74)	[13.55] 84.34 (10.82)	[20.68] 90.91 (17.59)	83.00	.061

Note. YBT-LQ = Y balance test lower quarter; Risk for clinical depression: CES-D ≥ 16; IQR= Interquartile; % LL = normalized to leg length expressed as a percentage; ANT = anterior; PM = posteromedial; PL = posterolateral; R = Right leg; L = Left leg; Difference = between right and left leg; Composite score is the sum of the three reach distances (anterior, posteromedial, posterolateral), divided by three times leg length, and multiplied by 100, using the following formula: [(anterior)+(posteromedial)+(posterolateral)/3 × Leg length] × 100 %; *$p < .05$.

3.2. Comparison of dynamic balance between the Risk for clinical depression and normal groups

A comparison of both groups' three YBT-LQ reach distance scores (ANT, PM, and PL) is shown in Table 2. All the six reach distance scores (three directions x both legs) were normalized according to % LL. The difference between the right and left legs in each reach direction (cm) was also compared between the groups. The right leg's ANT, PM, PL, and composite scores were significantly lower in the risk group compared to the normal group. The result indicates that the risk for clinical depression group had a reduced balance in the right leg side measured by the YBT-LQ compared to the normal group. The left leg scores were not significantly different between the two groups.

3.3. Asymmetry of reach distances between the Risk for clinical depression and normal groups

The asymmetry of reach distances between the groups is shown in Table 3. The difference in reach between the right and left legs of any direction was not significant between the groups.

3.4. Correlation among depressive symptoms, dynamic balance, and other variables

Table 4 shows the correlation among variables. The total CES-D score, which was used as a continuous variable, had a negative association with all the YBT-LQ scores, except with that of the ANT-L leg. Among the CES-D's sub-factors, somatic and retarded activity showed negative correlations with all the YBT-LQ scores, whereas age was positively associated with some YBT scores, and negatively related to CES-D.

4. Discussion

Our results revealed negative associations of depressive symptoms with balance. Specifically, the higher the depression score on the CES-D, the lower the body balance score. In a comparison between the normal group and risk for clinical depression group, the latter showed a significantly lower mean rank of balance scores. Among the CES-D's four sub-factors, as somatic and retarded activity had robust negative correlations with the YBT-LQ's composite scores of both legs, it can contribute to the YBT-LQ's use in clinical applications, specifically in measuring motor symptoms of depression. Our findings support the underlying neurobiological and pathological mechanisms of depression, where affection and motor behavior are closely connected and synergistically impact each other [7]. Furthermore, targeting to increase body balance could be an efficient intervention for depression [27,28].

Moreover, our findings indicated that mainly only the right leg was significantly different between the two groups. In a study by Lina Huang (2021), an fMRI comparison of subjects with subthreshold depression after physical exercise intervention reported that the difference before and after exercise was mainly only on the right side [28]. There is a need to explore the exact mechanism through future convergence research.

Our study measured body balance using the YBT-LQ, one of the few clinical tools with good reliability and validity [26]. Based on our findings on the correlation between body balance and depressive symptoms, the YBT-LQ can be used as an objective tool for depression evaluation. While very few studies with YBT-LQ have been previously conducted with young adults in the community, our study's participants showed a significantly lower balance level than athletes [23]. Comparisons with adolescents were either similar or had somewhat lower YBT-LQ balance scores [29]. In particular, the risk for clinical depression group's YBT-LQ balance scores were almost equal to the scores of those with low back pain [16].

We explored the association between depressive symptoms and body balance in young adults recruited from the community. Of the 36 participants who were not diagnosed with any medical or psychiatric disorders, 11 (30.6 %) were at risk for clinical depression based on the CES-D (a self-report measure for depression) with 9 of them (81.8 %) in their 20s. Although our study's age range was narrow (18–39 years), the correlation analysis between depression and age showed that depressive symptoms were greater and more severe in younger age groups, based on the significance difference in age between the two groups. Additionally, when comparing the group homogeneity of the participants in this study, there were significant differences in gender and level of education. Women and those with low education level were more likely to be at risk for depression. This has limitations in generalizing because the sample in this study is small, but future research should be conducted to increase homogeneity between groups.

In the United States, depression is most prevalent among adults aged 18–25 years, compared to other adult age groups [24].

Table 3
Asymmetry of reach distances between the Risk for clinical depression and normal groups (N = 36).

Variables	Categories	Risk for clinical depression (n = 11)	Normal (n = 25)	χ^2	p
		n (%)			
Difference_ANT	<4 cm	9 (81.8)	14 (56.0)	2.207	.137
	≥4	2 (18.2)	11 (44.0)		
Difference_PM	<4 cm	5 (45.5)	12 (48.0)	.020	.888
	≥4	6 (54.5)	13 (52.0)		
Difference_PL	<4 cm	4 (36.4)	16 (64.0)	2.363	.124
	≥4	7 (63.6)	9 (36.0)		

Note. ANT = anterior; PM = posteromedial; PL = posterolateral

Table 4
Spearman's rank-order correlation coefficients among depression, cognitive function, dynamic balance, and others.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Age[1]	1.000													
CES-D[2] (Total score)[2]	−.386*	1.000												
Depressed affect[3]	−.237	.806**	1.000											
Positive affect[4]	−.440**	.657**	.439**	1.000										
Somatic and retarded activity[5]	−.334*	.865**	.532**	.441*	1.000									
Interpersonal functioning[6]	−.430**	.710**	.542**	.388*	.564**	1.000								
ANT (R) (% LL)[7]	.363*	−.507**	−.384*	−.367*	−.436**	−.303	1.000							
PM (R) (% LL)[8]	.293	−.520**	−.474**	−.298	−.413*	−.325	.789**	1.000						
PL (R) (% LL)[9]	.345*	−.572**	−.457**	−.335*	−.499**	−.329*	.724**	.869**	1.000					
ANT (L) (% LL)[10]	.363*	−.327	−.217	−.239	−.343*	−.111	.932**	.724**	.722**	1.000				
PM (L) (% LL)[11]	.379*	−.501**	−.435**	−.412*	−.341*	−.290	.809**	.905**	.867**	.796**	1.000			
PL (L) (% LL)[12]	.299	−.436**	−.361*	−.221	−.401*	−.190	.744**	.849**	.894**	.775**	.800**	1.000		
Composite score (R) (% LL)[13]	.306	−.541**	−.453**	−.310	−.461**	−.299	.869**	.969**	.923**	.825**	.915**	.891**	1.000	
Composite score (L) (% LL)[14]	.345*	−.461**	−.368*	−.335*	−.389*	−.191	.860**	911**	.895**	.888**	.934**	.936**	.953**	1.000

Note. CES-D = Center for epidemiological studies depression scale; ANT = anterior; PM = posteromedial; PL = posterolateral; R = Right leg; L = Left leg; Difference = between right and left legs; Composite score is the average of the three reach distances (anterior, posteromedial, and posterolateral), divided by three times Leg length and multiplied by 100, using the following formula: [(anterior)+(posteromedial)+(posterolateral)/3 × Leg length] × 100 %; $^{*}p < .05$, $^{**}p < .01$.

Especially since the COVID-19 pandemic, young adults have reported significantly increased mental health problems [25]. Our study's results also confirm young adults being at a higher risk of depression and suggest that more attention should be paid to their mental health by health professionals. Additionally, the study showed a positive relationship between age and balance. Contrary to the general expectation of younger adults having better balance [23], our study showed that older age groups had better balance. While this statement is limited given that our small sample was between 18 and 39 years old, there were no significant aging effects that otherwise could have affected their body balance.

The exact mechanisms or systems responsible for balance impairments in individuals with depression are complex and multifaceted. For example, depression is associated with imbalances in neurotransmitters such as serotonin, norepinephrine, and dopamine [6]. Some studies also suggest that depression might impact brain regions involved in balance control, such as the cerebellum and areas of the brainstem [4,6]. Additionally, depression leads to psychomotor impairments, which is characterized by slowed movement and reduced motor activity [5]. Depression can also affect cognitive processes such as attention, concentration, and executive functioning [10]. Impairments in these areas could impact the ability to perceive and respond to sensory cues related to balance. Reduced physical activity levels also result in depression [13,28]. Finally, some medications used to treat depression might influence balance and coordination due to their side effects [10].

Our study found no significant difference between the risk for clinical depression and normal groups on the asymmetry of reach distances, based on the cut-off (≥4 cm) [6] difference in reach distance between the right and left legs. Previous studies on athletes reported that the risks for injuries during exercise were higher if there was asymmetry of reach distances between the legs [30]. Cut-off scores varied among studies, and the reach direction as a risk factor for injuries was not consistent [29,31]. As such, these incongruent findings may have been due to population diversity; hence, more research is required to find a population-specific cut-off point.

4.1. Limitations

Our study has some limitations. First, the small size of a convenient sample with the cross-sectional design and the differences in size between groups do not allow generalization of the results of this study. Therefore, we plan to repeat the study in the future with larger samples and with numerical concordance and homogeneity between groups. The issue of group size imbalance should be considered when evaluating the generalizability of our study results. With a relatively small sample size of 11 subjects in the depression group compared to 25 in the control group, caution is warranted when attempting to extrapolate our findings to broader populations. Second, despite the YBT-LQ's well-proven reliability and validity, direct comparison of its scores is difficult given the lack of studies on young adults. Additionally, the cut-off standard for asymmetry of body balance has not been set. Future research with different cut-offs should be conducted across various populations. Finally, we did not use other standard physical activity measure, such as IPAQ-SF; therefore, we cannot rule out hidden influence by inactivity to body balance, not necessarily depressive symptoms. Factors affecting depression are multifaceted and the consequences of depression are diverse; thus, multidisciplinary and extensive research is needed to fully understand the mechanisms and interactions between depression and physical balance.

5. Conclusions

Our study was the first to investigate the correlation between (self-reported) depressive symptoms and balance performance among young adults in the community using the YBT-LQ. Depression is a complex and multi-dimensional disorder. Our study's findings have demonstrated the possibility of utilizing the YBT-LQ as a motor symptom for depression risk evaluation. Furthermore, body balance measures may provide more objective aspects in interpreting effects of difference types of depression interventions, for instance, physical activity and exercise intervention that can improve depressive symptoms.

Additional information

No additional information is available for this paper.

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Ethics approval

This study was approved by the UNLV institutional review board (IRB# UNLV-2021-198).

Data availability statement

The data associated with this study have not been deposited into a publicly available repository. However, data will be made available on request.

CRediT authorship contribution statement

Jinyoung Park: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Cynthia Lee:** Writing – review & editing, Data curation. **Ye Eun Nam:** Writing – review & editing, Data curation. **Hyunhwa Lee:** Writing – review & editing, Writing – original draft, Supervision, Software, Resources, Project administration, Methodology, Investigation, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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